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Literature Survey on Vaporizing and Endothermic Fuels for Advanced Engine Application

Special Report
for
Aeronautical Systems Division
Wright-Patterson AirForce Base, Ohio

Contract No. AF 33(657)-11096
Project No. 54-84730

November, 1965

SHELL DEVELOPMENT COMPANY
A DIVISION OF SHELL OIL COMPANY
Emeryville, California

S-13979

LITERATURE SURVEY ON VAPORIZING AND ENDOTHERMIC FUELS FOR ADVANCED ENGINE APPLICATION

SPECIAL REPORT

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Written and Reviewed: A. C. Nixon
I. S. Bjorklund
R. D. Hawthorn
H. T. Henderson
A. W. Ritchie
R. B. Olney

Approved: J. C. Dygert

SHELL DEVELOPMENT COMPANY
A DIVISION OF SHELL OIL COMPANY
EMERYVILLE, CALIFORNIA

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FOREWORD

This special report was prepared by Shell Development Company under U. S. Air Force Contract No. AF 33(657)-11096. The contract was initiated under Project No. 3048, Task 304801. The work was administered under the direction of the Air Force Aero Propulsion Laboratory, Research and Technology Division, Messrs. J. R. Fultz and C. J. Johnson, Project Engineers.

The personnel of the Library and Technical Files of the Emeryville Laboratories were very helpful in the preparation of this report, and their contributions are gratefully acknowledged.

This report is being distributed without prior Air Force review.

ABSTRACT

A review of the literature has been made as part of an extensive study of vaporizing and endothermic fuels for advanced engine application. Abstracts are presented for 1086 references covering cooling requirements of supersonic aircraft, properties of vaporizing and endothermic fuels, thermal and catalytic reactions of hydrocarbon fuels, high temperature fuel stability, fuel contaminants and additives, fuel combustion characteristics, physical-chemical properties, heat transfer and flow behavior, and advanced engine design.

The references are arranged by author. Subject and source indexes are provided.

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LITERATURE SURVEY ON VAPORIZING AND ENDOTHERMIC FUELS FOR ADVANCED ENGINE APPLICATION

Introduction

A thorough review of the pertinent literature has been made as part of an extensive study of vaporizing and endothermic fuels for advanced engine application. Such a fuel must be capable of acting as a heat sink for the aerodynamic heat generated by aircraft operating in the Mach 3 to 6+ range. It is intended that the fuel absorb the heat by virtue of its sensible and latent heat and its endothermic reaction capability, either thermal or catalyzed. This requires that the fuel have excellent thermal stability at temperatures up to its reaction temperature and that it then react rapidly and cleanly to give products which can be burned effectively in the engine. Realizable heat sink capacities, reaction rates, composition of the reaction products, and heat transfer parameters of the fuel and products are all important in the selection of suitable fuels.

The literature survey covers the subject areas central to the utilization of vaporizing and endothermic fuels, and also includes some references in peripheral areas such as the commercial SST program, design of test apparatus, and advanced engine design. Because endothermic fuels may be applied to engines using supersonic combustion, there are also some references on mixing in supersonic streams, ignition delay, and related subjects.

The references cited include principally reports of government-sponsored research, most of which were obtained from the Defense Documentation Center; technical translations obtained through the Foreign Technology Division and DDC; and papers published in the open literature. The latter were discovered through a search of Chemical Abstracts, vol. 50 (1956) through vol. 59 (1963); Engineering Index, 1945 through June 1964; Applied Mechanics Review, vol. 1 (1948) through vol. 17 (April 1964); and International Aerospace Abstracts, vol. 3 (1963).

The classified literature, as well as the unclassified, was searched to obtain pertinent references. For those classified reports which are included in this survey, an unclassified abstract is presented if one was available or could be prepared. Otherwise no abstract is given.

The references have been arranged alphabetically according to the last name of the principal author, and serial numbers have been assigned for simplicity in indexing. Indexes are provided so that references may be located by subject matter or by names of secondary authors. Additional indexes list reports of government "in-house" studies, and reports of government-sponsored research arranged by contracting agency and contract number, and by contractor.

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INDEX TO GOVERNMENT "IN-HOUSE" RESEARCH

Abas-zade, A. K. and Akhmedov, A. G., HEAT CAPACITIES OF SOME PARAFFINIC HYDROCARBONS IN THE LIQUID STATE. Akademiya Nauk Azerbaidzhanskoi SSR. Doklady, 18, no. 4, 15-18, (1962), (CA 57, 15410a, 1962). 0001

Heat capacities of the paraffin hydrocarbons C_7H_{16}, C_8H_{18}, C_9H_{20}, $C_{10}H_{22}$, $C_{12}H_{26}$, and $C_{15}H_{32}$ were determined at 50, 70, and 90°. The accuracy of the method was checked with benzene, toluene, and distilled H_2O. The values obtained at a single temperature varied within 4%. An equation is given for the molar heat capacity of paraffin hydrocarbons: $C_{n,t} = C_{5,t} + (n - 5)\Delta C$, where $\Delta C = 8$ cal./mole/°C. and $C_{n,t}$ and $C_{5,t}$ are the molar heat capacities of a liquid paraffin hydrocarbon with n C atoms and n-pentane, respectively, at the given temperature. Experimental and calculated values show satisfactory agreement.

Adamenkova, M. D., and Poltorak, O. M., DEPENDENCE OF THE CATALYTIC PROPERTIES OF PLATINISED SILICA GELS ON THE CONDITIONS OF THEIR PREPARATION. Russian Journal of Physical Chemistry, 37, no. 6, 741-2 (1963). 0002

The catalyst samples, prepared by adsorbing platinum ammoniate on silica gel resulting from the hydrolysis of silicon tetrachloride, were dried, reduced, and aged under different conditions. They were tested with respect to their activity in the decomposition of hydrogen peroxide. The results showed that the length of adsorption time, the temperature of the drying and reducing operations, and aging time all have a significant effect on catalytic activity. Some samples were three times as active as others. The curve of specific activity vs. platinum content of the catalyst had two horizontal steps, at 0.5-3.5% and 3.5-7% platinum, respectively, rather than a continuous slope.

Adams, H. W. (Douglas Aircraft), TEMPERATURE PROBLEMS OF EQUIPMENT IN HIGH SPEED AIRCRAFT. American Society of Mechanical Engineers. Transactions, 77, 735-40 (1955). 0003

This paper takes an over-all look at the heat problem facing the equipment in the high-speed aircraft of the future. It discusses briefly the basic problem - the high temperatures that result when a body moves rapidly through the air; the kind of airplant and equipment that might be faced with the problem; methods of combating the problem; and the alternatives that are available to the airplane designer. Up to speeds of 2 or 3 times the speeds that we are now flying, aircraft need not be limited by the high temperatures encountered. The use of insulated aluminum structures at modest supersonic speeds is considered. Values of expected heat input for various types of insulated surfaces are given. Brief mention is made of possible use of fuel as coolant.

Adamson, T. C., Jr., IGNITION AND COMBUSTION IN A LAMINAR MIXING ZONE. California Institute of Technology, Jet Propulsion Laboratory, Report No. 20-79, U. S. Army, Ordnance Department, Contract DA 04-495-ORD-18, ORDCIT Proj., June 1954. 118 pp. (AD 44824). 0004

This analysis considers the ignition and combustion in the laminar mixing zone between two parallel moving gas streams. One stream consists of a cool combustible mixture, the second is hot combustion products. The two streams come into contact at a given point and a laminar mixing process follows in which the velocity distribution is modified by viscosity, and the temperature and composition distributions by conduction, diffusion and chemical reaction. The decomposition of the combustible stream is assumed to follow first-order reaction kinetics with temperature dependence according to the Arrhenius law. For a given initial velocity, composition, and temperature distribution, the questions to be answered are: (1) Does the combustible material ignite and (2) How far downstream of the initial contact point does the flame appear and what is the detailed process of development?

Affens, W. A., Johnson, J. E. and Carhart, H. W. (U. S. Naval Research Laboratory), EFFECT OF CHEMICAL STRUCTURE ON SPONTANEOUS IGNITION OF HYDROCARBONS. Journal of Chemical and Engineering Data, 6, 613-19 (1961). 0005

The general purpose of this investigation was to study the influence of chemical structure on the spontaneous ignition processes. Specifically, the influence of chainlength, chain branching, unsaturation, and of cyclic and aromatic structures on the preignition processes was examined by measuring internal gas temperature and oxygen consumption. In addition to minimum ignition temperature in air for cool- or hot-flame ignition, minimum reaction temperature, preignition temperature range, temperature rise, and oxygen consumption at ignition were measured. A correlation between these values and ease of oxidation and ignition was noted.

Agronomov, A. E. and Mardashev, Yu. S., STRUCTURE AND ACTIVITY OF NICKEL CATALYSTS ON CARRIERS. II. Russian Journal of Physical Chemistry, 35, no. 9, 1006-8 (1961). 0006

The relative activities of 20 supported nickel catalysts for the dehydrogenation of cyclohexane were examined. The best carriers appeared to be kieselguhr and industrial Al_2O_3. The method of placing nickel on the carrier did not appear to influence catalyst activity.

Agronomov, A.E. and Mishchenko, A. P., DEPENDENCE OF THE CATALYTIC ACTIVITY ON THE POROSITY OF THE Co-SiO$_2$ CATALYST. IV. Moskovskii Universitet. Vertnik. Seriya II: Khimiya, 15, no. 1, 35-9 (1960). (CA, 54, 20446f). 0007

In the dehydrogenation of cyclohexane over cobalt-silica catalysts of various pore radii, the activity was highest in the catalyst with a pore radius of 38 A. In addition to the main reaction of benzene formation, cleavage of the cyclohexane ring and biphenyl formation were observed. The activation energy in the dehydrogenation reaction varied from 5700 to 8500 cal./mole and was highest for catalysts with smallest pore radius.

Akiyoshi, S., Matsuda, T., Yamashita, G. and Fujii, M., AROMATIZATION OF 2-ETHYLHEXANE AND 3-METHYLHEPTANE. Kogyo Kagaku Zasshi, 59, 446-9 (1956). (CA, 52, 3704e). 0008

2-Ethylhexane and 3-methylheptane were reacted over chromia on alumina and molybdena on alumina catalysts at 450°-575°C. Maximum conversion to aromatics was observed at about 500°C. The rate of conversion to aromatics was greater with the molybdena catalyst below 500° and with the chromia catalyst above 500°. In general 2-ethylhexane had a greater tendency to aromatize than did 3-methylheptane.

Albright, R. E., Heath, D. P., and Thena, R. H. (Socony-Vacuum Laboratories), FLAME VELOCITIES OF LIQUID HYDROCARBONS. Industrial and Engineering Chemistry, 44, no. 10, 2490-6 (1952). 0009

The paper describes results of an experimental study of fuel flame propagation rate, minimum ignition energy, flame temperature characteristics and quenching effect of relatively cold surfaces on laminar gas flames for normally liquid hydrocarbons.

0010 Allbright, C. S., Whisman, M. L., Schwartz, F. G., USE OF TRITIUM TRACER TECHNIQUES IN STUDIES OF GASOLINE STORAGE STABILITY. U.S. Bureau of Mines, RI 6373, 1964.

Radioactive tracer techniques were used to investigate compounds that cause gum formation in gasoline during storage. A labelled organic compound was blended into an unstable gasoline and stored at 100°F for 16 weeks. The amount of test compound converted to gum was determined by liquid scintillation counting on the recovered gum. 70 compounds of various types were studied. Order of decreasing reactivity: sulfur compounds, nitrogen compounds, polycyclic hydrocarbons, olefins, alkylbenzenes, and saturates. Order of decreasing percentage of each compound in the gum: monoolefins, alkylbenzenes, sulfur compounds, polycyclic hydrocarbons, nitrogen compounds, diolefins.

0011 Allen, H., Jr. and Fletcher, E. A., COMBUSTION OF VARIOUS HIGHLY REACTIVE FUELS IN A 3.84- BY 10-INCH MACH 2 WIND TUNNEL. U. S. National Aeronautics and Space Administration, Memo 1-15-59E, April 1959. 28 pp.

Attempts were made to burn a number of highly reactive fuels below the top wall of a Mach 2 wind tunnel. Of the fuels investigated the following were successfully burned and gave associated pressure rises: aluminum borohydride, pentaborane, mixtures containing up to 41 percent JP-4 fuel in aluminum borohydride, and JP-4 fuel piloted by an aluminum borohydride flame. When water was injected along with trimethyl aluminum and diethyl aluminum hydride, the combustion of these two fuels could also be accomplished. Studies probing the combustion region with water injections indicated that the flow downstream of the flame front is subsonic and recirculating.

0012 Allen, H., Jr. and Fletcher, E. A., A STUDY OF THE COMBUSTION OF ALUMINUM BOROHYDRIDE IN A SMALL SUPERSONIC WIND TUNNEL. U.S. National Advisory Committed for Aeronautics, TN D-296, July 1960.

The combustion of aluminum borohydride in a Mach 2 airstream was studied by analyzing gas samples taken from the stream. The combustion efficiency was high. The increase of the lateral surface area of the combustion region was found to be dependent upon the degree of mixing of fuel and its combustion products with air. In the flame zone where there was insufficient oxygen for complete combustion, the metal components of the fuel appeared to burn preferentially to the hydrogen component.

Allred, R.C., FIRST QUARTERLY REPORT. Continental Oil Company Report, U.S. Army Contract DA-18-064-AMC-47-A, October 1, 1962 to January 1, 1963. (AD 335674), REPORT CLASSIFIED SECRET. 0013

Sixty microbial floras are being screened for their ability to utilize hydrocarbon fuels. An attempt is being made to find the optimum fuel/nutrient media for maximum hydrocarbon utilization. No conclusions can be drawn from the work thus far.

Altenburg, K., ZUR WARMELEITFAHIGKEIT ISOMERER ALKANE. Zeitschrift für Physikalische Chemie, 223, no. 5/6, 429-32 (1963). 0014

Available experimental values for five C_6, two C_8, and two C_9 normal and branched alkanes are compared with values calculated by a published equation, and the ratio of heat conductivities of the normal and branched isomers is shown to depend linearly on the ratio of the mean squares of their molecular radii.

Amano, A., and Uchiyama, M., (Tohoku University), MECHANISM OF THE PYROLYSIS OF PROPYLENE: THE FORMATION OF ALLENE. Journal of Physical Chemistry, 68, no. 5, 1133-7 (1964). 0015

On the basis of an evaluation of reaction rates of a number of related elementary reactions, a free-radical chain mechanism is proposed for the pyrolysis of propylene under ordinary cracking conditions. In the low-temperature zone and at the higher propylene pressures, the mechanism predicts the production of ~74% of the higher boiling fraction and a 1.5 order rate law; in the high temperature zone and at the lower pressures, unimolecular decomposition of the allyl radical to allene becomes important and a first order rate law is obeyed. When the existing data are critically analyzed for both product distributions and reaction rates, the results are consistent with the proposed mechanism; overestimation of the stabilization energy of the allyl radical may explain the discrepancies which do exist. The analysis also indicates that the Szwarc value of 78 kcal/mole for the bond dissociation energy between the allyl radical and hydrogen may be considerably in error.

American Petroleum Institute. Division of Refining, BIBLIOGRAPHY OF VAPOR PRESSURE DATA FOR HYDROCARBONS, BIBLIOGRAPHY NO. 2. New York, 1964. 66 pp. 0016

In connection with the evaluation of methods for predicting vapor pressure data for pure hydrocarbons, an extensive literature search was made for sources of experimental values. The resulting bibliography is believed to be the most complete available for pure hydrocarbons, covering the published literature to November 1, 1963. Presentation is in two parts: a series of seven tables listing the various hydrocarbons and giving the references in chronological order along with the range of temperatures covered, and an alphabetical author list of the references.

American Society for Testing and Materials. Committee D-2, PHYSICAL CONSTANTS OF HYDROCARBONS C_1 TO C_{10}. ASTM Special Technical Publication No. 109A, 1963. (Abstract in: Materials Research and Standards, 3, no. 11, 935-6 (1963).) 0017

This compilation is a revision and amplification of Am. Soc. Testing Mater. Spec. Tech. Publ. No. 109 (1950), on the physical constants of hydrocarbons boiling below 350°F. The new constants, given in both English and metric units, were based on data from API Res. Projects 44 and 45 and the work of C. E. Miller (Carnegie Inst. Technol.) and are tabulated separately for paraffins; cycloparaffins; mono- and diolefins; cycloolefins; acetylenes; alkylbenzenes, naphthalene, indans, and tetrahydronaphthalene; styrenes and indenes; and C_1-C_5 gaseous hydrocarbons. A key to footnotes (superscripts), the equations used for the calculated values, a key to the references, and a list of references are appended.

Anagnostou, E., Brokaw, R. S. and Butler, J. N., EFFECT OF CONCENTRATION ON IGNITION DELAYS FOR VARIOUS FUEL-OXYGEN-NITROGEN MIXTURES AT ELEVATED TEMPERATURES. U. S. National Advisory Committee for Aeronautics, TN 3887, December 1956. 34 pp. 0018

Ignition delays for mixtures of ethane, n-butane, isobutane, hydrogen, or propane with oxygen and nitrogen were measured at various temperatures and fuel and oxygen concentrations using a flow system. Ignition delays for all fuels were inversely proportional to fuel concentration to some power between 0.6 and 1.7. They also decreased slightly with increasing oxygen concentration and decreased with increasing temperature. Two experimental procedures were used, and these gave different absolute values for the delay but the trends observed were the same by either method.

Anderson, R. A. and Brooks, W. A., Jr. (NASA, Langley Research Center), **EFFECTIVENESS OF RADIATION AS A STRUCTURAL COOLING TECHNIQUE FOR HYPERSONIC VEHICLES.** Journal of the Aerospace Sciences, 27, 41-8 (1960). 0019

The effectiveness of radiation as a structural cooling technique is examined for vehicles which are subject to large variations in heating over their surface. An analysis is made of the more significant effects of internal heat transfer within idealized structures, both with and without external insulation on areas of greatest aerodynamic heating intensity. Selective use of insulation leads to structural temperature reductions substantially greater than those obtained without insulation. The results are presented in nondimensional form, and numerical examples illustrate applications to hypersonic flight vehicles.

Appell, H. R. and Berger, C. V. (Universal Oil Products), **DECOMPOSITION OF HYDROCARBONS, PYROLYTIC AND CATALYTIC.** Industrial and Engineering Chemistry, 50, no. 9, part 2, 1330-4 (1958). 0020

This is a review article covering catalytic and thermal cracking and catalytic reforming of hydrocarbons. Fifty references for the years 1957-1958 are given.

Appleby, W. G., Archibald, R. C., Castner, R. C., and Gibson, J. W. (Shell Development), **HYDROCARBON FUELS FOR SUPERSONIC AIRCRAFT.** American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, C31-7 (September 1960). 0021

Supersonic jet aircraft require fuels of high stability and high reproducibility of properties for use at relatively high temperatures. Polycyclic naphthenes are promising fuels, of high thermal stability and high net heat of combustion per gallon, which can be manufactured from pure hydrocarbons and from plentiful refinery streams with high reproducibility of properties. Paraffin fuels of low luminosity and high net heat of combustion per pound may be obtained from certain crude petroleum sources and via separation and synthesis methods. When these types of fuels are obtained from conventional refinery streams they will cost less than pure hydrocarbons and more than current turbine fuels.

Appleby, W. G., Gibson, J. W., and Good, G. M., (Shell Development), COKE FORMATION IN CATALYTIC CRACKING. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, B71-91 (September 1960). 0022

Coke formation in catalytic cracking proceeds through intermediate aromatic structures of increasing size and complexity. While the process appears to be strongly dependent on the molecular size of the aromatic, molecular structure is at least as important. The coke-forming tendency of many aromatics and their alkyl derivatives correlates well with their basicity. The mechanistic implications of this are discussed for several of the aromatics studied.

Appleby, W. G., Gibson, J. W., and Good, G. M. (Shell Development), COKE FORMATION IN CATALYTIC CRACKING. Industrial and Engineering Chemistry Process Design and Development, 1, no. 2, 102-10 (1962). 0023

Coke formation over catalysts appears to occur mainly via the reactions of aromatic hydrocarbons, present as reactants or formed as intermediates or products in the process. The coke-forming reactions appear to be governed by: adsorption of the aromatics on the catalyst surface, which may be dependent mainly on their molecular weight; reaction of the adsorbed species with the surface to form aromatic or unsaturated ions, a process dependent mainly on the basicity of the several ionic species; reactions of the polymer to form large aggregates of polynuclear aromatics which exhibit the turbostratic graphite structure of cokes from other sources. The tendency to form coke appears to increase with substitution of the aromatic nucleus.

Archibald, R. C., May, N. C., and Greensfelder, B. S. (Shell Development), EXPERIMENTAL CATALYTIC AND THERMAL CRACKING - AT HIGH TEMPERATURE AND SPACE VELOCITY. Industrial and Engineering Chemistry, 44, no. 8, 1811-17 (1952). 0024

Catalytic cracking of cetane and cumene over silica-alumina catalyst at 550°-675°C was investigated. With increased temperature and at constant space velocity less coke deposition and increased amounts of methane, ethane, and ethylene were observed. Some thermal (free-radical) cracking appeared to occur at the higher temperatures.

Arens, M. (Israel Institute of Technology), A HYPERSONIC RAMJET USING A NORMAL DETONATION WAVE. Israel. Research Council. Bulletin. Section C, 8C, 35-46 (February 1960). 0025

The utility of conventional ramjets at hypersonic speeds is seriously limited due to performance deterioration and growing structural complexity, as flight speed increases. Some of the associated problems can be alleviated by operating the engine combustion chamber at supersonic mean inlet velocities. The governing equations for engine performance with a normal detonation wave in the combustion chamber are derived, and the flight regime for which combustion through normal detonation is possible is investigated. Performance of an ideal detonative ramjet using acetylene fuel is presented for flight Mach numbers of 6 to 10. A ramjet engine configuration is suggested for performance with normal detonation.

Areshidze, Kh. I. and Chivadze, G. O., PREPARATION OF C_2-C_4 MONOMERS BY THE PYROLYSIS OF HYDROCARBON MIXTURES SEPARATED FROM PETROLEUM. Neftekhimiya, 3, no. 4, 518-22 (1963). 0026

The pyrolysis of hydrocarbon fractions of n-heptane and of methylcyclopentane-cyclohexane have been studied. The results of the thermal decomposition of n-heptane fraction show that the concentration of olefins and dienes of the composition C_2-C_4 is 56.3%, of which the ethylene fraction is 26.6%. The results of the pyrolysis of methylcyclopentane and cyclohexane differ from the pyrolysis of n-hexane. At a temperature of 735°C, the content of olefine and diene fractions of the composition C_2-C_4 is 64.9%, which contains 18.7% of butadiene. The maximum content of olefins and dienes from the thermal decomposition of cyclohexane and methylcyclopentane at a temperature of 730°C was 73.7% and a maximum content of butadiene in the gas at 735°C was 18.6%.

Armstrong, G. T., Fano, L., Jessup, R. S., Marantz, S., Mears, T. W., and Walker, J. A. (U. S. National Bureau of Standards), NET HEAT OF COMBUSTION AND OTHER PROPERTIES OF KEROSINE AND RELATED COMPOUNDS. Journal of Chemical and Engineering Data, 7, no. 1, 107-16 (1962). 0027

The work described was undertaken to provide accurate information on fuels boiling in the kerosine range, including net heat of combustion, aniline point, API gravity, hydrogen, carbon, and sulfur content, and composition in terms of hydrocarbon types. Specifications were previously established as MIL-F-25578A (USAF) for Rocket Engine Fuels, grade RP-1, but few commercial products meet them. The results of the present work provide a basis for possible modification of the above specifications and also information of interest in connection with estimating net heat of combustion of a hydrocarbon fuel from more easily measured properties. As in previous work on other fuels, it is shown that for a given class of fuels, net heat of combustion can be reported to a fair degree of approximation by a linear function of any one of the following fuel properties: aniline point, API gravity, product of aniline point and API gravity, and per cent hydrogen.

Armstrong, G. T., Jessup, R. S., and Mears, T. W. (U.S. National Bureau of Standards), NET HEAT OF COMBUSTION OF AVIATION GASOLINE AND ITS CORRELATION WITH OTHER PROPERTIES. Industrial and Engineering Chemistry. Chemical and Engineering Data Series, 3, 20-8 (1958). 0028

The work described was undertaken to determine the feasibility of finding for 115/145 grade aviation fuels relations between net heat of combustion and aniline-gravity product similar to those found previously for AN-F-28, AN-F-58, JP-4, and JP-5 fuels. The previous work had indicated that it is not possible to make a reliable estimate of the heat of combustion of a petroleum fuel from its aniline-gravity product alone, but that such an estimate can be made for members of a definite class of fuels. The data at present available show clearly that net heat of combustion of petroleum products is not a function of aniline-gravity product alone; thus, data on many pure hydrocarbons are not in accord with any such relation, the individual fuels of a given type depart from the equation for that type by considerably more than the experimental error of measurement, and different relations between aniline-gravity product and net heat of combustion are obtained for different types of fuels. It appears, therefore, that it will be necessary to investigate the effect of other factors in addition to aniline-gravity product. In particular, it seems desirable to make an approximate determination of composition in terms of hydrocarbon type.

Asaba, T., Gardiner, W. C., Jr. and Stubbeman, R. F. (University of Texas), SHOCK TUBE STUDY OF THE HYDROGEN-OXYGEN REACTION. "Symposium (International on Combustion, 10th, Cambridge, England, August 17-21, 1964." Pittsburgh, Combustion Institute, 1964. 0029

Results show that induction times in the hydrogen-oxygen reaction in shock waves depend on the concentrations of both hydrogen and oxygen. They indicate also that the degree of dependence on hydrogen concentration can be predicted in reasonable agreement with experiment using rate constants for the elementary reactions involved that are in accord with previous results. The effect of vibrational equilibration of oxygen was investigated under conditions where the oxygen vibrational relaxation times were comparable to the induction times. A small but clear effect was observed. The size of the effect of slow vibrational relaxation in these mixtures shows that no effect will be observed in usual mixtures containing hydrogen and argon.

Asaba, T., Yoneda, K., Kakihara, N. and Hikita, T. (University of Tokyo), SHOCK TUBE STUDY OF IGNITION OF METHANE-OXYGEN MIXTURES. pp. 193-200 in: "Symposium (International) on Combustion, 9th, Cornell University, August 27 - September 1, 1962." New York, Academic, 1963. 0030

Ignition of methane-oxygen mixtures was stidied by use of the shock tube. Data on ignition delay suggested that two different mechanisms exist, depending upon the methane content: first, for lean mixtures the branching chain mechanism at relatively low temperatures governs the reaction during the induction period; and second, for rich mixtures, the thermal chain mechanism governs the reaction at high temperatures. For rich mixtures, the controlling reaction is considered to be the second order reaction between methane and oxygen with an activation energy of about 55 Kcal. For lean mixtures, it is suggested the ignition is of the branching chain type and the activation energy is found to be about 21 Kcal.

Avery, W. H. (Johns Hopkins University), RAMJETS, STATE OF THE ART, 1961. Astronautics, 6, no. 12, 48-9 (1961). 0031

Unclassified current work on ramjets, including external ramjets, is reviewed in this paper. The Bomarc-B test program is mentioned - the ramjet stage using JP-4 has been tested to Mach 4 and 100,000 ft altitude. The French (Nord-Aviation, S. A.) Vega has been fired to Mach 4.06 and 96,500 ft. The fourth AGARD Colloquium (April 4-8, 1960) is reviewed.

Avery, W. H. and Dugger, G. L. (A. P. L., Johns Hopkins University), HYPERSONIC AIRBREATHING PROPULSION. Astronautics and Aeronautics, 2, no. 6, 42-7 (1964). 0032

Hypersonic ramjets, including those using supersonic combustion promise great gains in performance and operating economy for missiles, aircraft and aerospace planes. Improvement in rocket performance is possible through use of a combination engine, the air-augmented rocket. The use of liquid hydrogen to cool the aircraft structure is mentioned.

Bachman, K. C. (Esso Research and Engineering), RELATION OF LUMINOMETER NUMBER TO MOLECULAR STRUCTURE. American Chemical Society. Division of Petroleum Chemistry. Preeprints 5, no. 4, C39-47 (September 1960). 0033

The luminometer provides a test method in which combustion quality is evaluated by determining the heat released on burning at a fixed level of radiant energy. Combustion quality is defined as luminometer number; high values define fuels which burn with non-luminous flames and have high smoke points; low values represent fuels which burn with luminous flames and have low smoke points. Interest in the instrument developed when it was shown that luminometer numbers correlate with liner temperatures in jet engine combustors. Because of this and the fact that the instrument uses a different approach in determining combustion properties, a variety of hydrocarbons were evaluated with it to see if any new relationships between molecular structure and combustion quality could be found. Results show that the luminometer ranks hydrocarbons according to molecular structure in regard to combustion quality in much the same way as they have been ranked previously on the basis of smoke point.

Bachman, K. C., Matthews, E. K. and Zudkevitch, D. (Esso Research and Engineering), EVALUATION OF HYDROCARBON MATERIALS AS VAPORIZING FUELS. U. S. Air Force, ASD TDR 62-254, Contract AF 33 (616)-7502, August 1962. 253 pp. (AD 281 898). 0034

Theoretical and experimental data for determining which hydrocarbon types and structures are most promising for use as vaporizing fuels in Mach 3^+ aircraft are presented. Thirty-three hydrocarbons covering a broad range of types and structures were evaluated. The source, e.g. literature, laboratory measurement and correlation method (used also to extend data to 1000°F. and 800 psia), of required physical property and thermodynamic data are presented. Calculated liquid and vapor heat transfer coefficients are provided. A heat exchanger designed to check the calculated coefficients, but which could not be made operable during the contract period, is described. Thermal cracking studies on sixteen hydrocarbons are described. Combustion studies in which vaporization was simulated by ultrasonically-produced fuel fogs are described for four hydrocarbons. The results show that condensed or uncondensed dicyclic naphthenes, specifically spiro(4,5)decane, hydrindan, and spiro(5,5)undecane, best fill ASD target requirements for a vaporizing fuel.

Bacigalupi, R. J. and Lezberg, E. A., BLOWOFF OF PROPANE AND HYDROGEN DIFFUSION FLAMES AT HIGH MACH NUMBER, RAMJET CONDITIONS. U. S. National Aeronautics and Space Administration, TN D-67, December 1959. 24 pp. 0035

Blowoff conditions are presented for hydrogen and propane diffusion flames stabilized in the wake of cylindrical fuel injectors. The effect of varying pressure, temperature, and air and fuel flows was determined for several fuel-orifice and tube diameters. The propane blowoff data were correlated as $d_o^{0.7}p^{0.9}T_a^{1.2}w_f^{0.5}$ as a function of U_a for 0.188- and 0.25-inch-diameter tubes. The hydrogen data were correlated as $T_a^{1.2}U_a^{0.2}$ as a function of pressure for various fuel and orifice diameters. The correlations were derived from a thermal ignition model for flame stabilization.

Badger, G. M. and Novotny, J. (University of Adelaide, Australia), THE FORMATION OF AROMATIC HYDROCARBONS AT HIGH TEMPERATURES. PART XII. THE PYROLYSIS OF BENZENE. Chemical Society (London). Journal, 3400-2 (1961). 0036

Pyrolysis of benzene at 700° has been shown to yield biphenyl as the major product, with significant amounts of p-terphenyl, m-terphenyl, and triphenylene. Fluorene, phenanthrene, anthracene, o-terphenyl (?), fluoranthene, chrysene, and 3,4-benzofluoranthene were also detected. and methane and ethylene were identified in the exit gases.

Bagnetto, L., **THERMAL STABILITY OF HYDROCARBON FUELS.** Phillips Petroleum Company, Research Division Report 3873-64R, U. S. Air Force, Contract AF 33 (657)-10639, Progress Report No. 4, September 1964, 13 pp. 0037

A storage program has been initiated with five aviation turbine fuels to study the environmental effects of temperature and oxygen content on the deterioration of thermal stability quality during storage. Removing dissolved oxygen from the fresh, aerated fuels resulted in significant improvements of 193°F and 275°F for two fuels having threshold failure temperatures (TFT) of 300°F and 425°F respectively. One fuel having a TFT of 625°F was improved 60°F and two fuels having TFT of 700°F showed no improvements as a result of dissolved oxygen removal. From these results it appears that improvements in thermal stability quality resulting from the removal of dissolved oxygen to less than one part per million is inversely proportional to the thermal stability of the fresh, aerated fuels. Studies concerning the effect of dissolved oxygen on changes in light transmittance loss experienced by these fules as they go through the coker indicate a relationship with the changes found in thermal stability as a result of oxygen removal.

Bagnetto, L. and Quigg, H. T., **THERMAL STABILITY OF HYDROCARBON FUELS.** Phillips Petroleum Company, Progress Report No. 3, U. S. Air Force, Contract AF 33(657)-10639, March 1964. 0038

Storage stability studies of five JP-6 type fuels are underway. Temperatures of 130°F, 212°F, and 300°F will be used. Pairs of samples with and without (<1 ppm) dissolved O_2 are being stored. A method for removing dissolved O_2 is described. A small scale (5-ml bomb) thermal stability test is being compared with the standard CRC Fuel Coker for correlation of results. Repeatability of the 5-ml bomb method is also being checked. An attempt is being made to correlate storage stability with thermal stability quality of JP-6 type fuels. To do this "fresh" JP-6 type fuels of known storage behavior were treated with azodiisobutyronitrile (ADN) and the rate of light transmittance deterioration was determined for the interval of 16.5 to 109.5 hours at 100°F.

Bagnetto, L. and Quigg, H.T. (Phillips Petroleum), **THERMAL STABILITY OF HYDROCARBON FUELS.** U.S. Air Force, APL TDR 64-89, Part I, Contract AF 33(657)-10639, August 1964. 161 pp. 0039

This report covers the first year's work on a study of factors that affect deterioration in thermal stability during storage of aviation turbine fuels, and the development of a small-sample test method for prediction of changes in thermal stability with time in storage. A 5-ml Bomb test method based on the loss in UV light transmittance has been found to correlate with ASTM-CRC Coker ratings for eleven non-additive fuels, but not for seven additive-containing fuels. A good relationship was found between the 5-ml Bomb and MINEX heat exchanger test rig, using seven fuels, three of which contained additives. Several procedures were evaluated for accelerating the aging of fuels as possible test methods for predicting deterioration in thermal stability during storage. None of the accelerated aging procedures predicted the change in light transmittance or ASTM-CRC Coker performance of all fuels that occurred during 26 weeks of 110°F hot room storage.

Bailey, W. A., Jr. and Sartor, A. F. (Shell Oil), SECONDARY REACTIONS IN CATALYTIC CRACKING. Advances in Petroleum Chemistry and Refining, 5, 211-52 (1962). 0040

Secondary reactions in catalytic processes such as further cracking, isomerization of double bond, hydrogen transfer, polymerization, aromatization, alkylation and further dehydrogenation are discussed. Factors affecting the various reactions and possible mechanisms by which the reactions products are formed are enumerated. Over 65 references are cited.

Bair, W. E., Olson, D. R. and Lichty, L. C. (Yale University), SPONTANEOUS IGNITION OF N-HEPTANE-AIR MIXTURES IN A STEADY-FLOW PROCESS. Industrial and Engineering Chemistry, 49, no. 4, 774-9 (1957). 0041

The spontaneous ignition of fuel-air mixtures was studied under steady flow conditions. Heat loss from the mixture was found to have an important effect on spontaneous ignition. In future work, control and evaluation of this effect in spontaneous-ignition experiments are recommended.

Bakanauskas, S., BACTERIAL ACTIVITY IN JP-4 FUEL. U.S. Air Force, WADC TR 58-32, March 1958. 15 pp. (AD 151034). 0042

Studies were made with sludge samples obtained from tanks used to store JP-4 fuel, a kerosene-type fuel used in USAF jet aircraft. The tanks were located at Lincoln AFB, Schilling AFB, and Davis-Monthan AFB. Results of these studies indicated the following: (1) Sludge was caused by bacteria, and by products resulting from bacterial metabolic activity. (2) JP-4 fuel, and additives (corrosion and gum inhibitors) approved for USAF use in JP-4 fuel, are not bacteriostatic agents. JP-4 fuel, and some additives were found to be nutritive for bacteria. (3) A 1.5-2.0% concentration of sodium tetraborate, by weight, or a 2.0% concentration of potasium tetraborate, by weight, in water bottoms of JP-4 storage tanks can product bacteriostatic conditions within the tank.

Balandin, A. A., THE NATURE OF ACTIVE CENTERS AND THE KINETICS OF CATALYTIC DEHYDROGENATION. Advances in Catalysis, 10, 96-129 (1958). 0043

The kinetics of catalytic dehydrogenation are interpreted in terms of the geometry and energy aspects of the multiplet theory. Active centers on the catalyst are postulated and the possibility is shown for experimental determination of free energy, enthalpy and entropy of adsorption on the active centers.

Balandin, A. A. and Isagulyants, G. V., THE DEHYDROGENATION OF CERTAIN HYDROAROMATIC HYDROCARBONS ON A CHROMATE CATALYST. Academy of Sciences (U. S. S. R.). Bulletin. Division of Chemical Sciences, 1958, 1257-63. 0044

The dehydrogenation of cyclohexane, decalin, methylcyclohexane, 1,3-dimethylcyclohexane, tetralin and 2-methyl-5, 6, 7, 8-tetrahydronaphthalene were studied over a chromate catalyst. Energies of activation were determined for the dehydrogenation of cyclohexane, 1,3-dimethylcyclohexane, methylcyclohexane, tetralin and methyltetralin on chromic oxide. Arrhenius constants were about the same for the structurally closely related hydrocarbons cyclohexane, methylcyclohexane, dimethylcyclohexane, and decalin. The appearance of the methyl groups in the cyclohexane ring somewhat diminishes the values of these constants, this, in turn, leading to marked differences in the rates of dehydrogenation at high temperatures.

Balandin, A. A., Karpeiskaya, E. I. and Tolstopyatova, A. A., CATALYTIC PROPERTIES OF RHENIUM. COMMUNICATION 1. RHENIUM AS A DEHYDROGENATION CATALYST. Academy of Sciences (U. S. S. R.). Bulletin. Division of Chemical Sciences, 1959, 1318-24. 0045

Rhenium on charcoal was found to be an active catalyst for cyclohexane dehydrogenation. However, the nature of the carrier considerably affects the activity of rhenium catalysts. Over this catalyst, n-heptane was dehydrocyclized and cumene was dehydrogenated to α-methylstyrene.

Balandin, A. A., Karpeiskaya, E. I., and Tolstopyatova, A. A., CATALYTIC PROPERTIES OF RHENIUM. COMMUNICATION 2. DEHYDROGENATION OF CYCLOHEXANE. Academy of Sciences (U.S.S.R.). Bulletin. Division of Chemical Sciences, 1959, 1479-84. 0046

The dehydrogenation of cyclohexane was studied over a rhenium-on-charcoal catalyst at 330°-397°C. The reaction was zero order with activation energy of 12.8 to 20.3 kcal/mole. The activation energy declined with increased rhenium content of the catalyst.

Balandin, A. A., Karpeiskaya, E. I., and Tolstopyatova, A. A., INVESTIGATION OF THE CATALYTIC DEHYDROGENATION OF HYDROCARBONS AND ALCOHOLS OVER METALLIC RHENIUM. Academy of Sciences (U. S. S. R.). Proceedings. Chemistry Section, 122, 661-4 (1958). 0047

It is shown that rhenium supported on carbon is an active catalyst for the dehydrogenation of cyclohexane, its homologs, and cumene and for the dehydrocyclization of n-heptane in the temperature region of 246-450°C.

Balandin, A. A., Karpeiskaya, E. I., and Tolstopyatova, A. A., THE PRINCIPLE OF STRUCTURAL CORRESPONDENCE AND THE CATALYTIC PROPERTIES OF RHENIUM. Russian Journal of Physical Chemistry, 33, no. 11, 481-3 (1959). 0048

The kinetics of dehydrogenation of cyclohexane, methylcyclohexane, and ethylcyclohexane, have been studied over a rhenium on charcoal catalyst. With this catalyst, the rate of dehydrogenation decreased from cyclohexane to methylcyclohexane and ethylcyclohexane; the energy of activation increased in the same series.

Balandin, A. A., Karpeiskaya, E. I. and Tolstopyatova, A. A., RHENIUM AS A CATALYST. Renii, Trudy Vsesoyuznogo Soveshchaniya Po Probleme Reniya, Akademiya Kauk SSSR, Institut Metallurgii Im A. A. Baikova, 1958, 170-9 (Publ. 1961). (C. A. 58, 3943C, 1963). 0049

An investigation was made of a new active form of Re catalyst for the dehydrogenation of alcohols and cyclic hydrocarbons at increased reaction rates and with decreased activation energy compared with earlier catalysts (CA 54, 12757b). Cyclohexane was dehydrogenated on rhenium/carbon at 250-340°. The gaseous reaction products consisted of H and CH_4. The role of the carrier and the method of prepn. of the catalyst is important. Methylcyclohexane was dehydrogenated on Re/C at 270-320°: activation energy = 10.3 kcal./mole. Ethylcyclohexane was dehydrogenated at 256-358°: activation energy = 12.6 kcal./mole. A comparison of data on the dehydrogenation of hydrocarbons indicates that with an increase in mol. wt. of the hydrocarbon, the reaction rate decreases and the activation energy increases.

Balandin, A. A. and Matyushenko, V. Kh., KINETIC RELATIONS IN THE DEHYDROGENATION OF COMPOUNDS WITH SIX-MEMBERED RINGS. II. Russian Journal of Physical Chemistry, 37, no. 1, 54-9 (1963). 0050

A study was made of the kinetics of dehydrogenation of methylcyclohexane on a Pt/asbestos catalyst using an improved technique. Several anomalies were observed in the reaction, whose elucidation requires further experimental and theoretical study. Somewhat improved procedures are proposed for the calculation of kinetic constants.

Balandin, A. A. Pi-Hsiang, P., and Tolstopyatova, A. A., KINETICS OF DEHYDROGENATION AND DEHYDRATION OF ISOPROPYL ALCOHOL AND DEHYDROGENATION OF TETRALIN ON GADOLINIUM OXIDE. Academy of Sciences (U S.S.R.). Bulletin. Division of Chemical Sciences, 1962, 1250-5. 0051

As part of a study on the catalytic properties of rare earth oxides, the dehydrogenation of tetralins and the dehydrogenation and dehydration of isopropyl alcohol were studied over gadolinium oxide. The kinetics suggest that these reactions obey Balandin's equation for monomolecular heterogeneous catalytic reactions.

Balandin, A. A. and Rozhdestvenskaya, I. D., MECHANISM OF DEHYDROGENATION OF CYCLOHEXANE ON THE CRYSTALLINE α-OXIDE OF CHROMIUM. Academy of Sciences (U.S.S.R.). Bulletin. Division of Chemical Sciences, <u>1961</u>, 1824-9. 0052

The dehydrogenation of cyclohexane was studied over unsupported α-chromia at 335°-395°C. The results are discussed in terms of the proposed Sextet and Doublet Mechanism hypotheses.

Ballentine, O. M., SPECTROPHOTOMETRIC-CUPRETHOL METHOD FOR THE QUANTITATIVE DETERMINATION OF COPPER IN AVIATION FUELS. U.S. Air Force, WADC TR 54-596, May <u>1955</u>. 9 pp. (AD 76880). 0053

A method has been established for the quantitative determination of ionic copper in aviation fuels in concentrations as low as 1 ppm of copper. In this method the cupric ion reacts with a compound prepared from carbon disulfide and diethanolamine to form the yellow salt complex of bis(2-hydroxyethyl) dithiocarbamic acid. The concentration of copper is determined by first measuring the optical density of the resulting solution, at the maximum wave length, with an absorption spectrophotometer and then relating this optical measurement to a previously prepared concentration-optical density curve.

Bankoff, S. G. (Northwestern University), A NOTE ON LATENT HEAT TRANSPORT IN NUCLEATE BOILING. A. I. Ch. E. Journal, <u>8</u>, no. 1, 63-5 (<u>1962</u>). 0054

A simple one-dimensional transport calculation is made which indicates that latent heat transport, by simultaneous evaporation and condensation at different portions of the bubble surfaces, can account for the major portion of the total heat flux in the neighborhood of the departure from subcooled nucleate boiling (burnout). This differs from the previously held view that the stirring action of the bubbles accounted for most of the heat flow in subcooled nucleate boiling. Other evidence is discussed which favors the latent heat transport theory.

Bankoff, S. G. and Mehra, V. S. (Northwestern University), A QUENCHING THEORY FOR TRANSITION BOILING. Industrial and Engineering Chemistry Fundamentals, 1, 38-40 (1962). 0055

A quenching theory of transition boiling is proposed, which is consistent with Berenson's data. An interesting result is that the thermal boundary layer in the liquid contacting the surface is very much larger than the critical bubble radius for nucleation.

Banner, R.D., Kuhl, A.E. and Quinn, R.D., "PRELIMINARY RESULTS OF AERODYNAMIC HEATING STUDIES ON THE X-15 AIRPLANE". U.S. National Aeronautics and Space Administration, TM X-638, March 1962. 18 pp. (AD 328547). REPORT CLASSIFIED CONFIDENTIAL. 0056

No Abstract.

Barnard, D. P. and Eltinge, L. (Standard Oil, Indiana), AIRCRAFT TURBINE FUEL PROPERTIES AFFECTING COMBUSTOR CARBON. Industrial and Engineering Chemistry, 46, no. 10, 2160-3 (1954). 0057

In high speed flight, maximum power output per unit of engine size and weight is essential. Jet fuel must burn in such a small space and so fast that compromises with clean combustion are inescapable. Excess air passes through the jet engine, but zones of oxygen deficiency lead to carbon formation. The same fuel properties influence combustion as in any other furnace - volatility and hydrogen-to-carbon ratio. Smoke points determined in a standard test lamp are a practical measure of carbon-forming tendencies.

0058

Barnett, H. C. and Hibbard, R. R., PROPERTIES OF AIRCRAFT FUELS. U. S. National Advisory Committee for Aeronautics, TN 3276, August 1956. 152 pp. (Supersedes RM E53A21 and RM E53I16). (AD 105026).

The primary objective of this report is to collect fuel data that should aid in the design of aircraft fuel systems. It includes a survey of recent production jet fuels and shows the ranges of fuel properties which can be encountered for each grade of fuel. The effect of temperature and pressure on many of these properties is given. In the future fuel oils may be used in jet aircraft; and, therefore, these fuels have also been treated. In addition there are discussions on the development of jet fuel specifications and the pertinence of fuel properties to fuel-system design. The practical problems associated with the use of aircraft fuels are also discussed.

0059

Barrère, M. and Français, G. (ONERA), COMBUSTIBLES POUR STATOREACTEUR-PROPRIETES ET PREPARATION. pp. 318-367 in: Penner, S. S. and Ducarme, J., eds., "The Chemistry of Propellants; a meeting organised by the AGARD Combustion and Propulsion Panel, Paris, France, June 8-12, 1959", Oxford, Pergamon, 1960.

The main problems concerning preparation, storage, and use of propellants for ramjets are discussed. Physical, chemical, thermodynamic and combustion properties are tabulated for various liquid fuels including hydrocarbons, metal slurries in hydrocarbons, boron fuels, and cryogenics. Thermal stability and deposit formation are discussed, and storage, handling, and safety problems are mentioned.

0060

Barringer, C. M. (E. I. du Pont de Nemours), JET FUEL STABILITY STUDIES. SAE Journal, 63, Dec, 39-44, (1955).

In supersonic aircraft, the fuel encounters extreme temperature changes before it is burned. These extreme changes break it apart chemically. As a result, sediment is formed which plugs nozzles and screens in the engine. Since the fuel is used as a coolant before it is burned, heat exchanger surfaces become fouled. The overall effect slows up the airplane. Du Pont, Socony, Shell, and Esso - among others - have each been trying to improve jet fuel.

0061

Barringer, C. M., Corzilius, M. W., and Rogers, J. D., HIGH TEMPERATURE STABILITY OF JET FUELS. E. I. Du Pont de Nemours, Wilmington, Delaware, September 1954. 4 pp. (AD 112363).

Thermal stability of jet fuels and earlier test methods such as the ASTM grease bomb are discussed. Failure of the oxygen bomb-fuel filterability methods to correlate with full-scale results and to give good reproducibility is pointed out. A new thermal stability test employing a 4 ml glass coil tube immersed in a 400°F bath is introduced. Fair agreement between results in the glass coil with those from full-scale engines is claimed. The polymeric nature of fuel deposits is attributed to the ability of oxidized nitrogen and sulfur compounds to polymerize into insoluble residues. Chemical analysis of deposits showed high percentages of sulfur, nitrogen, and oxygen.

0062

Barringer, C. M., Corzilius, M. W., and Rogers, J. D. (E. I. DuPont de Nemours), JET FUEL THERMAL STABILITY. Petroleum Processing, 10, no. 12, 1909-11 (1955).

The stability of jet fuels, especially under heat, is a big problem which may become bigger if present plans to use a jet's fuel supply as a heat sink for the temperatures of high speed flight are successful. In such a cooling system, heat forms sludge and insoluble residues in the fuel supply. These contaminants clog fuel filters and burner nozzles. Considerable research is underway to prevent this jet fuel deterioration. Until recently this work was hampered by the inefficient stability testing equipment available. Most of these tests were static and involved high temperature bombs. However, the Erdco Jet Fuel Coker, a unit similar to the one described briefly at the end of this article, has been selected as a standard test apparatus. It is a high pressure unit which provides good results. The test described in this article is a low pressure method yielding results correlating with those of full scale rigs.

0063

Bartick, H. and Couch, J., A THEORETICAL EVALUATION OF MATERIALS USED IN SLURRY FUELS. U.S. Air Force, WADD-TR 60-653, April 1961. (AD 323 237). REPORT CLASSIFIED CONFIDENTIAL.

A theoretical study was performed for the evaluation and optimization of materials to be used for slurry fuels. These systems were analyzed using a Univac Scientific Computer 1103A.

Bartz, D. R. (Jet Propulsion Laboratory), FACTORS WHICH INFLUENCE THE SUITABILITY OF LIQUID PROPELLANTS AS ROCKET MOTOR REGENERATIVE COOLANTS. Jet Propulsion, 28, 46-53 (1958).

0064 A brief review of methods of utilizing liquid propellants as rocket-motor coolants is given, and criteria for acceptable cooling are established. Methods of analytical and experimental determination of the pertinent heat-transfer characteristics of propellants are described. The measured maximum rates at which liquid ammonia can satisfactorily accept heat are presented to show typical trends with variations of fluid pressure, temperature and velocity. Measured maximum rates for several propellants are compared with predictions of heat fluxes from the combustion gases of these propellants when producing the same thrust in a hypothetical rocket motor. From this comparison, an insight into the importance of various propellant properties and operating conditions is gained.

Bartz, D.R., Noel, M.B. and Grant, A. F., Jr., "EVALUATION OF HYDRAZINE AS A REGENERATIVE COOLANT". California Institute of Technology, Jet Propulsion Laboratory, Publication No. 111, U.S. Army Contract DA-04-495-ORD18, October 1957. (AD 146 386). REPORT CLASSIFIED CONFIDENTIAL.

0065 No Abstract

Batdorf, S. B. (Lockheed Aircraft), STRUCTURAL PROBLEMS IN HYPERSONIC FLIGHT. Jet Propulsion, 27, 1157-61 (Nov. 1957).

0066 The main structural problems arising from hypersonic flight are those associated with aerodynamic heating. There does not appear to be a single best way to solve these difficulties, but rather a combined attack is needed in which material properties, structural design and evasive tactics such as cooling are carefully optimized. Maximum heating rate for aerodynamic surfaces as a function of Mach number and altitude is given. For practical altitudes this is of the order of 3 Btu/sec-ft^2. Strength and structural properties of materials as a function of temperature are discussed.

0067 Battelle Memorial Institute, Radiation Effects Information Center, SECOND SEMI-ANNUAL 125A RADIATION EFFECTS SYMPOSIUM, OCTOBER 22-23, 1957. PROCEEDINGS. 239 pp. (U. S. Atomic Energy Commission, NP-6521, vol. IV; Nuclear Science Abstracts, 12, 467, 1958).

Papers are presented covering the effects of radiation on polymeric materials, fuels, and lubricants. Topics covered include the effects of radiation on metalloorganic polymers; the mechanism of radiation damage to elastomers; the effects of radiation on reinforced plastics and structural adhesives; the engineering evaluation of radiation effects on organic materials; post irradiation changes in silicone rubber; radiation effects on plastic a review of the program for the development of nuclear radiation resistant fluids and lubricants, with emphasis on turbine engine lubricants and jet fuels; variation of results of dynamically and statically irradiated aircraft fluids; the dynamic effects of radiation on hydrocarbon fluids under thermal, oxidative, and mechanical stress; the effects of radiation of fluorocarbons and related substances; the development of radiation resistant high temperature lubricants; and the behavior of fuels and lubricants in dynamic test equipment operating in a radiation environment.

0068 Bauer, R. H. and Coppinger, G. M. (Shell Development Co.), CHEMISTRY OF HINDERED PHENOLS. REACTIVITY OF 2,6-DI-T-BUTYL-4-METHYLPHENOXYL. Tetrahedron, 19, no. 8, 1201-6 (1963).

Chemistry of hindered phenols. The reactivity of the 2,6-di-tert.-butyl-4-methylphenoxyl radical, formed by reaction of 2,6-di-tert.-butyl-4-methylcyclohexa-3,5-dienone with mercury, conformed to the general behavior pattern of hindered phenol type compounds. The radical reacted with itself to form 2,6-di-tert.-butyl-4-methylphenol and 3,5-di-tert.-butyl-4,1-quinone-methide; the latter gave 1,2-bis(3,4-di-tert.-butyl-4-hydroxyphenyl)ethane and 3,3',5,5'-tetra-tert.-butylstilbene-4,4'-quinone via free-radical intermediates.

0069 Behrens, H. and Roessler, F. (Institut Franco-Allemand de Recherches de Saint-Louis), SUPERSONIC DIFFUSION FLAMES. pp. 159-85 in: North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, "Combustion and Propulsion". New York, Pergamon, 1961.

The hot, not fully oxidized exhaust gases of a solid propellant rocket, emitted as a supersonic jet by a simple underexpanded nozzle into quiescent air or oxygen, was used to produce supersonic flames of the diffusion type. Propellants of a high heat of explosion produce flames that ignite without delay at the first shock of the jet. The flames are stable, the temperature has a distinct maximum along the flame axis. The flames of propellants of a low heat of explosion ignite with a delay behind the first shock, their instability increasing with decreasing heats of explosion of the propellants. By firing the rocket jet into oxygen instead of air, stable regular flames are achieved. The ignition delay, however, does not disappear. The relationship between supersonic flames of non-premixed gases and those of the premixed type studied by American research groups is discussed in qualitative terms.

Beighly, C. M. and Dean, L. E. (Bell Aircraft), STUDY OF HEAT TRANSFER TO JP-4 JET FUEL. Jet Propulsion, 24, no. 3, 180-6 (1954). 0070

Heat transfer to jet engine fuel JP-4 was studied, employing a transparent annular test section with an electrically heated, stainless-steel tube. Heat transfer data were obtained in the nonboiling, nucleate boiling, and film boiling regions for velocities from 3 to 40 ft/sec and pressures from 30 to 500 psia. Burnout data were obtained over the same range of variables. The phenomenon of coking was studied visually and by the use of colored films. Nonboiling data were correlated with Sieder-Tate equation using a constant of 0.023 and an adjusted viscosity-temperature curve. Nucleate boiling data were obtained at 50, 300, 400 and 500 psia, but no attempt was made to correlate the data. At high pressures film boiling was established and observed. Coke was formed at high wall temperatures but buildup on walls was erratic and non-homogeneous.

Belenkii, M. S., Kuzyatina, N. S. and Skorupko, Ya. P., EFFECT OF THE ADDITION OF GROUP II ELEMENTS ON THE CATALYTIC PROPERTIES OF A MOLYBDENUM-ALUMINUM SILICATE CATALYST. Izvestiya Vysshikh Uchelonykh Zavedenii. Neft i Gaz, 1958, no. 10, 87-93. (CA, 53, 17484i). 0071

As a part of an over-all study of elements serving as promoters for molybdenum-aluminum silicate catalysts for aromatization, oxides of Group II (Be, Ca, Sr, Ba, Zn, and Cd) were added at 0.272% mol concentration. The catalysts were tested on hydrocarbons containing 77% naphthenes and 23% paraffins. CaO and SrO lower the activity of the unpromoted catalyst. A high yield of aromatic hydrocarbons was obtained with CdO.

Belenyessy, L. I., Fabuss, B. M., Gudzinowicz, B. J. and Wurster, C. F., PHYSICAL AND CHEMICAL PROPERTIES OF POTENTIAL HIGH TEMPERATURE HYDROCARBON FUELS. Monsanto Chemical Co., Special Report, U.S. Air Force Contract AF 33(616)-5799, 15 December 1960. 0072

The report presents tables of physical and chemical properties, structures, suppliers, and serial numbers of potential high temperature hydrocarbon fuels (97 hydrocarbon compounds, mainly naphthenes, plus petroleum fractions). Properties tabulated include molecular weight, H/C ratio, density, freezing and boiling points, decomposition temperature, heats of vaporization and combustion, heat capacity, thermal conductivity, luminometer number, viscosity, vapor pressure, distillation range and purity.

Belenyessy, L. I., Gudzinowicz, B. J., Reid, R. C. and Smith, J. O. (Monsanto Research), HEATS OF COMBUSTION OF COMPLEX SATURATED HYDROCARBONS. Journal of Chemical and Engineering Data, 7, no. 1, 66-8. 1962. 0073

This article summarizes briefly experimentally determined heats of combustion for many new compounds not heretofore reported and demonstrates the applicability of the Handrick method for correlating such heats of combustion. The five general families of hydrocarbons studied are: cyclohexanes, bicyclohexyls, tercyclohexyls, Decalins, and hydrindans. Forty-two compounds belonging to these classes were synthesized at the Monsanto laboratories or purchased from other chemical companies. Heats of combustion were determined with a Parr oxygen bomb calorimeter according to ASTM D 240-57T. Results tabulated are believed accurate to less than 25 B.t.u. per pound. The values reported for liquids at 77°F. are net values--the water product is taken to be in vapor form. This work was sponsored by the U. S. Air Force under Contract AF 33(616)-5799.

Bell, D. W. (Combustion Engineering, Inc.), CORRELATION OF BURNOUT HEAT-FLUX DATA AT 2000 PSIA. Nuclear Science and Engineering, 7, 245-51 (1960). 0074

A study and statistical analysis has been performed on available burnout heat-flux data for vertical upflow of water in uniformly heated rectangular channels at 2000 psia. Two correlating equations were developed with the fluid mass velocity and enthalpy at the burnout location as the two independent variables. It was not found necessary to include the channel length-to-thickness ratio as a third independent variable. The range of variables studied are: 540 to 1000 Btu/lb burnout enthalpy and 0.2×10^6 to 5×10^6 lb/hr-ft^2 mass velocity. It is shown that the burnout heat-flux decreases as mass velocity increases for a constant burnout enthalpy in the quality range. Also, a comparison of the developed correlations based upon data for uniformly-heated channels was made with 25 burnout data points for channels having a cosine-shaped axial heat-flux distribution. The cosine data fall on the average of about thirty percent below the burnout heat-flux values for uniformly heated channels under the same coolant conditions at the burnout location.

Belles, F. E. and Lauver, M. R. (NASA, Lewis Research Center), EFFECTS OF CONCENTRATION AND OF VIBRATIONAL RELAXATION ON THE INDUCTION PERIOD OF THE H_2-O_2 REACTION. "Symposium (International) on Combustion, 10th, Cambridge, England, August 17-21, 1964." Pittsburgh, Combustion Institute, 1964. 0075

Schott and Kinsey had observed that the product $t_i(O_2)$ increased with increasing mole fraction of oxygen at constant temperature. This is not anticipated on the basis of the simplified kinetic model, and was tentatively ascribed to slow vibrational relaxation of O_2. In order to investigate more fully this important possibility a more detailed kinetic model without simplifying assumptions was set up. Calculations with this model show that this product should, in fact, increase as the ratio of H_2/O_2 decreases and that in addition there is some dependence upon (O_2). Further comparison of the calculated results was made with new data obtained by other workers using shock tube techniques, including some in which the H_2/O_2 ratio was varied from 24 to 0.0075 at a given temperature. It is demonstrated that simple calculations can interpret the observed effects of temperature, pressure, and concentration on induction time. It is not necessary to invoke any influence due to slow vibrational relaxation.

Belles, F. E. and Lauver, M. R. (Lewis Research Center), **EFFECTS OF CONCENTRATION AND VIBRATIONAL RELAXATION ON INDUCTION PERIOD OF HYDROGEN-OXYGEN REACTION.** U. S. National Aeronautics and Space Administration, Technical Note D-2540, December 1964. 14 pp. 0076

Induction times for the hydrogen-oxygen reaction that are in excellent agreement with experimental data from three different kinds os shock-tube measurements can be calculated by solving the differential rate equations for the following kinetic scheme: an initiation reaction, plus the three usual chain-branching reactions. It is concluded that the experimental data do not show any effects caused by slow vibrational relaxation. In support of this conclusion, calculations are presented to show that the greatest possible effect of slow oxygen relaxation would, in fact, be a small one.

Belomestnykh, I. P., Bogdanova, O. K. and Balandin, A. A., INFLUENCE OF THE STRUCTURE OF HYDROCARBONS ON THE KINETICS OF THEIR DEHYDROGENATION. Petroleum Chemistry U.S.S.R., 2, 341-8 (1963). 0077

The kinetics of the catalytic dehydrogenation of a number of aklylaryl hydrocarbons were studied. It was shown that alkylaryl hydrocarbons with a branched radical and with substituents in the ring dehydrogenate at a high velocity. A logarithmic relationship between the activation energy and the constant of interaction was found, and the changes in the free energy, heat content, and entropy on adsorption displacement from a catalytically active surface were determined. It was also shown that high yields of dehydrogenation products can be obtained at 565-620° and high space velocities. For example: vinyltoluene with a yield of 43-57% at a space velocity of 0·5-1·0 hr^{-1}; and 30-36% of divinylbenzene + 22·0-20% of ethylvinylbenzene per pass at a space velocity of 0·5-0·7 hr^{-1}.

Bentur, S., Babitz, M., and Stern, A. B. (Technion- Israel Institute of Technology), EFFECT OF ORGANIC PEROXIDES ON THE CORROSIVENESS OF AVIATION FUELS AND PURE HYDROCARBONS. Journal of Chemical and Engineering Data, 9, no. 1, 115-18 (1964). 0078

Various amounts of tert-butyl hydroperoxide, 0.5 to 2.5 meq. O_2 per liter, were added to aviation gasoline, jet fuel and pure hydrocarbons which had been contaminated with elemental and mercaptan sulfur, 15 mg. per liter each. ASTM copper strip tests at 100°C were carried out by the standard procedure and in an inert-gas atmosphere. After the copper strip test, the fuel was analyzed for changes in sulfur and peroxide content. An HCl test was devised for a more exact estimation of the corrosion test. The copper strip after the corrosion test was placed in a nitrogen atmosphere in a specially designed apparatus. 1:1 HCl was added, and the evolved H_2S was absorbed in a $Cd(OH)_2$ suspension and determined from the methylene-blue reaction in a Beckman spectrophotometer at 670 mμ. The results show that an inert atmosphere favors higher results in the copper strip test, and that organic peroxides added to a corrosive fuel reduce corrosiveness. The effect of peroxides in reducing corrosiveness is more pronounced in air and their stability higher than in an inert atmosphere.

Berger, C. V. and Appell, H. R. (Universal Oil Products), **DECOMPOSITION OF HYDROCARBONS.** Industrial and Engineering Chemistry, 48, no. 9, part 2, 1566-75 (1956). 0079

This is a review article covering catalytic and thermal cracking and catalytic reforming of hydrocarbons. Ninety-seven references for the years 1955-1956 are given.

Berl, W. G. and Renich, W. T. (John Hopkins University), **RAMJET FUELS; A BRIEF SURVEY.** Astronautics, 3, no. 9, 36-7 (1958). 0080

Potential ramjet fuels with appropriate physical properties and availability and costs are listed. The conclusion reached is that only the borohydrides are serious competitors with hydrocarbons for most uses.

Bert, J. A. and Porter, H. R. (California Research Corp.), **SURFACTANTS IN JET FUELS - SYMPTONS, SOURCES, AND SOLUTIONS.** American Petroleum Institute. Proceedings, 43, Section III, 165-71 (1963). 0081

A jet fuel surfactant problem was recognized in the field. Surfactants were identified in the laboratory. Laboratory tests are used to demonstrate how fuel containing a small amount of surfactant prevents the normal water and particulate removal by a filter-coalescer. A sensitive method for measuring sulfonates as low as 0.03 ppm in fuel was developed. The performance of refinery and pipeline clay treaters in surfactant removal is discussed.

0082 Bertolette, W. de B. and Rogers, J. D., **IMPROVING FUEL OILS THROUGH ADDITION AGENTS.** Petroleum Engineer, 28, no. 12, C 41-2, C 45-6 (1956).

A discussion is given of problems of distillate fuel oil instability and the benefits to be derived from the use of additives. Reduction of residue in fuel oils, diesel oil, and jet fuels by caustic washing, hydrogenation, and additive treatment are considered.

0083 Bespolov, I. Ye., Guseva, A. B., and Timonicheva, O. I., **ON THE DEPENDENCE BETWEEN THE VALUE OF THE HEAT-TRANSFER COEFFICIENT AND THE LOWER HEAT OF FUEL COMBUSTION.** Khimiya i Tekhnologiya Topliv i Masel, 1963, no. 4, 64-5.

The heat-transfer coefficients, heat of combustion, and calorific capacity of Soviet fuels TS-1, T-1, T-2, and T-5, and of JP-1, JP-4 and aviation turbine kerosene were determined. A linear relation between heat-transfer coefficient and lower heating value was established. It is proposed that the lower heating value could be simply calculated from this relation using a heat-transfer coefficient calculated from data on density and the aniline point of the fuel.

0084 Bespolov, I. Ye., Kestner, O. E. and Pletneva, O. V., **THE CATALYTIC EFFECT OF ALLOYS OF COPPER ON THE FORMATION OF TARS FROM FUELS OF TYPE "T".** Khimiya i Tekhnologiya Topliv i Masel, 1957, no. 9, 66-70. (CA, 52, 7079e).

A bronze, VB-24, containing 0.9% phosphorous, which promotes the catalytic action of the copper, exerts a significant influence on tar formation in fuels of type "T", and disqualifies this metal for use with products of thermal cracking. A suitable alloy was found to be one in which the phosphorous content was reduced to 0.2%, and 4% nickel and 3-4% zinc were added.

Beverly, J. B. and Marschner, R. F., RELATIONSHIP BETWEEN HYDROCARBON STRUCTURE AND JET-FUEL PROPERTIES. American Chemical Society. Division of Petroleum Chemistry. Preprints 4, no. 2, B41-6 (April 1959).

0085 Energy content, density, volumetric heating value, freezing and boiling points and deposit formation tendencies are discussed for hydrocarbons in relation to the molecular structure of the hydrocarbon. Some interesting generalizations are reached. It is concluded that volumetric heating value of jet fuels can be increased about 25 percent without departing from hydrocarbon mixtures, but only by use of polycyclic hydrocarbons.

Bialy, J. J., Frost, R. A., and Dille, K. L. (Texaco), AN INVESTIGATION OF THE THERMAL STABILITY OF POTENTIAL SUPERSONIC JET FUELS. U. S. Air Force, ASD TDR 62-852, Contract AF 33(616)-8045, September 1962. 87 pp. (AD 296 407).

0086 A Texaco Research Coker was developed which can thermally stress fuels in a closed reservoir for 0 to 10 hours at 90 to 500F under an air, nitrogen or air-nitrogen atmosphere prior to determining fuel thermal stability and vapor phase decomposition. Threshold temperatures for a JP-5, JP-6, Soltrol 170, alkyl decalins, isopropyl bicyclohexyl, hydrogenated lauryl alcohol, Furfural Extract of LCGO and 3 kerosines were compared after being thermally stressed for 1 hour at 350F under nitrogen. Increasing the storage time and the storage temperature in the fuel reservoir was found to affect fuels differently. Investigation of the effect of oxygen availability in the reservoir on fuel stability indicated that there is a relationship between the oxygen content of the blanketing atmosphere and fuel thermal stability, vapor phase deposits and color of the fuel. The effect of repetitive heating and of trace impurities on fuel thermal stability were also investigated.

Bialy, J.J., Norris, T.A. and Frascati, F.P. (Texaco), AN INVESTIGATION OF THE THERMAL STABILITY OF POTENTIAL SUPERSONIC JET FUELS. U.S. Air Force, ASD TDR 62-852, Part II, Contract AF 33(616)-8045, May 1963. 23 pp.

0087 In continuation of research program on investigating the thermal stability of supersonic jet fuels, Texaco research coker was modified to assure more reliable operation. Threshold temperatures for SO_2 extracted paraffinic and naphthenic kerosines and Soltrol 170 were obtained after being thermally stressed for one hour at 350°F under blanketing atmosphere containing different amounts of oxygen in nitrogen. Increasing the skin temperature of reservoir cover was found to affect fuels differently. Differential thermal analysis, infrared analysis and polarographic analysis showed considerable potential for detecting changes in jet fuels which had been thermally stressed.

Bialy, J. J., Norris, T. A. and Frascati, F. P. (Texaco), **RESEARCH ON THERMAL EFFECTS ON FUELS ATTRIBUTABLE TO STORAGE**, U. S. Air Force, APL TDR 64-83, Contract AF 33(657)-10746, July 1964. 39 pp. 0088

The Texaco Research Coker was modified to a more dynamic system, to both approach the test conditions used in various fuel test rigs, such as the CRC rig, and to simulate actual mission profiles for different supersonic aircraft. The modifications included a vacuum system for the fuel reservoir, a cold finger device and a sampling port for fuel sampling. A series of shakedown runs have been completed using the modified test aggregate. The analytical phase of the program entailed development of a sampling method and determination of dissolved oxygen and nitrogen gases in fuel at the ppm range.

Billig, F. S., (Applied Physics Laboratory, Johns-Hopkins University), SUPERSONIC COMBUSTION OF STORABLE LIQUID FUELS IN MACH 3.0 TO 5.0 AIR STREAMS. "Symposium (International) on Combustion, 10th, Cambridge, England, August 17-21, 1964." Pittsburgh, Combustion Institute, 1964. 0089

Supersonic combustion of reactive aluminum alkyl fuels has been experimentally demonstrated in two-dimensional ducted combustors and adjacent to a flat plate. Fuel was injected from the combustor walls through multiple orifices and ignited spontaneously. Stable supersonic heat release was maintained as evidenced by schlieren and direct motion pictures of the flow field and deduced from static and pitot pressure measurements in the combustion zone. The results from the ducted combustor tests were correlated with simple theoretical models thus enabling a reasonable determination of combustion efficiency.

Blackman, A. W., PROBLEM AREAS AND RESEARCH NEEDED FOR THE DETERMINATION OF SIZE REQUIREMENTS FOR SUPERSONIC COMBUSTION RAMJETS. pp. 728-30 in: International Astronautical Congress, 12th, Washington, D. C., 1961. Proceedings, Vol. II. New York, Academic, 1963. 0090

The flow conditions which can be expected to exist in a hypersonic ramjet employing supersonic combustion, the processes which can be expected to control the combustion chamber size requirements, existing problem areas and needed research associated with these processes are discussed. The primary rate-controlling processes occurring in a combustion chamber with supersonic flow at the entrance are considered to be mixing, ignition delay, and reaction kinetics.

Blackstock, T. A. and Ladson, C. L., COMPARISON OF THE HYPERSONIC AERODYNAMIC CHARACTERISTICS OF SOME SIMPLE WINGED SHAPES IN AIR AND HELIUM. U. S. National Aeronautics and Space Administration, TN D-2328, June 1964. 40 pp. 0091

An investigation is made to study the simulation of high Mach number aerodynamics in air by the use of helium as a test medium. Force and moment characteristics for a series of wings of square and delta planform are presented at Mach numbers of 6.8 and 9.6 in air and 10.9 and 18.0 in helium for angles of attack up to 25°. The effects of leading-edge bluntness on all the wings and a vertical forward facing step on the square wing are also investigated. The experimental data are compared with theory, and normal-force coefficients are correlated by two methods. It was concluded that lift and drag coefficients could be predicted over the range of Mach numbers and for the test media used.

Blanchard, G.C., MECHANISM OF MICROBIOLOGICAL CONTAMINATION OF JET FUEL AND DEVELOPMENT OF TECHNIQUES FOR DETECTION OF MICROBIOLOGICAL CONTAMINATION. Melpar, Inc., Quarterly Progress Report, U. S. Air Force Contract AF 33(657)-9186, 1 March 1963 to 1 June 1963. 0092

Research objectives include rapid determination methods for micro-organisms in fuel-water environments and the mechanisms of their related problems to aircraft fuel systems. The investigations covered: a) ecology, microbial population, pH, microbial types; b) detection. In detection, the esterase enzyme approach is most rapid (10 minutes). On a 1 ml. sample it can detect 10^5-10^7 microbes. c) aluminum corrosion. Studies were in JP-4 fuels.

Blanchard, G.C., MECHANISM OF MICROBIOLOGICAL CONTAMINATION OF JET FUEL AND DEVELOPMENT OF TECHNIQUES FOR DETECTION OF MICROBIOLOGICAL CONTAMINATION. Melpar, Inc., Quarterly Progress Report, U. S. Air Force Contract AF 33(657)-9186, 1 June 1963 to 1 September 1963. 175 pp. 0093

The program has 2 objectives: study of techniques for rapid detection of fuel micro-organisms in the laboratory and the field, and the study of mechanisms by which micro-organisms and other contaminants cause problems in the fuel systems of aircraft. Several detection systems have been studied, and a system is being developed for rapid detection of fuel contaminants in the laboratory. Enzymatic methods are being developed for detection purposes. Preliminary studies using redox dyes as the tetrazoliums are described. The metabolism study is focused on corrosion, but the work is hampered by the long incubation time required. Metabolic studies with fuel organisms growing in both fuel and rich media may give some clue to fuel contamination problems and should provide information useful in devising controls and detection techniques. An extensive bibliography is included.

Blanchard, G. C. and Goucher, C. R. (Melpar), **MECHANISM OF MICROBIOLOGICAL CONTAMINATION OF JET FUEL AND DEVELOPMENT OF TECHNIQUES FOR DETECTION OF MICROBIOLOGICAL CONTAMINATION. PART I.** U. S. Air Force, APL TDR 64-70, Part I, Contract AF 33(657)-9186, January 1964. 127 pp. 0094

This report, subtitled Relationship Between Aluminum Corrosion, Sludge Formation, and Microbial Metabolism, describes results in the following areas. (1) Two assays using tetrazolium reduction were developed for the detection of small numbers of fuel microorganisms. (2) Growth of microorganisms in fuel-water media causes chemical changes in environment which result in a changing microbial flora. (3) The conditions for demonstrating microbial corrosion were further defined. The corrosion studies carried out were of value in showing the multiplicity of factors entering into the corrosion process. (4) Research on the nutrition of fuel-oxidizing Pseudomonas resulted in the formulation of a fuel-water medium capable of yielding 100 times the growth observed on any medium described in the literature. (5) Differences have been observed in survival of normal nonfuel-utilizing organisms and fuel-utilizing organisms when exposed to fuel. Fuel is not toxic to normal cultures in the presence of rich media. In fuel-water media, however, only fuel organisms survive.

Blyumberg, E. A., Norikov, Yu. D. and Emanuel, N. M., ROLE OF THE SURFACE IN CHAIN PROPAGATION REACTIONS IN THE LIQUID PHASE OXIDATION OF n-BUTANE. Doklady Physical Chemistry, 151, no. 5, 702-4 (1963). 0095

The isomerization and decomposition of the intermediate butyl peroxide radical proceeds by catalytic reaction on a stainless steel surface; at 145°C and 50 atm, the secondary products from the radical, i.e., acetaldehyde, acetone, methanol, ethanol, and methyl and ethyl acetate were equivalent to ~20 mole % butane in a stainless steel reactor and to ~1 mole % in a glass reactor. Packing the steel reactor with steel shavings increased the effect of the metal surface as expected. The latter also accelerated the consumption of butyl hydroperoxide, formed by an alternative reaction from the butyl peroxide radical with butane. Thus, 10-15 times more butyl hydroperoxide was detected in the glass reactor than in the steel reactor.

Bollinger, L. E. (Ohio State Univ.), FORMATION OF DETONATION WAVES IN COMBUSTIBLE GASEOUS MIXTURES. Combustion Institute. Western States Section. 1964 Spring Meeting. Paper WSS/CI, 64-15. 0096

A review is presented of selected papers and reports which pertain to the formation of detonation waves in combustible gaseous mixtures. During the past decade, extensive progress has been made in elucidating the mechanism, and the parameters that influence it, by which a deflagration wave accelerates and forms a stable detonation. Propulsion devices which employ stabilized detonation waves are being studied; thus, it is necessary to learn more about the transition process. The review treats both the work on moving detonations and stationary detonative combustion.

Bollinger, L. E., Fong, M. C. and Edse, R. (Ohio State University), DETONATION INDUCTION DISTANCES IN COMBUSTIBLE GASEOUS MIXTURES AT ATMOSPHERIC AND ELEVATED INITIAL PRESSURES. U. S. Air Force, WADC T. R. 58-591, Part II, Contract AF 33(616)-5615, August 1959. 78 pp. (O. T. S. 16178). 0097

Experimental measurements were made to determine the detonation-induction distances in hydrogen-nitric oxide mixtures and in hydrogen-oxygen-diluent mixtures in a 50 mm. tube for various diluent (nitrogen, helium, argon, or carbon dioxide) concentrations at initial pressures of 1 and 5 atmospheres and an initial temperature of 40°C. Addition of any of the diluents caused an increase in the detonation induction distance by varying amounts. A theoretical analysis of the formation of a detonation wave was made. A correlation function was found which relates the induction distance to the Reynolds' number, normal burning velocity of the mixture, the sonic velocity of the unburned gas, and the adiabatic combustion temperature of the given mixtures.

Bollinger, L. E., Fong, M.C. and Edse, R. (Ohio State Univ.), EXPERIMENTAL MEASUREMENTS AND THEORETICAL ANALYSIS OF DETONATION INDUCTION DISTANCES. ARS Journal, 31, 588-95 (1965). 0098

Generally, it is assumed that either the deflagration wave accelerates with the shock wave to form a detonation wave or that the shock wave has sufficient strength to ignite the combustible mixture immediately behind the shock. The transition mechanism is an unsteady process involving the flame acceleration, the shock-deflagration-rarefaction wave interactions, the generation of turbulence and the effects of chemical and molecular kinetics. The parameters which are most characteristic of the formation of a detonation wave are the induction distance and the induction period. In this analysis an approximate expression for the induction distance in terms of the temperature ratio across the detonation wave is given and an empirical relationship between the induction distance and the initial physical and chemical properties of various gas mixtures established. This work was sponsored by the U. S. Air Force under Contract AF 33(616)-5615.

Bolshakov, G. F. and Davydov, P. I., INFLUENCE OF ORGANIC SULFUR COMPOUNDS ON THE PROPERTIES OF SIMPLE DISTILLATE FUELS. Akademiya Nauk SSSR, Bashkirskii Filial. Khimiya Seraorganicheskikh Soedinenii, Soderzhashchikhsya v Neftyakh i Nefteproduktakh, 5, 138-48 (1963). (CA, 59, 8510 f). 0099

The effect of 15 sulfur-containing organic compounds on the thermal oxidation stability of reactive petroleum distillate fuels was determined by bomb tests in glass or brass vessels at 100-300°. Most of the data were obtained at 150° for a hydrogenated fuel having a boiling range of 140-230°. Parameters were corrosion of and deposit formation on a bronze coupon, amount of oil insoluble sludge formed, and optical density of the filtered product. Compounds were used at concentrations yielding up to 0.3% sulfur in the fuel. Fuel stability was reduced in the order: Thiophene < substituted thiophenes < substituted thiophanes < aliphatic sulfides < aromatic sulfides < aromatic disulfides < mercaptans.

Bolshakov, G. F., Davydov, P. I., et al, EFFECT OF NATURAL AND SYNTHETIC SULFUR- AND NITROGEN-CONTAINING COMPOUNDS ON THE THERMAL-OXIDATION STABILITY OF STRAIGHT RUN FUELS. Akademiya Nauk SSSR, Bashkirskii Filial. Khimiya Seraorganicheskikh Soedinenii, Soderzhashchikhsya v Neftyakh i Nefteproduktakh, 5, 160-76 (1963). (CA, 59, 6163 e). 0100

Basic sulfur- and nitrogen-containing compounds were isolated from the resins in TS-1, T-1, and DA fuels of the kerosine type by dissolving the resins in ether and extracting the ether solution with 25% H_2SO_4. The isolated mixture of bases was then added in amounts of 0-0.18% by weight to the resin-free fuels, and its effects on the thermal-oxidation stability of the fuels at 150° in relation to the concentration were studied on the basis of the weight of precipitate formed by the fuel, the optical density of the fuel, the amount of corrosion of bronze, and the weight of deposit formed on bronze.

Bolt, R. O. and Carroll, J. G. (California Research Corporation), **EFFECTS OF RADIATION ON AIRCRAFT LUBRICANTS AND FUELS**. U.S. Air Force, WADC TR 56-646, Part II, Contract AF 33(616)-3184, April 1958. 253 pp. (AD 151176). 0101

Effects of radiation on greases, hydraulic fluids, engine and gear lubricants, and jet fuels were studied. The thermal stability of nine jet fuels (five JP-4's, three JP-5's, and an RP-1) was evaluated in the CFR coker. Original stocks and samples irradiated at three different levels were tested. Low level irradiation (8.7×10^6 to 8.7×10^9 ergs/g C) impaired thermal stability. Reactor irradiation reduced thermal stability more than the equivalent gamma dosage. At high gamma dosages (above 40×10^9 ergs/g C) fuel thermal stability was usually improved or unchanged. Viscosity increase was the major problem at higher radiation dosages; an equation was developed by which it was possible to predict increase in viscosity with irradiation at any dosage once a single dosage point was known.

Bondaryuk, M. M. and Ilyashenko, S. M., RAMJET AIRCRAFT ENGINES. Moscow, Oborongiz, 1958. 392 pp. 0102

The authors present information on the theory, characteristics, construction, and design of subsonic and supersonic ramjet engines, based on Soviet and foreign information published in books or periodicals. They consider the theory behind the basic elements of an engine - diffusers, combustion chambers, and jet nozzles - as well as the operation of the entire engine. As sources of energy they discuss the use of molecular as well as nuclear fuel. This book is the first attempt to collect the information necessary to understand the physical processes, as well as gas dynamics and traction calculation for ramjets. The primary material for the book is from monographs of magazine articles published in Soviet and foreign open literature, as well as works by the authors.

Bore, C. L. (Hawker Aircraft Ltd.), SOME PRACTICAL ASPECTS OF KINETIC HEATING CALCULATIONS. Royal Aeronautical Society. Journal, 63, 637-45 (1959). 0103

This paper is concerned primarily with some of the practical difficulties encountered in connection with the prediction of kinetic heating temperatures. Attention is concentrated upon methods for estimating temperatures and heat transfer rates for practical aircraft designed to fly at Mach numbers up to about five.

Borisov, A. A., Kogarko, S. M., and Lyubimov, A. V., IGNITION OF METHANE MIXTURES IN SHOCK WAVES. Academy of Sciences (U.S.S.R.). Proceedings. Physical Chemistry Section, 149, 274-5 (1963). 0104

The article presents a brief description of experimental work in which ignition delays were measured for methane-air, methane-oxygen, and methane-oxygen-argon mixtures. Measurements were made in the region behind the reflected wave in a shock tube. Measured delays were of the order of 6-300 μsec for temperatures in the range 1200-2500°K Interpretation of the data and comparison with that of other investigations is hindered by presentation in graphical form only, and the quotation only of the initial pressure of the experiment rather than the pressure behind the reflected wave.

Bott, T. R. (Birmingham University), HEAT TRANSFER - SOME RECENT CONTRIBUTIONS. British Chemical Engineering, 7, no. 1, 18-27 (1962). 0105

This review embraces heat-transfer phenomena to be found in air and film cooling, in fluid solid systems, in two-phase flow and in boiling. A treatment of heat transfer with chemical reaction and mechanical heat transfer including the influence of mechanical agitation, and of vibrational effects such as those produced by ultrasonic means, conclude the review.

Boudart, M. and Kwan, T. (Princeton University), HETEROGENEOUS CATALYSIS. Industrial and Engineering Chemistry, 48, no. 3, 562-9 (1956). 0106

A review article for the period 1954-1955 in which the papers that best reflect main trends in fundamental catalytic research are discussed. Over 160 references are cited.

Bradbury, J. T., Keely, W. M., and O'Hara, F. J. (Holland Color and Chemical), HYDROGENATION AND DEHYDROGENATION. Industrial and Engineering Chemistry, 52, no. 9, 803-6 (1960). 0107

This is a review article covering hydrogenation and dehydrogenation of organic compounds. One hundred-eleven selected references are given on hydrogenation and dehydrogenation reactions, and a more extensive bibliography is available.

Bradbury, J. T., Keely, W. M., O'Hara, F. J., and Vance, R. F. (Girdler Catalysts), HYDROGENATION AND DEHYDROGENATION. Industrial and Engineering Chemistry, 51, no. 9, part 2, 1111-20 (1959). 0108

This is a review article covering hydrogenation and dehydrogenation of organic compounds. Three hundred-sixty nine references are given.

Bradley, J. N. (University of Liverpool), SHOCK WAVE TECHNIQUES IN COMBUSTION RESEARCH. Industrial Chemist, 38, 557-62 (1962). 0109

This review article covers the fundamentals of shock tubes, various configurations used for pyrolysis and combustion reaction studied, and reviews results of recent pertinent work in the field of combustion reactions in which shock tubes have been used as experimental tools.

Brandaur, R. L., Short, B., and Kellner, S. M. E. (University of Rochester), THE THERMAL DECOMPOSITION OF METHYLENECYCLOBUTANE. Journal of Physical Chemistry, 65, 2269-71 (1961). 0110

Methylenecyclobutane decomposed to ethylene and allene at 460°C. The kinetics of the pyrolysis were similar to those of alkylcyclobutanes rather than carbonyl-containing cyclobutanes. The activation energy for decomposition was about 61 kcal/mole.

Branger, M., VEIL COOLING OF RADIAL-FLOW TURBINES. AiResearch Manufacturing Co., Final Report No. K500, U.S. Navy Contract N onr 3685(00), October 1963. (AD 421888). 0111

Effective reduction of turbine rotor temperatures in gas and turbocharger turbines has been a subject of research for decades. Air-cooled hollowed blades and disks are now in production for aircraft axial gas turbine wheels, allowing higher gas temperatures with given materials. However, relatively little research has been done on radial turbine wheel cooling, even though this turbine type is now produced in larger numbers. Cooling passages in radial turbine wheels are quite conceivable, but veil cooling, the subject of this study, appears by far the simplest solution, considering the design requirements. The introduction of coolant (air) used in this project represents one of many approaches, and was selected to make accurate study possible. The application to back-to-back rotor configurations with limited air flow to the turbine wheel side and simplified circumferential seals appears quite attractive for gas turbines as well as turbochargers. The main objective of the present study phase was to obtain accurate material temperatures on the blades and disk of a semi-shrouded radial inflow turbine wheel at reasonably high gas temperatures, tip speeds, and expansion ratios, and thereby asses the true merits of veil cooling in its simplest form.

Brauer, H., BERECHNUNG DES WÄRMEÜBERGANGES BEI AUSGEBILDETER BLASENVERDAMPFUNG. Chemie-Ingenieur-Technik, 35, no. 11, 764-74 (1963). (International Aerospace Abstracts, 4, no. 4, 216, abstr. A64-11652, 1964). 0112

A comparison of available formulas for the calculation of heat transfer during evaporation of liquids is given. The observed discrepancies are discussed on the basis of previous experimental results. It is found that, although derived from different concepts, all the formulas have a similar structure.

Brian, P. L. T. (Massachusetts Institute of Technology), TURBULENT PIPE FLOW HEAT TRANSFER WITH A SIMULTANEOUS CHEMICAL REACTION OF FINITE RATE. A. I. Ch. E. Journal, 9, no. 6, 831-41 (1963). 0113

The rate of heat transfer from a solid wall to a gas mixture can be substantially affected by rapid reversible homogeneous reactions occurring between components in the gaseous mixture. In this paper results are presented from numerical solutions for the effect of a reversible chemical reaction of finite rate upon the rate of heat transfer in turbulent pipe flow. Linearization of the problem for a very small temperature driving force permits the expression of the results in terms of partial derivatives of an arbitrary reaction kinetic expression. The problem was simplified by focusing upon the steady state region in which the reaction rate is invariant with axial position at a given radial position, which will develop when the wall heat flux is constant with axial position.

Brian, P. L. T. and Bodman, S. W. (Massachusetts Institute of Technology), EFFECT OF TEMPERATURE DRIVING FORCE ON HEAT TRANSFER TO A NONEQUILIBRIUM CHEMICALLY REACTING GAS. Industrial and Engineering Chemistry Fundamentals, 3, no. 4, 339-46 (1964). 0114

The rate of heat transfer from a solid surface to a gas mixture is considerably modified by the presence of a rapid, reversible chemical reaction in the gas phase. Such a reaction gives rise to concentration gradients causing diffusion of the reacting species through the boundary layer and providing what may be the dominating mode of energy transport. This paper presents a film theory solution for heat transfer accompanied by a chemical reaction having a finite reaction rate. Results are obtained for the NO_2 decomposition reaction, but the use of dimensionless groups in the analysis allows general conclusions to be made for other chemical systems.

0115 Brian, P. L. T. and Reid, R. C. (Massachusetts Institute of Technology), HEAT TRANSFER WITH SIMULTANEOUS CHEMICAL REACTION: FILM THEORY FOR A FINITE REACTION RATE. A.I.Ch.E. Journal, 8, 322-9 (1962).

Through the use of a film theory model, the effect of a chemical reaction upon the rate of heat transfer from a solid wall to a gas is derived for both a homogeneous reaction and a heterogeneous reaction on the wall. By limiting the analysis to the case of a very small temperature driving force and to the case where the bulk gas is essentially in chemical equilibrium it is possible to obtain a solution to the linearized problem which is given quite general expression in terms of partial derivatives of arbitrary chemical kinetic expressions.

0116 Bridges, J. M. and Houghton, G. (Gulf Research and Development), THE EVALUATION OF ACTIVATION ENERGIES USING A RISING TEMPERATURE FLOW REACTOR - THE DEHYDROGENATION OF CYCLOHEXANE OVER WS_2, Pt/Al_2O_3, Cr_2O_3/Al_2O_3, $NiWO_4/Al_2O_3$ and Cr_2O_3. American Chemical Society. Journal, 81, 1344-8 (1959).

A rising temperature flow reactor has been used to evaluate the apparent activation energies and kinetics for the hydrogenation of cyclohexane over WS_2, Pt/Al_2O_3, Cr_2O_3/Al_2O_3, $NiWO_4/Al_2O_3$ and Cr_2O_3. The method has also been used to compare rapidly the activities of the various catalysts. On the basis of equal volumes of catalyst, the order of the activities is approximately $Pt/Al_2O_3 >$ water washed $Cr_2O_3/Al_2O_3 > Cr_2O_3/Al_2O_3 > NiWO_4/Al_2O_3 > Cr_2O_3 > WS_2$. However, on the basis of equal surface areas, the order of the activities is $Pt/Al_2O_3 >$ water washed $Cr_2O_3/Al_2O_3 > Cr_2O_3 > NiWO_4/Al_2O_3 > WS_2 > Cr_2O_3/Al_2O_3$. Electron irradiation from a Van de Graaff accelerator has been found to have no permanent effect on the activity of Pt/Al_2O_3. The thermal cracking of cyclohexane over Vycor wool has been found to proceed in the temperature range 566-700° with an activation energy of 49 ± 5 kcal/g mole.

0117 Bridges, J. M., Rymer, G. T., and MacIver, D. S. (Gulf Research and Development), THE MECHANISM OF POTASSIUM PROMOTION OF CHROMIA-ALUMINA DEHYDROGENATION CATALYSTS. Journal of Physical Chemistry, 66, 871-7 (1962).

A study was made of the mechanism of the alkali promotion of chromia-alumina dehydrogenation catalysts using cyclohexane reactions. The magnetic and adsorptive properties of these catalysts were also determined and correlated with catalyst activity and selectivity. The results suggested that there were two types of active sites on chromia-alumina, a dehydrogenation type associated with the chromia portion of the surface and an acid type associated with the alumina surface. The acid sites catalyze the formation of methylcyclopentane, which poisons the chromia dehydrogenation sites. The addition of potassium "neutralizes" these acid sites, hence increasing the dehydrogenation activity. Potassium in excess of that required for this "neutralization" is associated with the chromia portion of the surface and lowers the dehydrogenation activity. The interaction of the potassium with the chromia apparently results in the formation of a potassium-chromium complex with the chromium in a +6 oxidation state, which under reaction conditions reduces to a +3 state.

Bringer, R. P. and Smith, J. M. (Purdue University), HEAT TRANSFER IN THE CRITICAL REGION. A.I.Ch.E. Journal, 3, 49-55 (1957). 0118

Heat transfer coefficients were measured experimentally for carbon dioxide in turbulent flow in an 0.18-inch ID pipe. Pressure was 1200 psia and temperatures 70-120°F. Fluid to wall heat transfer coefficients ranged from 300 to 2600 Btu/hr-ft^2-°F for a Reynold's number range 30,000 to 300,000. Correlation of results with common equations and with a method of Deissler are discussed.

Brinich, P. F. (Lewis Flight Propulsion Laboratory), RECOVERY TEMPERATURES AND HEAT TRANSFER NEAR TWO-DIMENSIONAL ROUGHNESS ELEMENTS AT MACH 3.1. U.S. National Advisory Committee for Aeronautics, TN 4213, February 1958. 20 pp. 0119

The effects of single and multiple two-dimensional roughness elements on the temperature distribution, the pressure distribution, and the heat transfer on a hollow cylinder and a cone-cylinder model were determined at Mach 3.1. Abrupt perturbations in surface temperature occurred in the neighborhood of the elements when the boundary layer was turbulent, but were absent when it was laminar. The type of perturbation depended on the element shape, forward-facing wedges giving the lowest temperatures immediately behind the element, and forward-facing steps the highest. For a turbulent boundary layer the heat-transfer rate behind the wedge element was less than that immediately ahead of the element.

Brinich, P.F., A STUDY OF BOUNDARY-LAYER TRANSITION AND SURFACE TEMPERATURE DISTRIBUTIONS AT MACH 3.12. U. S. National Advisory Committee for Aeronautics, TN 3509, July 1955. 39 pp. 0120

Surface temperature distributions and high-speed schlieren motion pictures were used to study transition with and without single roughness elements on a hollow cylinder at various wind-tunnel Reynolds numbers. Increasing the sharpness of the leading edge increased the abruptness of the recovery temperature rise near the transition point and decreased the transition Reynolds number. Single roughness elements in the laminar boundary layer moved transition upstream and produced slight local changes in temperature distributions. Roughness elements in transitional and turbulent boundary layers produced large perturbations in temperature distributions.

Brokaw, R. S. (Lewis Research Center), **ANALYTIC SOLUTIONS TO THE IGNITION KINETICS OF THE HYDROGEN-OXYGEN REACTION.** U. S. National Aeronautics and Space Administration, Technical Note D-2542, December 1964. 15 p. 0121

Solutions have been obtained for a reaction scheme involving 5 rate constants as parameters. Results were obtained for a high pressure-low temperature region, a high temperature-low pressure region of short delays and for the boundary between these two regions. Experimental ignition delays in both regions are adequately explained, and delays computed by numerical integration of the rate equations are reproduced to within a few percent. Delays for the Van Neumann spike condition in Chapman-Jouquet detonations around the lean limit of detonability in air have been calculated. At the limit, delays decrease by two orders of magnitude as the hydrogen mole fraction increases by 0.01.

Brooks, D. B. (Office of Director of Defense Research and Engineering), MILITARY RESEARCH ON JET FUEL CONTAMINATION. American Petroleum Institute. Proceedings, 43, Section III, 172-7 (1963). 0122

Serious aircraft troubles, including engine flameouts, fuel gage malfunctions, integral tank corrosion, and other fuel system difficulties have been traced to contaminants in the fuel. The chief offenders, singly or in combination, have been found to be water, dirt (especially from rust), surfactants, and microorganisms. Improper operation and maintenance of fuel-handling equipment have been found to be the causative factors in each case of serious fuel contamination thus far investigated. The consensus of informed opinion is that the troubles encountered in field handling of fuels can be averted by good housekeeping throughout the fuel-handling system. 47 references are given.

Bruszak, A. E., Burgess, D. S., and Wijnen, M. H. J. (U.S. Bureau of Mines), REACTION KINETICS IN HOT-GAS IGNITION OF ETHANE-AIR. Combustion and Flame, 7, no. 3, 245-51 (1963). 0123

The reaction order was unity with respect to ethane and 0.25 with respect to oxygen, assuming an unchanged course of reaction over 800°-875°C. The activation energy was calculated as 49 kcal/mole. Heat balances were studied and rates of heat production obtained for the oxidation of ethane at low concentration near the axis of a jet of hot nitrogen issuing into cool ethane-air. Assuming purely thermal ignition, experimental results agreed well with predicted temperatures of hot-gas ignition, and also qualitatively with Spalding's centroid procedure for predicting burning velocity. The technique, originally used by Vanpee and Wolfhard, may be useful in studying the effects of additives on combustion.

0124

Burgess, R.W., Isakson, V.E., Tomlison, W.H., Burkhardt, C.E., Peterson, H.D. and Etheridge, B.R. (Beech Aircraft), HIGH TEMPERATURE FUEL SYSTEMS INVESTIGATIONS. U.S. Air Force, ASD TR 61-312, Contract AF 33(616)- 7073, August 1961. 54 pp. (AD 263457).

High-temperature hydrocarbon fuels were subjected to coker, gas chromatographic, and IR spectro-photometric analysis to determine the effects of various additives and thermal stressing. Aircraft fuel system components were installed in the pre-conditioning system to determine their suitability for operation under the test conditions, particularly with respect to elastomeric seals. Metal samples were physically stressed and subjected to the higher temperature ranges, both immersed in liquid and suspended in the vapor space. The tendency of the fuels to produce solids and the accumulation of the solids in the preconditioning system were continuously monitored. Appreciable solids accumulation was encountered. No accelerated stress corrosion occurred. It is thought that the duration of the exposure was insufficient to produce concrete results. Proper containment and restraint can extend the operating range of elastomeric seals considerably over their normal high temperature rating.

0125

Burgoyne, J. H. and Williams-Leir, G. (Imperial College), THE INFLUENCE OF INCOMBUSTIBLE VAPOURS ON THE LIMITS OF INFLAMMABILITY OF GASES AND VAPOURS IN AIR. Royal Society (London). Proceedings, A193, 525-39 (1948).

The influence of some incombustible vapours upon the upward propagation of flame through mixtures of combustible gases and vapours with air contained in a 1-7/8-inch glass tube has been examined and some comparisons made with results in a 4-inch tube. From the data obtained with the small tube it has been possible to plot diagrams for each of the combustibles with inert vapour and air showing completely the compositions of inflammable and non-inflammable mixtures. From these, the limiting "safe" composition of mixtures of inert vapour with air and with the combustible respectively have been derived. The combinations studied were hydrogen, methane, ethylene, carbon monoxide, n-hexane, cyclohexane and benzene with methyl bromide; hydrogen and n-hexane with difluorodichloromethane, and methane with carbon tetrachloride.

0126

Burton, E. J. and Hurden, R. K , RECENT ADVANCES IN MEASURING FLAME AND GAS TEMPERATURES. Iron and Coal Trades Review, 164, 1211-15 (May 30, 1952).

This review of the technique of measuring flame temperatures discusses attempts that are being made to give intelligible results for turbulent flames. In the investigation of the heat transfer from luminous flames, both flame temperature and emissivity need to be measured. The Schmidt method of emissivity measurement, using the furnace wall and a cold surface as comparison background radiators, seems likely to be the most reliable, and least difficult method to attempt in industrial furnaces. Instruments have been developed for the measurement of the sensible heat content of gases, although there appears to be no pyrometer available for the continuous metering of pre-heat temperatures.

Buschfort, H.G. and Hundere, A. (ALCOR, Inc.), **DEVELOPMENT OF HIGH TEMPERATURE DEPOSITION RIG FOR ADVANCED ENGINE LUBRICANTS.** U.S. Air Force, ASD TDR 63-255, Contract AF 33(616)-7136, March 1963. 19 pp. 0127

The objective of this program covered by Contract AF 33(616)-7136, S3(62-1026), is to develop a deposition rig that will rate lubricants in the same order as the engine with respect to coke, sludge, and oil degradation, be capable of operating with oil in temperatures up to at least 700°F and surface temperatures up to at least 1000°F, and have repeatability and reproducibility for close quality control. A rig was developed which duplicates dynamically the thermal and oxidation stresses to which the oil is subjected in an engine. The effect of operating variables was studied using a polyphenyl ether (0-61-20). The rig was modified considerably from the original design developed utilizing diester base oils because it was necessary to increase the maximum design operating temperatures to stress polyphenyl ethers to the break point and also to obtain satisfactory continuous operation at these extreme temperatures.

Buschfort, H. G. and Hundere, A. (ALCOR, Inc.), **DEVELOPMENT OF HIGH TEMPERATURE DEPOSITION RIG FOR ADVANCED ENGINE LUBRICANTS.** U. S. Air Force, APL TDR 64-49, Contract AF 33(657)-10037, June 1964. 31 pp. 0128

The objective of this program was to develop a test rig and a procedure to evaluate experimental gas turbine lubricants at surface temperatures up to 1000°F and to yield results that are indicative of lubricant performance in advanced high mach gas turbine engines with respect to sludge, coke, acidity, and viscosity change. The phase of the program covered by this report was directed to studying the effect of variables on a polyphenyl ether, 0-61-20, utilizing a 48-hour test. Major emphasis was placed on the formation of deposits. Tests were also conducted on engine-tested MIL-L-7808 oils to further check the correlation previously established.

Buschfort, H. G. and Hundere, A. (ALCOR, Inc.), **DEVELOPMENT OF STANDARDIZATION FLUID FOR ASTM-CFR FUEL COKER.** U. S. Air Force, WADD TR 60-878, Contract AF 33(616)- 7266, February 1961. 17 pp. (AD 260 603). 0129

Studies were made to develop a standardization fluid for the ASTM-CFR Fuel Coker to give a no. 3 preheater rating and 10- to 15-in. Hg filter pressure drop across the filter at 300 F/400 F/6 conditions at the same time having maximum sensitivity to temperature changes and adequate storage stability. A total of 59 chemicals were investigated as poisoning agents in heart cut alkylate bottoms (Soltrol 170). The poisoning agents that best fulfilled the objective were pyrrolidine at a concentration of 0.5 ml/gal and pyrrole at a concentration of 4.0 ml/gal. Both combinations gave no. 3 preheater ratings, but in both cases the filter pressure drop was only about 2-in Hg. Pyrrolidine is more satisfactory from the standpoint of storage stability, but pyrrole has somewhat greater sensitivity to temperature changes. It is concluded that although a poisoning agent in a stable base stock could be used as a standardization fluid, a better approach would be to utilize a production fuel of the desired thermal stability, the rating of which would be monitored and controlled by a central laboratory.

Bushueva, E. M. and Bespolov, I. A., EFFECT OF THE FRACTIONAL AND HYDROCARBON COMPOSITION OF (JET) FUELS ON THEIR THERMAL STABILITY. Khimiya i Tekhnologiya Topliv i Masel, 8, no. 8, 49-54 (1963). 0130

In tests involving bubbling air for 3 hr at 150°-300°C the total content of oxidation products increased as the boiling range of the fuel fraction rose. The tendency to formation of precipitate was greater in straight-run oils than in fractions of hydrogenated green oil from pyrolysis or hydrogenated gas oil from catalytic cracking. The amount of precipitate reaches a maximum in oxidation at 200°C, decreasing at higher temperatures. Upon dearomatization, the fuels are very stable. With rise in aromatic content of the fuel, the amount of oxidation products increases. The tendency to form precipitate reaches a maximum at an intermediate concentration of aromatics, decreasing at higher concentrations, presumably because the highly oxidized compounds are dissolved in the aromatic-rich fuel. Tables and references. (in Russian)

Byington, A., A CORRELATION OF WATER SOLUBILITY IN JET FUELS WITH API GRAVITY, ANILINE POINT, PERCENT AROMATICS, AND TEMPERATURE. Texas A and M College, Master's Thesis, January 1964. 29 pp. (AD 423 062). 0131

The solubility of water in jet fuels is of particular interest in aircraft operation because at low temperatures this water could form ice which would deposit on fuel filters and control mechanisms and adversely affect fuel flow and engine performance. Long range, high altitude flights aggravate the problem, and the use of micronic filters in fuel lines maximizes the danger of plugging from any ice present. The solubility of water was determined for several samples of jet fuels at various temperatures. The samples covered the range of fuels normally encountered in military and civilian use. An equation was developed for predicting the solubility of water in jet fuels. The equation includes API gravity, aniline point, and percent aromatics. The average absolute deviation is 8.122% with a maximum deviation of 32.4%.

Calvelli, E. A. (Grumman Aircraft), DON'T BLAME THE BACTERIA. Society of Automotive Engineers. SAE Paper 749C, September 1963. 4 pp. 0132

Investigation of the corrosion problem associated with microbiological contamination of jet fuel reveals a definite relationship between microorganisms and other contaminants. These contaminants include: saline water, rust, surfactants, and dirt. If we destroy the microorganisms without effectively removing the ingredients which cause both their growth in, and the corrosion of wing tanks, we are only flying on borrowed time. The problem of corrosion will never be completely solved by the elimination of bacteria alone. Only a concentrated effort to keep the total list of ingredients out of the fuel system will suffice.

0133 Campbell, J.R., THIRD QUARTERLY PROGRESS REPORT OF THE CY 1962 AIR FORCE-MARQUARDT CONTRIBUTING ENGINEERING PROGRAM. The Marquardt Corporation, Report No. 25,059, Vol. II, U.S. Air Force Contract AF 33(600)-40809, October 1962. (AD 332720). REPORT CLASSIFIED CONFIDENTIAL.

The contents of this report include study of multicomponent fuels, high energy fuels, solid and slurry hydrogen, advanced controls systems, auxiliary power generation, and advanced test facilities. The calendar year 1962 Air Force-Marquardt Contributing Engineering Program was authorized as a part of Contract AF 33(600)-40809 by Supplemental Agreement No. 13. Contract AF 33(600)-40809 also covers the RJ43-MA-11 Ramjet Engines, Data, and Publications Program. The detailed description of the over-all Contributing Engineering activity is included in The Marquardt Corporation Proposal No. 9027A, dated 13 December 1961 and revised 9 January 1962 and 22 March 1962.

0134 Canning, F. R., Fisher, A., Ford, J. F., Holmes, P. D. and Smith, R. S., DEHYDROCYCLIZATION OF 2,2-DIMETHYL-4-(METHYL-C^{14})-PENTANE AND 3-(METHYL-C^{14})-HEPTANE OVER CHROMIA-ALUMINA. pp. 205-16 in: International Atomic Energy Agency, "Radioisotopes in the Physical Sciences and Industry, vol III", Vienna, Globus, 1962.

The relative specific activities of the reaction products suggest the following mechanisms for dehydrocyclization. With 2,2-dimethyl-4-(methyl-C^{14})-pentane the methyl groups at both ends of the molecule become attached at adjacent sites on the catalyst surface. Rearrangement at the trisubstituted end of the molecule to give a six-membered ring, followed by dehydrogenation, gives p-xylene with 50% activity in the methyl groups. With methyl heptane the activity distribution in the aromatic products shows that the products were not formed by simple ring closure but probably via C_5, C_6 and C_7 ring intermediation.

0135 Carberry, J. J (University of Notre Dame), THE DESIGN OF LABORATORY CATALYTIC REACTORS. American Chemical Society, Abstracts of Papers, 145th Meeting, September 1963, pp. 28 I-29 I.

A comparatively novel well-stirred, constant-environment, gas-solid catalytic reactor was designed which promises to be free of interparticle heat and mass transfer gradients commonly existing in fixed-bed systems. This device is described in detail; problems associated with experimental determination of kinetic data on heterogeneous catalytic reactions and specific limitations of various common laboratory reactor types are discussed; and some design criteria for small-scale fixed-bed reactors are suggested

Carne, M. (Atomic Energy of Canada, Ltd.), STUDIES OF THE CRITICAL HEAT-FLUX FOR SOME BINARY MIXTURES AND THEIR COMPONENTS. Canadian Journal of Chemical Engineering, 41, no. 6, 235-41 (1963). 0136

A pool boiler and a forced convection loop used for studying critical heat fluxes in binary mixtures are described. The geometry of the test element is shown to be an important variable in pool boiling experiments, affecting both absolute flux values and the variation with composition. Data given for AC and DC power supplies show that the critical heat flux is relatively unaffected by the power supply source. Empirical equations for critical flux vs velocity and subcooling are given for benzene, toluene and acetone, which correlate the forced convection subcooled data with average deviations of 3.1%, 5.0% and 5.1% respectively. Forced convection subcooled data are given for the systems benzene-toluene and acetone-toluene showing the effect of composition on critical heat flux. It is concluded that, at forced convection subcooled conditions in certain concetration ranges, binary mixtures may exhibit critical heat fluxes which are higher than for either of the pure components. In this respect loop experiments are analogous to pool boiling ones. However, extrapolation from pool boiling experiments to loop conditions does not appear to be feasible under the present test conditions.

Carr, N. L. and Schagrin, E. F. (Gulf Research and Development Co.), UTILIZATION OF DIGITAL COMPUTERS IN KINETICS STUDIES. American Chemical Society, Abstracts of Papers, 145th Meeting, September 1963, p. 29 I. 0137

A method of studying reaction kinetics in reasonably complex systems by using a combination of computers and model building techniques has been developed. The availability of certain computer programs makes this kind of approach feasible; one of these is a reactor simulation (REASON) program developed specifically for analyzing reactor data. This approach is valuable mainly during the early stage of a study, since it reduces the experimental work needed and broadens both the amount and scope of the knowledge generated from the data. Examples are given on use of these methods (1) to develop and study reaction kinetics models; (2) to develop and test chemical reaction mechanisms; (3) to predict how the catalyst might be utilized more effectively; (4) to provide a basis for conjecture about the role of the catalyst, thereby leading to its improvement; and (5) to explore types of reactors and modes of operation as the first step towards optimization of the reactor system.

Carroll, J. G., Bolt, R. O., and Bert, J. A. (California Research Corporation), A SURVEY OF THE RADIATION STABILITY OF HYDROCARBON FUELS. Aeronautical Engineering Review, 17, 61-6 (March 1958). 0138

Small samples of a gasoline stock, kerosene, stove oil, and typical JP-3, JP-4, and JP-5 jet fuels were exposed to gamma radiation. Postirradiation tests were performed and these results compared with those from the original fuels. Gas evolution as a result of irradiation was also measured. The results obtained are compared for the various types of fuels.

Carroll, J. G., Bolt, R. O. and Bert, J. A. (California Research Corp.), A SURVEY OF THE RADIATION STABILITY OF JET FUELS. U. S. Atomic Energy Commission, TID-5363, Contract AT(11-1)-174, 1956. 38 pp. (CA, 59, 8510 b). 0139

Seven fuels were exposed to γ-radiation. The fuels included stove oil, furnace oil, JP-3, JP-4, JP-5, kerosine, and aviation gasoline. The latter 4 were also irradiated in the Materials Testing Reactor. For neutron-irradiated fuels, viscosity and gassing information was obtained. For the γ-irradiated samples, several physical properties were obtained by micro methods, including ASTM distillation. For 1 kerosine-type fuel, sufficiently large amounts were γ-irradiated so that thermal stability tests were run in the Erdco Fuel Coker.

Cauha, M., Jr. and Gardiner, K. W. (Consolidated Electrodynamics), AN ANALYZER FOR MOISTURE AND SOLIDS IN JET FUELS. U. S. Air Force, WADD TR 60-461, Contract AF 33(616)-6588, December 1960. 27 pp. (AD 247114). 0140

An instrument for continuously and simultaneously measuring total water, suspended water, and dissolved water in jet fuels was developed in conjunction with the anti-icing program at WADD. Studies were also made of photometric techniques for solid contamination detection and of the adaptability of a nephelometric method to the moisture analysis equipment to form a unitized contaminants analyzer.

Ceresuela, R., Marguet, R. and Vaucheret, X. (O.N.E.R.A.), L'ECHAUFFEMENT CINETIQUE D'UNE MAQUETTE SCHEMATIQUE D'AVION DE TRANSPORT SUPERSONIQUE. International Council of the Aeronautical Sciences, Fourth Congress, Paris, Paper 64-560, August 24-28, 1964. 0141

The present study was undertaken to study the kinetic heating of a supersonic aircraft. The particular problem of interest is the development of significant thermal stresses during the rapid acceleration and climb portion of the mission. Such stresses can be quite severe in the vicinity of leading edges of aerodynamic surfaces. The study comprised examination of kinetic heating effect on model structures in wind tunnel experiments and rocket flight experiments.

0142 Chang, Y. P. (State University of New York), SOME POSSIBLE CRITICAL CONDITIONS IN NUCLEATE BOILING. American Society of Mechanical Engineers. Transactions. Series C. Journal of Heat Transfer, 85, no. 2, 89-100 (1963).

The primary purpose of this theoretical treatment is to introduce into boiling heat transfer certain basic ideas from which several critical conditions are derived. The heat transfer in nucleate boiling is considered as being limited by the maximum rate of bubble generation from a unit area of the heating surface. With certain simplified assumptions, an equation is obtained for the first critical heat flux of nucleate boiling with and without forced convection and subcooling. This study was sponsored by the U. S. Atomic Energy Commission under Contract AT (11-1)-785.

0143 Chauvin, L. T., AERODYNAMIC HEATING OF AIRCRAFT COMPONENTS. U. S. National Advisory Committee for Aeronautics, RM L55L19b, February 1956. 12 pp. (AD 84750).

Aerodynamic heat-transfer data obtained at supersonic speeds are presented for various airplane components such as a conical nose, a blunt conical nose, a cone cylinder body, a flat face canopy, a delta wing at an angle of attack, and a deflected flap. The data are correlated on the basis of Stanton number for various supersonic Mach numbers and Reynolds numbers. For all cases investigated, the measurements were in reasonable agreement with theoretical predictions except for the sheltered surface of the delta wing at angle of attack. In addition to the heat transfer measured on the 50° blunt cone, transition was found to occur at a Reynolds number of 0.5×10^6 based on local conditions at a free-stream Mach number of 4.84.

0144 Chertkov, Ya. B., INCREASING THE ENERGY CONTENT OF HYDROCARBON FUELS. Khimiya i Tekhnologiya Topliv i Masel, 1962, no. 2, 63-7.

The increase of energy content by selecting hydrocarbon groups of a certain structure and high density was investigated. The yield, refractive index, density, molecular weight, empirical formula, mean content of CH atoms in side chains and specific heat of combustion of monocyclic aromatic hydrocarbons produced from 50°C fractions from various feedstocks are tabulated. The results show that in industrial hydrocarbon fractions boiling in the range 100 to 350°C, the monocyclic hydrocarbon content ranges from 8 to 38% depending on the feed and the method of refining. The use of monocyclic aromatic hydrocarbons as feedstock for producing new naphthenic fuels for supersonic aircraft is proposed.

Chertkov, Ya. B., **METHODS OF INCREASING THE ENERGY CONTENT OF HYDROCARBON FUELS.** Khimiya i Tekhnologiya Topliv i Masel, <u>1960</u>, no. 4, 1-4. (U.S. Air Force Trans. MCL 1300/1+2; AD 264501). 0145

Liquid hydrocarbon fuel with a maximum heat of combustion can be produced only with proper blending of hydrocarbons, taking into account their chemical structure. For hydrocarbons of all classes the density and the heat of combustion per unit volume increases with an increase in the number of short side-chains (methyl groups) added to the basic structure. The heat of combustion per unit volume also increases with an increase in the molecular weight of the hydrocarbon blend. Among the different classes of hydrocarbons the heat of combustion per unit volume increases in the following order: paraffin, naphthene monocyclic aromatic, bicyclic aromatic. The most effective method for increasing the energy content of hydrocarbon fuel is to add the maximum amount of high density aromatics. Work is required to improve the combustion properties of such aromatics in an engine.

Chertkov, Ya. B., **ON THE MECHANISM OF SEDIMENT FORMATION IN T-TYPE FUELS.** Khimiya i Tekhnologiya Topliv i Masel, <u>1960</u>, no. 9, 57-61. (Extensive summary available as AD 245716. 2 pp.) 0146

This article is a further contribution to the studies on sediment formation in ligroin-kerosene jet fuels. It is stated once again that the formation of sediment is due to the oxidation of nonhydrocarbon (N-, S-, and O-containing) constituents of fuel. The sediment deposits are assumed to be the products of condensation and polymerization of oxygen-rich compounds (presumably hydroxycarboxylic acids) into lactides, estolides, etc.

Chertkov, Ya. B., Ragozin, N. A., and Marinchenko, N. I., **COMPOSITION OF DEPOSITS FORMED ON FUEL FILTERS OF TRANSPORT JET AIRCRAFT (SUMMARY).** Khimiya i Tekhnologiya Topliv i Masel, <u>1961</u>, no. 4, 57-60. (U.S. Library of Congress AID 61-100; AD 261443). 0147

A study of sediment from TC-1 fuel which clogs fuel-system filters of transport jet aircraft and refueling-unit filters is reported. On the fuel-system filter, sediment formed at 45 to 50°C, while in the refueling units sediment formation took place at the ambient temperature. The inorganic component of the refueling-unit sediment differed from that of the aircraft in higher Fe and Zn contents, while the ash-forming elements remained at approximately the same level (48%). Na was found in much smaller quantities than in the aircraft sediment. In both cases considerable contamination by ground dust was found. The refueling-unit sediment contained a smaller amount of the organic component than the aircraft sediment, except in one case. A suggestion was made that jet fuels be stored in hermetic reservoirs provided with corrosion-resistant linings and that fuel to be dispensed be filtered until complete removal of mechanical impurities with particle size over 1 to 2 microns is achieved.

Chertkov, Ya. B. and Shchagin, V. M., DEGREE OF DISPERSION OF INSOLUBLE SEDIMENTS FORMED IN HEATED FUELS. Khimiya i Tekhnologiya Topliv i Masel, 1959, no. 11, 23-28. 0148

Elevated temperature is the main factor in sediment formation. These are formed by oxidation and polymerization of nitrogen-sulfur and oxygen-containing (heteroatomic) compounds. Hydrocarbons have a limited capacity to retain such high-molecular compounds either in solution or in colloidal dispersion.

Chertkov, Ya. B. and Zrelov, V. N., EFFECT OF CHEMICAL COMPOSITION ON THE THERMAL STABILITY OF FUEL T-1. Azerbaidzhanskoe Neftyanoe Khozyaistvo, 1959, no. 10, 39-40, (CA, 54, 20172h) 0149

The fuel T-1 (U. S. S. R. standard 4138-49) has d_{20} 0.8182; molecular weight 152; and a boiling range of 147-279°. The following group chemical composition (in %) was found: aromatic hydrocarbons 17.6, naphthenes 44.6, and paraffins 37.8, actual gum 6.4 ml./100 ml., I no. 0.98, acidity 0.55 ml. KOH/100 ml., and S 0.03%. Nonhydrocarbon compounds and especially their high-molecular-weight reaction products, adversely affect the thermal stability of the fuel T-1. The aromatic hydrocarbons, because of the presence of small amounts of olefinic-aromatic structures, have some adverse effect on the thermal stability of the fuels. Olefinic-aromatic compounds appear to be the basic cause for the formation of non-hydrocarbon compounds in the fuels, and their removal greatly increases thermal stability.

Chertkov, Ya. B. and Zrelov, V. N., INHIBITION OF THE FORMATION OF TRUE GUM DURING STORING OF CRACKED GASOLINES. Khimiya i Tekhnologiya Topliva i Masel, 1957, no. 2, 67-8. (CA, 51, 13369c). 0150

Removal from gasoline of O compounds which are natural gum inhibitors (e.g. chromatographically), increases sharply the true gum content of the gasoline. Addition of wood-tar antioxidants inhibits gum formation. Storage of stabilized cracked gasolines for 12 months increased the true gum content by 5-25 mg/100 ml. Addition of 0.008% of p-hydroxydiphenylamine caused an immediate lowering of the gum content to its initial value. Repeated stabilization of gasoline can preserve its good quality for long storage periods.

Chertkov, Ya. B. and Zrelov, V. N., **OXIDATION OF HYDROCARBON FUELS DURING PROLONGED STORAGE**. Novosti Neftyanoi Tekhniki, Neftepererabotka, 1956, no. 2, 19-20. (Referativnyy Zhurnal. Khimiya, 1956, abstr. 79098). (C. A., 53, abstr, 9631d, 1959). 0151

The oxidation processes are discussed, which take place during the storage of hydrocarbon fuel. It was found that the oxidation products are mainly primary, secondary, and tertiary aromatic alcohols, with side chains with 3-7 C atoms which are formed by the oxidation of aromatic hydrocarbons with an unsaturated side chain.

Chertkov, Ya. B., Zrelov, V. N. and Afanaseva, N. A., **CHARACTERISTICS OF THE NONHYDROCARBON COMPOSITION OF LIGROIN-KEROSENE PETROLEUM FRACTIONS**, Journal of Applied Chemistry (U.S.S.R.), 33, No. 8, 1861-71 (1960). (Two page summary also available as AID Report 60-58, AD 245711). 0152

Chromatographic separation and further fractionation of nonhydrocarbon constituents (resins) of Soviet kerosene-type fuels were performed in order to provide a closer chemical determination of resin composition and structure. Soviet straight-run jet fuels and cracked tractor kerosene were used for the investigation. Resins were separated and fractionated further on silica gel (65-120 mesh) with isopentane and methanol used as eluents. Acids and basic nitrogen compounds were extracted. The chemical findings indicate that:
(a) Basic nitrogen compounds seem to belong to derivatives of pyridine and in heavier fractions to derivatives of quinoline. The total amount of basic nitrogen compounds is small, approximately one percent on resins. (b) Sulfur compounds are predominantly of cyclic structure and strongly unsaturated. (c) Oxygen compounds contain mainly hydroxyl, ether, and ester functional groups. It was possible to separate hydroxyl and ether compounds as individual fractions of considerable purity. (d) The structures found are mostly cyclic, i.e., naphthenic in straight-run and aromatic in cracked fuels.

Chertkov, Ya. B., Zrelov, V. N., Marinchenko, N. I. and Shchagin, V. M., **RESIDUE FORMATION IN FUELS FOR GAS TURBINE ENGINES**. Khimiya i Tekhnologiya Topliva i Masel, 1957, no. 7, 57-63 (CA 52, 3302e). 0153

To stimulate likely conditions in fuel tanks of jet planes, the fuel (for several of which sp. gr., boiling limits, I no., and S, mercaptan, and tar contents are given in a table) is heated for 6 hrs. at 120° in the presence of 20 sq. cm. of Sb bronze/100 ml. of fuel. Elementary analysis of residue and elementary analysis of ash from residue are given in tables. Greatest thermal stability is shown by highly purified fuels from direct distillation which contain a minimum of unsaturated hydrocarbons and have the least nonhydrocarbon contaminations such as O-, N-, and S-containing compounds. Exclusion of air O from contact with fuel in storage should increase its thermal stability.

Chertkov, Ya. B., Zrelov, V. N., and Rudakov, V. V., THE HEAT OF COMBUSTION OF HYDROCARBON MIXTURES OF DIFFERENT COMPOSITION. Novosti Neftyanoi Tekhniki, Neftepererabotka, <u>1956</u>, no. 2, 11-14, (CA, <u>53</u>, 9630 i). 0154

Data are given for the lower weight and volumetric heats of combustion of paraffins, naphthenes, and aromatic hydrocarbons, separated chromatographically from 50° fractions, obtained by distillation of gasolines from various sources and having a boiling range of 100-300°. The relation between the structure of hydrocarbons and their heats of combustion indicates that naphthenes are needed to obtain a fuel with a high volumetric heat of combustion.

Chiantella, A.J. and Johnson, J.E., FILTERABILITY OF DISTILLATE FUELS. PART 2. EFFECT OF FUEL VISCOSITY AND RELATED FACTORS. U.S. Naval Research Laboratory, NRL 5971, September <u>1963</u>. 18 pp. (AD 421 925). 0155

Studies of additional factors influencing filterability of distillate fuels further substantiate the utility of a constant-head gravity-flow method for rating filterability. Quantitative relationships were made possible by selecting filter papers of uniform porosity. It was shown that the filterability of a distillate fuel contaminated by a given amount of sediment is directly proportional to the fuel viscosity. The effect of temperature on filterability was proven to be due to the variation of viscosity with temperature. Filterability is also directly proportional to the fuel pressure (head) on the filter. It was shown that variations in filter porosity could be balanced by proper adjustment of fuel head. No significant change in fuel viscosity was found due to aging, either normal or accelerated. It is proposed, therefore, that changes in fuel filterability due to aging are due to accumulation of insoluble residues in the fuel.

Chinitz, W., RESEARCH IN SUPERSONIC COMBUSTION. Symposium on Jet Propulsion for Industry Research Associates, Polytechnic Institute of Brooklyn, Feb. 16-17, <u>1961</u>. 0156

In recent years, the necessity for high Mach number vehicles has resulted in considerable research on supersonic flow streams. Concurrently, interest has arisen in the possibility of sustaining combustion in supersonic flow. This paper discusses research on combustion in supersonic flow which was carried out by the Research Group at the Fairchild Engine Division headed by Dr. R. A. Gross from 1957-1959. Work previously dealt with in the technical literature is treated only briefly here. On the other hand, a segment of the research, dealing with chemical reactions in a supersonic boundary layer and flame stabilization, which was not extensively reported before, is dealt with in greater detail.

Chinitz, W., A SURVEY OF FUELS SUITABLE FOR EXTERNAL COMBUSTION APPLICATIONS. General Applied Science Laboratories, Inc., Technical Memo No. 109, U. S. Army Contract DA-30-069-AMC-216(Z), June 1964. 26 pp. (AD 602 274). 0157

A wide variety of fuels are examined to determine those suitable for an external combustion application in a specified range of flight conditions. The original list of 27 fuels in 5 classes is reduced to 9 which are potentially acceptable. The 5 classes of fuels examined are: hydrocarbon and alcohol liquids, hydrocarbon gases, hydronitrogens, pyrophoric fuels and monopropellants. The nine selected fuels are: JP-4, JP-5, acetylene, TEA, TMA, TEB, TBB, pentaborane and aluminum borohydride. Further considerations regarding ignitability, stability of combustion and availability and cost indicate that only TEA, TMA, TEB and mixtures of hydrocarbons and these three pyrophoric fuels may be acceptable.

Chinitz, W., Bohrer, L.C. and Foreman, K.M. (Fairchild Engine and Airplane Corp.) PROPERTIES OF OBLIQUE DETONATION WAVES. U.S. Air Force, AFOSR TN 59-462, Contract AF 49(638)-15, April 1959. 10 pp. (AD 215267). 0158

The two-dimensional steady flow equations for oblique detonation waves are solved for the conditions across the wave in terms of the initial Mach number, the heat addition, and the wave angle. Using an I.B.M. digital computer, the resulting equations are solved over a range of the independent variables. Graphs are presented which show the results of this computation.

Chouikine, N. I. and Minatchev, Kh. M., NOUVEAU CATALYSEUR AU PALLADIUM POUR LA DÉSHYDROGÉNATION DES CYCLANES A 6 ATOME DE CARBONE. Paris. Institut Français du Pétrole. Revue, 11, no. 12, 1611-15 (1956). 0159

The authors have examined activity and stability of low percentage palladium (approximately 0.5%w) on alumina pellets (3 x 4 mm). Catalyst was treated with HF before impregnation and post treated with $H_2$3 after calcining. The catalyst showed little activity at 300-310°, but with 0.3 LHSV at 450°, 93.4% conversion of cyclohexane was obtained. In a life test with practical fuel containing 7.5% aromatics and 0.0025% sulfur at 20 atm, 5/1:H_2/oil, 450-460° and LHSV of 1.0, 40% aromatics in the product was obtained for over 260 hours. Emphasis in the work has been toward development of palladium catalysts as replacements for platinum in platforming.

Chouikine, N. I. and Naryshkina, T. I., DESHYDROGENATION DES CYCLANES ET DES CYCLENES EN PRESENCE DE CHARBON ACTIVE. Paris, Institut Francais du Petrole. Revue, 17, no. 1, 170-9 (1962). 0160

Cyclohexane and methylcyclohexane were converted to benzene and toluene, respectively, over birchwood charcoal at 500-600°C. With this catalyst at the same temperature, cyclopentene and methylcyclopentene were converted to the corresponding cyclopentadienes. Substantial yield of aromatics or of cyclopentadiene were obtained with this catalyst. Pressures were 1 atm for the cycloalkane dehydrogenation and 10-15 mm for the alkene dehydrogenation. Space velocities of 0.1 to 0.3 were employed.

Chrisney, J. B., GAS SOLUBILITY IN TWO MILITARY FUELS AND EFFECT ON VISCOSITY. Thompson Products, Inc., ING. ER. 204, Phase III Interim Report, U. S. Air Force, Contract AF 33(616)-3729, May 1957. 47 pp. (AD 132857). 0161

Research was undertaken to determine (1) the equilibrium solubility of ethane in a JP-4 fuel at temperatures up to 500°F and pressures up to 400 psia; (2) the equilibrium solubility of nitrogen, air, and ethane in Shell UMF grade C fuel at temperatures to 500°F and pressures to 400 psia; and (3) the viscosities of both fuels as functions of temperature and dissolved-gas concentrations. Each test fuel was subjected to the following physical and chemical inspections in accordance with Spec MIL-F-5624B: distillation, gravity, and Reid vapor pressure. Summaries of solubility and viscosity determinations are graphically presented. Results indicated an increasing solubility of nitrogen and air in Shell UMF fuel with increasing temperature, the opposite effect for ethane in either fuel, and lower ethane solubilities in the higher boiling fuel (Shell UMF). The apparent irregularities in air solubility at 300° and 400°F were attributed to oxygen-consuming chemical reactions such as gum formation.

Churchill, A. V., MICROBIOLOGICAL EXAMINATION OF JET FUEL-WATER SAMPLES - RAMEY AND EGLIN AIR FORCE BASES. U. S. Air Force, ASD-TDR 62-361, July 1962. 9 pp. (AD 285002). 0162

An investigation was conducted to identify microorganisms permitting microbiological contamination and resulting corrosion of B-52 and KC-135 integral fuel tanks at Ramey and Eglin Air Force Bases. Of the microorganisms isolated, the most predominant groups found were the transparent bacterium and the iron-depositing bacterium. Sulfur-oxidizing bacterium was possibly present in a wet sludge sample from a corroded wing tank. The role of these predominant microorganisms on corrosion of aircraft fuel tanks should be further investigated. The corrosive activity of jet fuel-water sample from Bulk Storage Tank No. 55, Ramey AFB, was also investigated, as well as analyses of sludge samples from aircraft based at Ramey AFB.

0163 Churchill, A. V. and Leathen, W. W. (Gulf Research and Development), **DEVELOPMENT OF MICROBIOLOGICAL SLUDGE INHIBITORS.** U. S. Air Force, ASD TR 61-193, Contract AF 33(616)-6989, June 1961. 66 pp. (AD 263009).

A research investigation was conducted to develop information and materials for control of microbiological sludge in jet fuel bulk storage tanks. From a total 184 microorganisms isolated from jet fuel-water samples, eight predominant groups were selected for further study. These consisted of five fungi and three bacteria. Of the total of 178 water-soluble materials evaluated as potential microbiological sludge inhibitors, alkyl quaternary ammonium acetate, ethylidene diacetate and tri-n-butyl borate showed the most promise and are recommended for trial in bulk storage tanks to control microbial growth. Microorganisms did not appreciably affect properties of jet fuel during 90 days' storage tests.

0164 Churchill, A. V. and Leathen, W. W. (Gulf Research and Development), **RESEARCH ON MICROBIOLOGICAL SLUDGE INHIBITORS.** U. S. Air Force, ASD TDR 62-368, Contract AF 33(616)-7729 April 1962. 71 pp.

A research investigation was continued to develop information and materials for control of microbiological sludge in jet fuel bulk storage tanks and in aircraft fuel tanks. The most predominant groups of fungi and bacteria, which were isolated from jet fuel-water bottom samples under Contract No. AF 33(616)-6989, were characterized and identified as to genus and species. Four groups of fungi, which were found occasionally, were characterized but not completely identified. Approximately 302 fuel-soluble materials were evaluated as potential microbiological sludge inhibitors. Three compounds are recommended for trial in jet fuel to control microbial growth. These are tributyltin acetate, 2-nitroresorcinol and β-nitro-styrene. Several others satisfactorily controlled microbial growth but had deleterious effects on fuel properties and/or fuel system materials. Substantial changes in properties and composition of jet fuel were noted between certain inoculated and unincolulated samples in storage tests of 270 days' duration. In addition, gas chromatographic studies indicated that the microorganisms utilize the hydrocarbons in their metabolic processes. The microorganisms also affect the water-holding capacity of jet fuel.

0165 Ciapetta, F. G., Dobres, R. M. and Baker, R. W., **CATALYTIC REFORMING OF PURE HYDROCARBONS AND PETROLEUM NAPHTHAS.** pp. 495-692 in: "Catalysis, vol. VI", New York, Reinhold, 1958.

This is a comprehensive article covering dehydrogenation of a) paraffins to olefins, b) naphthas to aromatics, c) alkyl cyclopentanes to aromatics; dehydrocyclization of paraffins and olefins to aromatics; and isomerization of normal paraffins and olefins to the corresponding iso-compounds. Pure hydrocarbons as well as practical feedstocks are considered. Results with metal oxide, single- and dual-function catalysts are described. Over 160 references are cited.

Cochran, R. P. and Dengler, R. P., EXPERIMENTAL INVESTIGATION OF AN AIR-COOLED TURBINE OPERATING IN A TURBOJET ENGINE AT TURBINE INLET TEMPERATURES UP TO 2500°F. U. S. National Aeronautics and Space Administration, TN D-1046, July 1961. 47 pp. 0166

An air-cooled turbine with corrugated-insert type stator and rotor blades was operated in a modified production-model engine. Results indicated that operation of turbojet engines at turbine inlet temperatures up to 2500°F appears to be feasible. Combustors and turbine stator blades, in addition to turbine rotor blades, were critical components at those temperature levels. An average chordwise rotor blade temperature of 1300°F was maintained with a coolant-to-gas weight-flow ratio of about 0.022 when the average turbine inlet temperature was 2500°F and coolant temperature was about 260°F. Leading-edge tip caps on the rotor blades improved the cooling of the leading-edge region.

Coker, G. T., Heiple, H. R., Davies, R. G. (Shell Oil), A NEW LOOK AT TURBINE FUEL FILTRATION. SAE Journal, 67, no. 6, 52-3 (1959). 0167

Performance of turbine fuel filters and separators is examined. Particles of 150-micron size are found in the effluent of "Five-micron" filter/separator equipment. Some portions of such equipment are fibrous in nature and in some instances, especially with new filters, have migrated beyond the filter. It appears to take 15-20 minutes to rid new elements of these loose fibers and it is recommended that fuel be recirculated for at least 30 minutes after installation of new elements. Also, a phenomena of unloading of partially loaded filters was observed when cyclic conditions of abrupt stops and starts occurred. While total solids are reduced, particle distribution by percent does not significantly change between influent and effluent streams.

Cole, C. A., Minor, H. B., Nixon, A. C., Skei, T., and Thorpe, R. E. (Shell Development), STABILITY OF JET TURBINE FUELS IN STORAGE. U.S. Air Force, WADC TR 53-63, Part 2, Contract AF 18(600)-37, February 1955. 146 pp. (AD 63285). 0168

Various methods for improving jet fuel stability have been investigated. Mild hydrogenation of cracked gas oil components appears capable of increasing fuel availability. No effective gum inhibitors have yet been found for desert storage conditions. The effects of other factors on desert storage are summarized. Electron microscopic examination showed filterability to be related to the type of insoluble material formed in aged fuels. The effects of inhibitors, dispersants and fuels were studied in a laboratory test which measured filter clogging tendencies under conditions simulating those in aircraft fuel-oil heat exchangers. Fractionation by distillation and chromatography of a catalytically cracked gas oil into its type components showed that stability under mild aging conditions generally decreased with increasing boiling point and with increasing olefinicity. For this phase of the program, a chromatographic method (chromatogum) was developed for determining gum in small samples.

0169 Cole, C.A. and Nixon, A.C. (Shell Development Co.), STABILITY OF JET (TURBINE) FUELS IN STORAGE. U.S. Air Force, AF Technical Report No. 6625, Contract AF 33(038)-7277, November 1951. 187 pp.

The general objective of this investigation was to increase the permissible storage life of JP-3 type jet fuels by employing methods which resulted in the utilization of the simplest possible refinery treatments and which were to result in maximum availability. Tests were carried out in the laboratory using accelerated and hot room aging methods and under desert storage conditions at El Centro, Calif. The results of the study may be summarized as follows: the stability decreases with an increase in the end point of the fuel and an increase in the proportion of cracked components, high boiling cracked components being more deleterious than low boiling. Soluble copper has an adverse effect on stability in thermally cracked and some straight run, but not in catalytically cracked fuels. Generally speaking, water has a beneficial effect. Caustic treatment and acid treating show some favorable effect. Some sulfur and nitrogen compounds catalyze the rate of gum formation.

0170 Cole, C.A. and Nixon, A.C. (Shell Development Co.), STABILITY OF JET (TURBINE) FUELS IN STORAGE. U.S. Air Force, AF Technical Report No. 6625, Supplement 1, Contract AF 33 (038)-7277, October 1952. 38 pp.

Accelerated aging tests on four emergency fuels, produced in accordance with the requirements of the Military Petroleum Advisory Board Questionnaire, show them to be relatively stable with respect to total gum formed, although significant quantities of insolubles comprised part of the total. Data are also presented which confirm earlier results showing that iron and aluminum as container materials have no significant effect on fuel stability. A rapid filtration test designed for routine work to show relative filter clogging tendencies of fuels is discussed. Further study of the correlations between desert and accelerated aging shows that accelerated aging tests are relatively more severe on cracked fuels than straight run fuels in comparison with the effect of desert storage.

0171 Cole, C. A. and Nixon, A. C. (Shell Development), STORAGE STABILITY OF JET TURBINE FUELS. U.S. Air Force, WADC TR 53-63, Contract AF 18(600)-37, November 1953. 171 pp. (AD 30243).

An investigation was made to ascertain the variables influencing the storage stability of jet fuels and to determine practical methods of controlling these variables to increase the storage life of fuels. Results indicated that both soluble and metallic Cu adversely affect stability. Sea water in the presence of Fe promotes insoluble gum formation; however, water generally reduces soluble gum formation. High boiling materials contribute more to the instability of a blend than do low boiling materials. The average thermally cracked fuel is more unstable than the average catalytically cracked fuel. None of the compounds tested as potential jet fuel inhibitors, including the specification inhibitors, showed consistent stabilizing action. No simple relationship was observed between stability and unsaturation, conjugated diolefins, N, S, or peroxide content. Correlations between accelerated and desert aging for all fuels tested indicated that 5 hr aging (at 100°C and 100 psig O_2) is about equivalent to 2 yr of desert drum storage. Fuels correlated on the basis of type showed wide variations from this relationship, however. Compatibility of various components of a blend is not affected in most cases by a moderate amount of aging before blending.

Cole, C.A. and Nixon, A.C. (Shell Development Co.), STORAGE STABILITY OF JET TURBINE FUELS. U.S. Air Force, WADC TR 53-63, Supplement 1, Contract AF 18(600) - 37, July 1954. 72 pp. 0172

The present phase of the investigation of jet fuel stability was concerned with the evaluation of practical methods of improving stability through the employment of existing conventional methods of treatment and inhibition. In addition to this, studies to determine the effects of storage variables on gum formation and the influence of aging on such fuel characteristics as filterability and freezing point were continued. Study attention was focused on gas oil components. Relatively severe treatments did not improve the inhibitor susceptibility of any of the fuels tested. Considerable improvement in stability was observed in the case of the more unstable cracked blends which had received sulfuric acid or combinations of treatments including sulfuric acid or hydrogenation. Oxygen availability in desert aging containers has been shown to be important in determining the extent of fuel degradation during storage.

Cole, R. A., DIESEL RAMJET DESIGN. Aircraft and Missiles, 3, no. 5, 50-1 (1960). 0173

The paper describes a novel engine configuration for high speed ramjets. The engine utilizes multiple shocks for compression heating (and ignition). Examples are for very high (6.5+) Mach numbers.

Conn, M. E. and Dukek, W. G. (Esso Research and Engineering Co.), HIGH PERFORMANCE HYDROCARBON FUELS FOR SUPERSONIC PROPULSION. Society of Automotive Engineers. SAE Paper 55S, 1959. 26 pp. 0174

Hydrocarbon fuels capable of meeting high performance standards in advanced supersonic propulsion systems can be produced in substantial volume at reasonable cost from petroleum streams by hydrogenating aromatic concentrates or processing certain cuts from selected crudes. These fuels are rich in polycyclic naphthenes and thermally stable, comparable in most respects to synthetic hydrocarbons prepared by expensive chemical syntheses.

Conners, J. F. and Obery, L. J. (NASA, Lewis Research Center), SOME CONSIDERATIONS OF HYPERSONIC INLETS. pp. 123-37 in: North Atlantic Treaty Organization, Advisory Group for Aeronautical Research and Development, "Combustion and Propulsion." New York, Pergamon, 1961.

0175 The various factors affecting hypersonic inlet characteristics are examined in relation to overall powerplant performance. It is shown that the inlet influences not only the engine thrust and impulse, but also the structured pressure and cooling loads on the engine. Hypersonic inlets will be faced with severe viscous effects, resulting in angle-of-attack penalties and laminar separation and bridging problems. Some form of boundary-layer control will be required for maximum performance. For use over a range of Mach numbers, large area modulation will be required to avoid the penalties of fixed-geometry configurations. Cooling of the hypersonic ramjet appears feasible. All internal surfaces must be cooled. The larger the engine, the easier it is to cool. Estimated heat transfer rates through a representative Mach 7 ramjet engine are given, and the peak heat transfer rate is found to be approximately 400 Btu/sec ft^2. This value is only about 25% of the rates handled successfully in rocket motors. Total heat load relative to cooling capacity of the fuel decreases sharply with engine size.

Coordinating Research Council, Inc. ANTICIPATED FUEL SYSTEM ENVIRONMENT FOR THE SUPERSONIC TRANSPORT. Special Technical Report, CRC Report No. LD-125, U.S. Air Force Contract AF 33(657)-8862, May 1963. 4 pp.

0176 This report outlines the typical supersonic transport mission profile and corresponding major fuel system parameters which have been selected by the Environmental Conditions Panel of the CRC-Aviation Group on Supersonic Transport Fuels and Related Equipment for use as a guide in establishing realistic test conditions for the other phases of the CRC Supersonic Transport Fuels program.

Coordinating Research Council, Inc., DEVELOPMENT OF SUPERSONIC TRANSPORT FUEL SYSTEM TEST RIG. Special Technical Report CRC REport No. LD-127, U.S. Air Force Contract AF 33(657)-8862, June 1963. 64+ pp.

0177 As a means toward obtaining factual information to determine the effect of the airframe and aircraft engine fuel system environment on fuel quality requirements in the supersonic transport, a full-scale test facility has been designed and constructed under the monitorship of the CRC. This test rig incorporates the fuel tanks and major components considered to be representative of a supersonic transport. Its development and forthcoming utilization in evaluation of candidate supersonic aircraft fuels constitutes the major portion of the CRC program covering the suitability of fuels for the supersonic transport, recognizing the interdependence of fuel availability or cost, aircraft performance, and airline economics.

Coordinating Research Council, Equipment and Procedure Panel of the Fuel Thermal Stability Group, THE HIGH TEMPERATURE RESEARCH FUEL COKER. October 1, 1958. 10 pp. 0178

This report presents the design of the High-Temperature Research Fuel Coker, a dynamic test rig for determining the stability of fuels when subjected to heating as may occur at high flight speeds. It is similar to the CFR Fuel Coker, except that it extends the temperature range at which fuels may be tested and includes also a heated reservoir to simulate the fuel tank heating which occurs during high-speed flights.

Coordinating Research Council, FINAL SUB-PANEL REPORT ON CRC-CFR JET FUEL BULK STORAGE STABILITY PROGRAM. 23 May 1955. 4 pp. 0179

The report presents results of a two year bulk storage program of two fuels at Port Arthur, Texas. The general conclusion drawn from the program is that very little degradation occurred in either straight-run or partly cracked JP-4 jet fuels during tank and drum storage for two years.

Coordinating Research Council, FUELS FOR THE SUPERSONIC TRANSPORT. Quarterly Progress Report No. 1, February 1 to April 30, 1962. U.S. Air Force Contract AF 33(657)-8862. 15 pp. 0180

The report describes the research program being conducted by the CRC to evaluate fuels for the supersonic transport. The aircraft and fuel system test rig to be built by North American Aviation is described.

Coordinating Research Council, FUEL THERMAL STABILITY EXCHANGE PROGRAM (CRC PROJECT NO. CA-2-58). Prepared by the Planning Panel Fuel Thermal Stability Group, May 1958. 88 pp. 0181

This report covers the results of: (1) the monthly sample exchange program of the CRC-Aviation Fuel Thermal Stability Group, and (2) the 100-hour flight test program conducted by the Air Force to secure correlation of information on CFR Fuel Coker data with actual aircraft performance. Also included in the report is a summary of experience obtained from the Air Force and the Navy at selected operating bases.

Coordinating Research Council, Inc., Group on High Temperature Stability of Fuels for High Performance Aircraft, FINAL REPORT ON EXTENDED CRC THERMAL STABILITY PROGRAM. Report No. 63-253, February 28, 1963. 0182

The program reported is concerned with the thermal stability performance of several selected CRC fuels and is a continuation of previous work. Data are presented for seven fuels in the Research Coker over a range of reservoir and preheater temperatures, and also for several other groups of tests to determine the possible effects of fuel residue from prior tests, purging the fuel reservoir with controlled gases, and the effect of storage on fuel stability. Tests comparing the Research Coker and the Modified Coker are also reported.

Coordinating Research Council, Inc., AN INVESTIGATION OF THE PERFORMANCE OF JET ENGINE FUELS FOR SUPERSONIC TRANSPORT AIRCRAFT. Status Technical Report, CRC Report No. LD-122, U.S. Air Force Contract AF 33(657)-8862, March 1963. 12 pp. 0183

This report summarizes the program of the CRC, under sponsorship of the FAA, to establish the suitability of fuels for use in commercial supersonic transports. A description of the large-scale test rig and the flight profiles to be used in connection with it for Mach 3 testing are included. The report covers: objectives of the CRC program, the airframe and engine test rig, small-scale studies, air frame and aircraft engine fuel system environment, physical properties, and fuels to be studied.

Coordinating Research Council, Inc., AN INVESTIGATION OF THE PERFORMANCE OF JET ENGINE FUELS FOR SUPERSONIC TRANSPORT AIRCRAFT. Sixth Quarterly Technical Report, CRC Report No. LD-129, U.S. Air Force Contract AF 33(657)-11173, August 1963. 5 pp. 0184

During the quarter reported on, progress was made in the following areas: a) completion of the large-scale airframe and aircraft engine fuel system test rig; b) conduct of small-scale studies in various fuel coker devices; c) preparation of write ups covering the best available techniques for measuring key physical and chemical properties of aircraft turbine fuels; and d) selection, storage, and procurement of fuels for the various phases of the program.

Cosgrove, S. L. (Battele), EFFECT OF NUCLEAR RADIATION ON HYDROCARBON FUELS. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, C101-13 (September 1960). 0185

This report reviews research and development studies aimed at the selection of an optimum jet fuel as auxiliary power in proposed nuclear-powered gas-turbine aircraft. Available information on the radiation stability of simple hydrocarbons representative of those found in commercial jet fuels is reviewed. The effects of both gamma and reactor radiation on fuel specification properties are discussed in relation to fuel composition. Although many pertinent variables, for example dose rate, and the influence of combined environments have received only superficial study, it seemed unlikely that further extensive radiation studies with jet fuels could be justified until a prototype aircraft is available.

Cowley, C. W. Timson, W. J. and Sawdye, J. A. (Linde Co.), A METHOD FOR IMPROVING HEAT TRANSFER TO A BOILING FLUID. Industrial and Engineering Chemistry Process Design and Development, 1, 81-4 (1962). 0186

Heat transfer rates from thermally conductive solids to boiling liquids can be improved by coating the solid with an insulator having sufficient insulation value to adjust the temperature difference between the coated solid and the liquid nitrogen to a value where more efficient heat transfer will result. The method is particularly applicable to conditions where the solid is at a much higher temperature than the boiling liquid. Under these conditions stable film boiling occurs. The solid is then blanketed by a stable, highly insulating layer of vapor resulting in a low heat transfer rate. By coating the solid with an insulator it is possible to alter the regime of boiling from stable film boiling to unstable film or nucleate boiling where higher heat transfer rates are possible.

Cowling, T. G., Gray, P. and Wright, P. G., THE PHYSICAL SIGNIFICANCE OF FORMULAE FOR THE THERMAL CONDUCTIVITY AND VISCOSITY OF GASEOUS MIXTURES. Royal Society (London). Proceedings, A276, 69-82 (1963). 0187

A physical interpretation is made of various complicated formulae which have been given for the thermal conductivity and viscosity of mixtures of gases. The interpretation is based on the recognition of two principal effects operating in the transport of heat or momentum through gaseous mixtures. The first and larger effect is that the molecules of one species impede transport by the other species. The second effect is a transfer of the transport of heat or momentum from one species to another.

Cox, J. D. (National Chemical Laboratory, Teddington), A BOND ENERGY SCHEME--2. STRAIN AND CONJUGATION ENERGIES IN CYCLIC COMPOUNDS. Tetrahedron, 19, no. 7, 1175-84 (1963). 0188

The strain energies in certain cyclic compounds and the conjugation energies in others containing delocalized π-electron systems were calculated by a novel treatment allowing for the hybridization states of carbon in C-X bonds, the energy differences between primary, secondary, and tertiary C-H bonds, and the next-nearest neighbor interaction energies in oxygen-containing compounds. The calculations were made for a large number of homo-and heterocyclic, three-to eighteen-membered ring compounds with the aid of bond-energy terms derived from the heats of formation of substituted and unsubstituted non-cyclic olefins, conjugated dienes, benzenes, and oxygen-, nitrogen-, and sulfur-containing compounds. In general, the magnitudes of the calculated strain energies were understandable in terms of likely angular or torsional strain, but the conjugation energies were appreciably lower than published values obtained with simpler bond-energy schemes. Tables and 56 references. (in English)

Cox, P.B., PHASE I SUMMARY TECHNICAL REPORT OF THE CY 1962 AIR FORCE-MARQUARDT CONTRIBUTING ENGINEERING PROGRAM - VOLUME V. The Marquardt Corporation, Report No. 25,065, Vol. V, U.S. Air Force Contract AF 33(600)-40809, February 1963. (AD 334747). REPORT CLASSIFIED CONFIDENTIAL. 0189

The Calendar Year 1962 Air Force-Marquardt Contributing Engineering Program was authorized as a part of Contract AF 33(600)-40809 by Supplemental Agreement No. 13. Contract AF 33(600)-40809 also covers the RJ-43-MA-11 Ramjet Engines, Data, and Publications Program. The detailed description of the over-all Contributing Engineering activity is included in The Marquardt Corporation Proposal No. 9027A, dated 13 December 1961 and revised 9 January 1962 and 22 March 1962. In order to provide a report which can be more easily handled, the Phase I Summary Technical Report has been divided into eight volumes. Volume V includes Industry Coordination on Advanced Propulsion Systems, Multicomponent Fuels Investigations, High Energy Fuels Investigation, and Solid and Slurry Hydrogen Research.

Cox, P.B. and Campbell, J.R., PHASE I SUMMARY TECHNICAL REPORT OF THE CY 1962 AIR FORCE-MARQUARDT CONTRIBUTING ENGINEERING PROGRAM - VOLUME III. The Marquardt Corporation, Report No. 25,065, Vol. III, U.S. Air Force Contract AF 33(600)-40809, March 1963. (AD 334842). REPORT CLASSIFIED CONFIDENTIAL. 0190

The contents of this report include advanced engine concepts, fixed jet compressor applications, rotary jet compressor, advanced supersonic burning ramjet engines, unique atmospheric breathing engine-vehicles, the consumable ramjet vehicle, advanced logistics systems studies, mission analysis results, and propulsion data.

Crawford, P. B. and Cunningham, W. A. (University of Texas), CARBON FORMATION IN CAT CRACKING. Petroleum Refiner, 35, no. 1, 169-73 (1956). 0191

Equations were developed for estimating the rate of carbon formation during catalytic cracking reactions from operating variables such as temperature and space velocity. The method applies to both fixed bed and fluidized bed reactors.

Cullis, C. F. (Imperial College), THE PYROLYSIS OF AROMATIC COMPOUNDS. Fuel Society Journal, University of Sheffield, 14, 7-16 (1963). 0192

The pyrolysis of simple aromatic compounds is discussed with particular reference both to the initial stages of decomposition and to the more complete breakdown to yield solid carbon. It is pointed out that the early course of the reaction depends on the interplay between "ring-stripping" and "ring-opening" and this is illustrated by a consideration of the products formed under different conditions from benzene and the chlorobenzenes. In the formation of carbon, the nature of the starting compound (provided that this contains only carbon and hydrogen) apparently has little effect on the structure and composition of the resulting solid phase. On the other hand, the presence of other elements in the initial fuel has a profound influence on crystallite size and degree of orientation, and possible reasons for this are advanced.

Cunningham, J., McGuire, R., Li, T. P., Streetman, J. R., Matten, F. A. and Anderson, R. C. (University of Texas), THERMAL DECOMPOSITION OF BUTANE. U. S. Air Force, AFOSR TN 58-40, Contract AF 18(603)-142, December 1957. 21 pp. (AD 148089). 0193

Initial measurements of the rate of thermal decomposition of butane were made in a special flow reactor. The order of reaction and rate constants were in essential agreement with results of others, but the energy of activation found was lower. The decomposition was essentially first order and the rate constant for the initial stages of reaction was $K = 3.5 \times 10^9 \exp -46{,}000/RT \sec^{-1}$. The value of the energy of activation found was about 12,000 cal/mole less than that established by others. An improved method for extrapolating to zero conversion was derived for calculating initial rate constants.

Dadashev, B. A., Alimamedov, G. G., and Agamirzoeva, Z. K., CATALYTIC DEHYDROGENATION OF ETHYLCYCLOHEXANE AND GASOLINE FROM THE CRUDE OIL FROM PESCHANYI ISLAND. Azerbaidzhanskiy Khimicheskiy Zhurnal, 1960, no. 3, 37-42. (CA 55, abstr. 20398h, 1961). 0194

The catalytic activity of Pt on activated C and the effect of space velocity and temperature on the yield of aromatic hydrocarbons in the dehydrogenation of ethylcyclohexane and gasoline b. 300-500° was studied. A decrease in space velocity greatly increases the content of aromatic hydrocarbons in the catalyzate. When the temperature is raised to 400°, olefins are formed in addition to aromatic hydrocarbons. The Pt catalyst was not active for the dehydrogenation of gasoline.

Danforth, J. D., Meents, M. R., and Scott, F. J. (Grinnell College), CRACKING ACTIVITY ON BINARY COMPOSITES OF HYDROUS OXIDES. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, B119-23 (September 1960). 0195

Of the 13 binary composites of hydrous oxides possessing cracking activity at least one of the components in each catalyst has a coordination number of four. It is suggested that cracking activity obtains when a substrate of four coordination number imposes a lower than normal coordination number on the second component. In this study, catalyst composites reliably reported in the literature and new combinations prepared in this work have been considered. Methods for preparing and evaluating catalyst on a very small scale are described.

Danilov, I. N. and Murzabulatov, Kh. A., THE EFFECT OF GAS CUSHION ON THE THERMAL STABILITY OF FUEL TS-1. Khimiya i Tekhnologiya Topliv i Masel, 1960, no. 2, 44-6. 0196

The effect of gas medium on the thermal stability of jet fuels used for supersonic flights was studied on special filter plugging apparatus. Pressure drop through the filter (up to 340 mm maximum) was measured in experiments up to 600 minutes maximum. The effects of fuel vapors, N$_2$, and air are compared. It is concluded that the formation of insoluble gum and coke is a result of oxidation processes.

Danilov, I. N. and Murzabulatov, Kh. A., FACTORS INFLUENCING THE THERMAL STABILITY OF FUELS FOR JET ENGINES. Ufa. Bashkirskii Nauchno-Issledovatel'skii Institut po Pererabotke Nefti. Trudy, 1962, no. 5, 238-50 (1962). (CA, 58, 2308a). (English translation available as FTD-TT-63-343/1 + 2 + 4, AD 407364). 0197

Thermal stability above 100° is increasingly important for fuels used in high-speed aircraft. Two similar dynamic test procedures simulating use conditions are described. The oil is pumped continuously for 1-10 hours at 3-4 l./hour and 23-25 seconds residence time through a heater at 100-230°, then through a fine-mesh filter. The oil is at the maximum temperature 5-7 seconds. Stability is measured by pressure drop across the filter, indicating the degree of sludge formation. Fuels studied were stable in air at 100-110°, and more stable in N than in air. A change in rate or duration of heating or cooling and reheating to the same temperature did not affect stability.

Danilov, I. N. and Murzabulatov, Kh. A., INCREASING THE THERMAL STABILITY OF FUELS BY PRELIMINARY FILTERING (USSR), Khimiya i Tekhnologiya Topliv i Masel, 1963, no. 4, 60-2. 0198

Effect of impurities on thermal stability of aviation fuels has been studied by filtering through filter paper to eliminate particles over 8 and over 30-40μ, respectively. Particle evaluation was by microscope. Preliminary filtering improved thermal stability at 200°C. Preheating fuels prior to filtering increased the number of larger particles formed by aggregation of the fuel oxidation products and fine impurities. Preliminary fine filtering and avoidance of contamination help preserve thermal stability of fuels.

Da-Riva, I. (INTA, Madrid, Spain), UNIDIMENSIONAL THEORY OF SUPERSONIC COMBUSTION. Sponsored by Office of Scientific Research--OAR, through the European Office, Aerospace Research, U. S. Air Force. AF-EOAR Grant 62-91, May 1963. (AD 416 528). 0199

This paper outlines a generalized unidimensional theory of supersonic combustion. It considers a stream of oxidizer flowing along a tube with lateral fuel supply governed by a certain injection law and the combustion occurring in conditions in which the pressure is kept constant. The principal results obtained by using the simple model under consideration are: a) If the injecting of fuel does not impart kinetic energy to the flow, the mixing process, even supposing it takes place in ideal conditions, appreciably lowers the upper limit to the practicability of supersonic combustion (the dissociation limit), b) as for the length required for combustion to take place, the estimate arrived at by this method is practically the same as that obtained by assuming that the mixing and the reaction are two independent processes, c) In most of the cases considered, the diffusion governs the process; in other words, the flow is closer to chemical-equilibrium than to frozen-flow conditions.

Davis, E. J. and David, M. M. (Gonzaga University), TWO PHASE GAS-LIQUID CONVECTION HEAT TRANSFER - A CORRELATION. Industrial and Engineering Chemistry Fundamentals, 3, no. 2, 111-18 (1964). 0200

A slip model, previously developed, has been used to develop an empirical correlation for two-phase gas-liquid heat transfer data. The data of many major investigators have been analyzed to determine and to extract those for which nucleate boiling did not occur. These experimental data have been compared with the results predicted from the proposed correlation. The data in the purely convective heat transfer region (no nucleate boiling) have been predicted within an average absolute error of 6 to 17% over a wide range of tube sizes, flow rates, pressures, and heat fluxes, and for vapor mass fractions from about 0.10 to the dry-wall or liquid-deficient condition. The data correlated by the proposed equation generally correspond to annular or mist-annular flow conditions. The results for the steam-water system are in good agreement with those for the air-water system that have been published. Many references are given.

Davydov, P. I. and Bolshakov, G. F., THE EFFECT OF NATURAL RESINOUS SUBSTANCES ON THE STABILITY OF REACTIVE FUELS AT HIGH TEMPERATURES. Khimiya i Tekhnologiya Topliv i Masel, 5, no. 10, 35-8 (1960). (CA, 55, abstr. 3045c, 1961). 0201

Thermal stability of jet fuel was tested by holding it at 150°C for 6 hours. Four indices of stability were used: corrosion of a bronze plate, deposit on the plate, quantity of sediment in the fuel, and acid value of the fuel. Natural fuel resins were first removed using silica gel and then reintroduced in controlled and varied amounts. It was found that there was an optimum resin concentration at about 0.07%w, and at higher or lower concentrations the thermal stability was worsened. Thermal stability could also be improved by the addition of 0.05%w of a sulfur compound (2-phenyl-2-mercaptobutylamine) or of 1,2,3,4-tetrahydroquinoline.

0202 Davydov, P. I. and Bolshakov, G. F., EFFECT OF SULFUROUS COMPOUNDS ON THE THERMAL STABILITY AND CORROSION PROPERTIES OF FUELS FOR TURBOJET ENGINES., pp. 272-80 in: "Bor'ba s Korroziei Dvigatelei Vnutrennego Sgoraniya i Gazoturbinnykh Ustanovok". Moscow Mashgiz, 1962.

Aliphatic mercaptans in jet fuels subjected to prolonged heating to 150°C produce intensive corrosion of bronze and the formation of tar and insoluble precipitate. Similar results are obtained with disulfides, aliphatic sulfides, aromatic sulfides, and thiophanes. However, 0.006% 2-phenyl-2-mercaptobutylamine had a corrosion inhibiting effect.

0203 Davydov, P. I. Bolshakov, G. F., and Glebovskaya, E. A., A STUDY OF THE EFFECT OF NITROGEN BASES ON THE STABILITY OF FUELS AT HIGH TEMPERATURES. Khimiya i Tekhnologiya Topliv i Masel, 7, no. 10, 20-6 (1962). (CA, 58, 394e).

N bases extracted from the standard fuels TS-1, T-1, and DA and identified by their infrared absorption spectra were studied with respect to their effect on gum formation, corrosion of Cu alloys, thermal oxidation, and other phenomena occurring with fuels. At optimum concentrations, in the range of 0.03-0.06%, the N compounds which consist mainly of derivatives of pyridine quinoline, and xylidine, and the more complex heterocyclic substances containing N, S, and O in the nucleus, are effective in raising fuel stabilities at high temperatures.

0204 DeGray, R. J. and Killian, L. N. (Standard Oil, Ohio), BACTERIAL CONTAMINATION OF REFINED PETROLEUM PRODUCTS. American Chemical Society. Division of Petroleum Chemistry. Preprints, 5, no. 1, 43-51 (March 1960).

Water samples taken at the oil-water interface in oil storage tanks were found to contain numerous aerobic bacteria. Samples collected over a period of 7 months showed the count level to vary with tank geometry, frequency of withdrawals and refillings of the tank, and with the source of the bottom water. Bacterial counts were usually highest when the pH of the water was near 7. Laboratory tests indicated that the bacterial population increases with agitation and in the presence of a hydrocarbon. Multiplication is faster in kerosine than in isooctane, and in the presence of rust inhibitors. An iron strip was corroded by bacteria and its presence accelerated their growth. Trialkyl boron compounds inhibit bacterial activity; the higher alkyl compounds, such as trioctyl boron, are more effective than compounds such as trimethyl boron.

Deissler, R. G. and Loeffler, Al L., Jr. (Lewis Research Center, NASA), HEAT TRANSFER AND FRICTION FOR FLUIDS FLOWING OVER SURFACES AT HIGH TEMPERATURES AND HIGH VELOCITIES. American Society of Mechanical Engineers. Transactions. Series C. Journal of Heat Transfer 81, 89-91 (1959).

0205 The demand for compact heat-transfer equipment having very high heat-flow rates has led to studies of the transfer of heat at very high fluid velocities and very high temperature differences between the surface and the fluid. The latter introduces the complicating factor into the theory that the fluid properties vary substantially through the boundary layer. This paper discusses the pertinent literature appearing in the period 1946 to 1956 on the transfer of heat by forced convection between surfaces and fluids for Mach numbers up to 8 and temperature differences of the order of 2500 F. Tubes of various cross-sectional shapes, flat plates, and nozzles are discussed.

Deissler, R. G. and Taylor, M. F., ANALYSIS OF HEAT TRANSFER AND FLUID FRICTION FOR FULLY DEVELOPED TURBULENT FLOW OF SUPERCRITICAL WATER WITH VARIABLE FLUID PROPERTIES IN A SMOOTH TUBE. U. S. National Advisory Committee for Aeronautics, RM E53B17, April 1953, 29 pp.

0206 A previous analysis of turbulent flow and heat transfer for air with variable properties flowing in smooth tubes is generalized in order to make it applicable to supercritical water. The generalization is necessary because all the pertinent properties of supercritical water vary markedly with temperature. Calculated velocity and temperature distributions, as well as relations among Nusselt number, Reynolds number, and friction factor, are presented. The effect of variation of fluid properties across the tube on the Nusselt number and friction factor correlations can be eliminated by evaluating the properties at a reference temperature which is a function of both the wall temperature and the ratio of wall-to-bulk temperatures.

Derbentsev, Yu. I., Balandin, A. A., and Isagulyants, G. V., AN INVESTIGATION OF THE ROLE OF CYCLOHEXENE IN THE HETEROGENEOUS CATALYTIC DEHYDROGENATION OF CYCLOHEXANE USING RADIOACTIVE CARBON. Kinetics and Catalysis (U.S.S.R.) 2, 667-73 (1961).

0207 The rates of the individual processes occurring in the dehydrogenation of cyclohexane over chromium oxide and rhenium catalysts were studied using carbon C^{14}. It was observed that in the dehydrogenation of cyclohexane at 450° over chromium oxide most of the benzene was formed directly, but some was formed via cyclohexene intermediate. A two-point mechanism for the dehydrogenation is likely for this latter cyclohexene was not an intermediate product in the formation of benzene from cyclohexane in the presence of rhenium catalyst (336°). With this catalyst, the principal reaction in the conversion of cyclohexene was dehydrogenation to cyclohexane.

deRosset, A. J. and Berger, C. V. (Universal Oil Products), **THERMAL AND CATALYTIC DECOMPOSITION OF HYDROCARBONS.** Industrial and Engineering Chemistry, 51, no. 9, part 2, 1075-80 (1959). 0208

This is a review article covering catalytic cracking, thermal decomposition and catalytic reforming of hydrocarbons. Ninety-two references for the years 1958-1959 are given.

Digman, W. J. (Douglas Aircraft), **CONTAMINANT CONTROL CURBS JET FUEL TANK CORROSION.** SAE Journal, 70, December, 56-8 (1962). 0209

This condensation of a longer paper discusses the sequence of events through which corrosion damage is believed to occur, and the measures which are required for corrosion control.

Dimmock, R. H. (Reaction Motors), **HEAT TRANSFER PROPERTIES OF ANHYDROUS AMMONIA; FIRST SPECIAL REPORT.** U.S. Air Force. Report RMI-124-S1, Contract AF 33(600)-32248, June 1957. 13 pp. (AD 133224). 0210

The heat transfer properties of anhydrous ammonia were investigated over the entire range of conditions and environments normally encountered in rocket technology. The data obtained were used directly in the design of a high performance rocket engine. Since it was impossible by conventional methods to obtain adequate data over the whole manifold of conditions encountered in the operation of even one rocket engine a machine was developed which provides a continuous plot of heat transfer from convection to film burnout. Using this machine, families of velocity related heat transfer curves were automatically plotted for any desired pressure. An essentially complete collection of heat transfer properties is presented in tabular and graphic form for anhydrous ammonia.

Dimpfl, L.H. (California Research Corporation), REPORT OF THE PANEL ON DATA ANALYSIS. Coordinating Research Council, CFR-AFD Fuel Thermal Stability Group, January 16, 1956. 15 pp. plus appendices. 0211

Experiments were set up to be run by each of the 27 cooperating laboratories to estimate repeatability and reproducibility of the Erdco test, and effects of operating conditions on test results. The first and most important conclusion from the work is that the reproducibility of the Erdco test apparatus is very poor. This arises from the units varying greatly in severity level from week to week and month to month. The reason for this is not known. The data permitted ranking of the fuels both in order of filterability and preheater coating tendency. There is no relation between the filter plugging and heater coating tendency of a fuel.

Dimpfl, L. H., Goodrich, J. E., Stayner, R. A. (California Research Corporation), EVALUATING ADDITIVES FOR DISTILLATE FUEL OIL - STORAGE TESTS. Industrial and Engineering Chemistry, 48, no. 10, 1885-91 (1956). 0212

Two test methods are presented for evaluating the effectiveness of distillate fuel additives: one, a laboratory test involving the determination of the insoluble materials which form in a fuel during 4 weeks' storage at 140°F. and the other a full scale pumping test carried out under conditions closely approaching those found in domestic fuel systems. Using these methods, it has been shown that additives may be remarkably effective in stabilizing distillate fuels which would otherwise deposit insoluble gums during storage and give unsatisfactory performance in service. These additives may be quite specific in their action and vary in their effectiveness. Optimum dosages depend on the fuel and on whether or not free water is present in the fuel system.

DiPiazza, J. T., A COMPILATION OF SUMMARIES FROM NACA REPORTS ON FUELS RESEARCH, 1945-1952. U.S. National Advisory Committee for Aeronautics, RM 53D28, August 1953. 124 pp. (AD 15766). 0213

A compilation of summaries from NACA reports on fuels research covering the period 1945 through 1952 is presented. Included are reports on fuel performance in reciprocating, turbojet, ramjet, and rocket engines, and, fundamental performance, fuel synthesis, physical properties, and analysis. Studies of combustion efficiency, carbon deposition and smoking, flame speed, and ignition and flammability are included. Liquid fuels covered include JP, metal hydride, and metal slurry types.

Dolan, J. P., Starling, K. E., Lee, A. L., Eakin, B. E., and Ellington, R. T. (Institute of Gas Technology), LIQUID, GAS AND DENSE FLUID VISCOSITY OF n-BUTANE. Journal of Chemical and Engineering Data, 8, no. 3, 396-9 (1963). 0214

Liquid, gas and dense fluid viscosity of n-butane was determined at 100°-340°F and pressures from atmospheric to 8000 psia. A table of recommended viscosity values for 100°-460°F and atmospheric to 10,000 psia pressures is presented, obtained from smoothed viscosity-pressure, viscosity-temperature, and residual viscosity-density plots. New and published experimental data are compared, and various correlation methods are discussed.

Donaldson, R. E., Rice, T., and Murphy, J. R. (Gulf Research & Development), METALS POISONING OF CRACKING CATALYSTS UNDER TYPICAL REFINERY CONDITIONS. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, B97-108 (September 1960). 0215

A study of the effects of metals contamination of cracking catalysts has been carried out using conditions which closely duplicate those in commercial fluid units. Sulfur-resistant natural and high-alumina synthetic catalysts were found to be more resistant to vanadium poisoning than low-alumina synthetic catalyst. Fresh catalyst make-up rates sufficiently high to increase equilibrium catalyst activity retarded the detrimental effects of vanadium poisoning on product distribution. The differences in resistance to poisoning of the high and low-alumina synthetic catalysts appear to be related primarily to the difference in equilibrium activity of these catalysts. Differences in the age of the vanadium deposit on sulfur-resistant natural catalysts, caused by variations in charge stock metals content or catalyst make-up rate, had very little effect on the degree of deterioration in product distribution. This is in contrast to previously reported results showing that metals freshly deposited on synthetic catalysts cause much greater deterioration in product distribution than do aged metals deposits. As expected, nickel contamination caused a considerably greater deterioration in product distribution than did vanadium contamination.

Donath, E. E. and Hess M. (Koppers), THERMALLY STABLE HYDROCARBON FUELS. Chemical Engineering Progress, 56, no. 4, 68-71 (1960). 0216

Saturated cyclic hydrocarbons, especially bicyclics, obtained by hydrogenation of substituted aromatics are expected to fulfill the requirements for thermally stable jet and missile fuels. Some properties of selected cyclic fuels are given, raw materials and manufacturing processes are discussed, and some figures on cost and availability of coal-tar derived compounds are tabulated. The mention of thermal stability refers only to CFR coker tests.

Dorofeyev, V. M. and Veniamin, Ya. L., THE TESTING OF AIR-BREATHING JET ENGINES. Moscow, Oborongiz, 1961. 220 pp. 0217

The book deals with various types of tests for air-breathing jet engines. Described are techniques and methods for the processing of measurement data, measuring instruments and devices, and laboratory and test-stand equipment.

Dorogochinskiy, A. Z., Nakhapetyan, L. A., Lavrentyev V. I., Boykova, Ye. P., Kost, A. N., and Yershov, V. V., ANTIOXIDIZING PROPERTIES OF SOME PYRAZOLINE DERIVATIVES. Izvestiya Vysshikh Ucheonyskh Zavedeniy. Neft i Gaz, 1960, no. 3, 69-71. 0218

The authors studied the antioxidizing properties of some pyrazoline derivatives as inhibitors in motor fuel. They studied the inhibited motor fuel for its stability to oxidation by determining the induction period on the basis of GOST 4039-48. The content of potential resins in the motor fuel was also determined. Results show that some pyrazoline derivative samples have a considerable inhibiting effect. Best results were yielded by use of 1-phenyl thiocarbanido-3,5,5-trimethyl pyrazoline.

Dorogochinskiy, A. Z., Viktorova, E. A., Shuikin, N. I., Boykova, Ye. P. and Malin, A. G., INFLUENCE OF CYCLOALKENYL PHENOLS ON THE STABILITY OF FUEL CONTAINING UNSATURATED HYDROCARBONS. Journal of Applied Chemistry (U. S. S. R.), 35, 1975-1979 (1962). 0219

4-methyl-2-(cyclopenten-2-yl)phenol and 3-methyl-6-(cyclopenten-2-yl) phenol act as antioxidants and retard gum formation in fuel containing up to 15% unsaturated hydrocarbons. The second of those is a universal inhibitor, retarding both gum and sediment formation, even at 150°C. 2-(Cyclohexen-2-yl) phenol also has a stabilizing effect on fuel in relation to sediment formation at a high temperature (150°C).

Dorsch, R. G., Serafini, J. S. and Fletcher, E. A., **EXPLORATORY INVESTIGATION OF AERODYNAMIC EFFECTS OF EXTERNAL COMBUSTION OF ALUMINUM BOROHYDRIDE IN AIRSTREAM ADJACENT TO FLAT PLATE IN MACH 2.46 TUNNEL.** U. S. National Advisory Committe for Aeronautics, RM-E57E16, 1957. 91 pp. (AD 138750). 0220

Pressure distributions associated with stable combustion of aluminum borohydride in the supersonic stream adjacent to a short, 13-inch chord, and an extended, 35-inch chord, flat-plate model were determined experimentally. The models were mounted in the center of the test section of a 1- by 1-foot Mach 2.46 wind tunnel. High-speed direct and schlieren motion pictures of the flame and associated shock waves were taken, and selected photographs are presented.

Static-pressure increases measured during combustion at selected chordwise, spanwise, and base static taps are presented. The increase in static pressure averaged about 60% of the nonburning value. The resultant lift force on the flat-plate surface during combustion was of the order of 100 lb/sq ft at a pressure altitude of about 62,000 ft.

Because the combustion took place in a small tunnel, the measurements were subject to quantitatively unkown tunnel effects, which can best be determined by performing a similar large-tunnel or free-flight test for comparison.

Dorsch, R.G. Serafini, J.S., Fletcher, E.A. and Pinkel, I.I., **EXPERIMENTAL INVESTIGATION OF AERODYNAMIC EFFECTS OF EXTERNAL COMBUSTION IN AIRSTREAM BELOW TWO-DIMENSIONAL SUPERSONIC WING AT MACH 2.5 AND 3.0.** U.S. National Aeronautics and Space Administration, Memo 1-11-59E, March 1959. 19pp. 0221

Pressure distributions associated with stable combustion of aluminum borohydride in the airstream adjacent to the lower surface of a 13-inch chord, two-dimensional, blunt-base wing were determined experimentally. Measurements were made with the wing at 2° angle of attack in a 1- by 1-foot tunnel at Mach 2.47 and 2.96. Static-pressure increases along the lower surface and base caused by the combustion are presented along with the resultant lift increases. The lift-drag ratio of the wing was nearly doubled by the addition of heat. The experimental values of lift during heat addition agree with those predicted by analytical calculations.

Dostálek, M., Staud, M. and Rosypalová, A., **EFFECT OF MICROORGANISMS ON PETROLEUM HYDROCARBONS.** Ceskoslovenska Mikrobiologie, 2, 43-8 (1957). (CA, 51, 7695a). 0222

The effect on naphtha under both aerobic and anaerobic conditions of 70 strains of dentrification bacteria and 42 strains of desulfurization bacteria isolated from oil-well waters was studied. About 90% of the strains assimilated preferentially paraffinic naphtha, degrading paraffins. About 10% assimilated naphthenic naphtha, attacking with preference naphthenic hydrocarbons. Intensity of growth decreased with rising density of naphtha. In both types of naphtha, hydrocarbons with lower molecular weight were preferentially decomposed. Asphaltic naphtha was assimilated very slightly by certain strains of desulfurization bacteria. Viscosity of naphtha was lowered under anaerobic conditions and raised under aerobic conditions by the action of microörganisms.

Douglas Aircraft Company, Inc., Aircraft Division, Long Beach, California, DEVELOPMENT AND TESTS OF THE LABORATORY SYSTEM FOR SIMULATION OF AERODYNAMIC AND RADIATIVE COOLING OF STRUCTURES. U. S. Air Force RTD TDR 63-4235, Contract AF 33(657)-8670, April 1964. 0223

This report presents the results of a research and development program to provide a controlled cooling system for laboratory simulation of aerodynamic and radiative cooling of structures. The report summarizes criteria that establish the requirements of the system, presents data and analyses on the most practical methods of implementing the system, shows the detail design features of a prototype system/and includes the results of a test program to insure the performance and workability of the system. These will be compatible with, and form an integral part of, an existing radiant heat facility. The cooling system consists of high-pressure air streams directed onto test structures/acting in conjunction with radiant heat from quartz heat lamps to provide controlled cooling at test temperatures up to 3000°F. A unique liquid "injection" system provides for high cooling rates of up to 20 btu/sec ft^2. The entire system operates automatically utilizing the existing function generation, thermal controller, and thermocouple feadback equipment to full advantage.

Drake, J. A., HYPERSONIC RAMJET DEVELOPMENT. pp. 71-83 in: North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, "Combustion and Propulsion". New York, Pergamon, 1961. 0224

The paper discusses the problems to be overcome in the development of the hypersonic ramjet employing conventional subsonic combustion processes.

Drake, J. F. and DeVault, R. T. (Marquardt), RAMJET SUPERSONIC TRANSPORTS. Mechanical Engineering, 81, Nov., 52-5 (1959). 0225

The article describes requirements in terms of engine size, fuel consumption and operating costs of a combination ramjet-turbojet power plant system for a Mach 2-3 transport plane for commercial use. These factors are compared with similar requirements for a pure turbojet system. The authors conclude that there are significant advantages for the ramjet system both in weight and fuel requirements.

0226

Droegemuller, E. A. (Pratt and Whitney Aircraft Div., United Aircraft), **FUEL REQUIREMENTS FOR SUPERSONIC TRANSPORT.** World Petroleum Congress, 6th, 1963. Sect. VI, Paper 20. 12 pp.

The author considers the problem of fuel selection for the Supersonic Transport by evaluating the several environmental and operating parameters associated with the SST which dictate specific fuel properties. Discussed are such fuel characteristics as vapor pressure and volatility, thermal stability, combustion characteristics, specific heat and viscosity, and their relationship to environmental parameters associated with the SST. It is shown that certain factors dictate specific fuel properties which must be met to satisfy SST requirements. Other fuel properties are discussed in relation to their effect on optimization of the SST system. It is indicated that both required and optimum fuel properties can be attained in a highly paraffinic kerosene fuel for which a brief description is given.

0227

Droegemueller, E. A. and Nelson, R. K., **JET ENGINES ASK STILL MORE OF FUELS.** SAE Journal, 66, 48-9 (June 1958).

Minimum fuel quality requirements for modern jet engines are discussed. Thermal stability and burning characteristic test methods are particularly considered.

0228

Duffy, R. E., and Rogers, D. F. (Rensselaer Polytechnic Institute), **DESIGN AND CHARACTERISTICS OF A SMALL HYPERSONIC SHOCK TUNNEL COMBUSTION DRIVER.** U. S. Air Force, ARL 62-307, Contract AF 33(616)7312, March 1962. 15 pp. (AD277198).

A combustion driver for a small hypersonic shock tunnel was designed and tested. Combustion pressure-time histories for stoichiometric hydrogen and oxygen mixtures diluted with varying percentages of helium were obtained. Tests indicated that the combustion results are repeatable and peak combustion pressure and temperature are controllable within a wide range. The dimensions of combustion drivers appeared to have an important effect in that rough burning conditions, reported by other investigators, were not noticeable except at very low percentages of helium.

Dugger, G. L., COMMENTS ON HIGH PERFORMANCE COMBUSTION SYSTEMS, pp. 715-27 in: International Astronautical Congress, 12th, Washington, D. C., 1961. Proceedings, Vol. II. New York, Academic, 1963.

0229 Effects of high operating temperature on ramjet performance, flamesampling techniques for obtaining high temperature kinetic data, analysis of hypersonic ramjets with supersonic combustion (some experimental data on ignition of hydrogen) and experiments and an analysis on "external ramjets" are considered. The potentialities of ramjets with supersonic combustion appear to be great and thus two important research areas will be: (a) mixing and reaction between confined, hot supersonic streams of fuel and air and (b) interaction between shock waves, boundary layers, and heat release regions.

Dugger, G. L., COMPARISON OF HYPERSONIC RAMJET ENGINES WITH SUBSONIC AND SUPERSONIC COMBUSTION. pp. 84-119 in: North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, "Combustion and Propulsion". New York, Pergamon, 1961.

0230 Performance estimates are presented for hypersonic, kerosene-fueled ramjets employing either subsonic or supersonic combustion. Calculations based on equilibrium expansion in the exit nozzle show that the conventional subsonic engine should achieve over-all efficiencies of 40-50% in the Mach 5-8 range and should be capable of producing useful thrust to at least Mach 10. With comparable component efficiencies, and on the assumption that stable supersonic combustion can be achieved, the supersonic combustion ramjet (SCRJ) should give significantly better performance than the conventional engine (CRJ) at speeds in the Mach 8-10 range. Lower combustion chamber pressures and temperatures may provide a significant design advantage for the supersonic combustion engine.

Dugger, G. L. (Johns Hopkins University), RECENT ADVANCES IN RAMJET COMBUSTION. ARS Journal, 29, 819-27, (1959).

0231 In addition to reviewing recent work directly applicable to current ramjet engines, this paper also includes a discussion of experiments and analyses related to unconventional combustion methods (supersonic combustion, stabilized detonation, or external combustion) which may find application in hypersonic ramjets. Temperatures (of external surfaces, inlet air, and combustion products) which may be typical in ramjet engines at supersonic and hypersonic speeds are given as functions of Mach number.

0232 Dukes, W.H., DESIGN STUDY - AUXILIARY POWER FROM AERODYNAMIC HEATING. Bell Aircraft Corporation, Report No. D143-941-005, U.S. Air Force Contract AF 18(600)-1607, October 1956. (AD113085). REPORT CLASSIFIED CONFIDENTIAL.

The large quantities of heat generated during high speed flight are a possible source of energy for the generation of auxiliary power. Methods of converting this heat into mechanical energy have been studied and compared with the conventional hydrogen peroxide system.

0233 Dunavant, J. C., HEAT TRANSFER TO A DELTA-WING-HALF-CONE COMBINATION AT MACH NUMBERS OF 7 AND 10. U. S. National Aeronautics and Space Administration, TN D-2199, March 1964. 31 pp.

The results of the investigation of this configuration showed no effect of any shock from the cone on the wing surface pressures or heat transfer. The heat transfer to the stagnation line of the cone is little affected by the presence of the wing. The heat transfer to the wing surface showed agreement with the appropriate laminar or turbulent theory using measured pressures and based on a strip type of flow from the leading edge. Transition, which may be the result of the vortex near the corner, was observed at Reynolds numbers of less than 0.5×10^6.

0234 Dunlap, R., Brehm, R. L., and Nicholls, J. A. (University of Michigan), A PRELIMINARY STUDY OF THE APPLICATION OF STEADY-STATE DETONATIVE COMBUSTION TO A REACTION ENGINE. Jet Propulsion, 28, 451-6 (1958).

The purpose of this study is to determine the feasibility of a reaction engine employing a continuous detonation process at the combustion chamber. A reaction-type engine employing steady-state detonative combustion is considered. A simplified analysis treats the supersonic mixing of fuel and air together with the requirements necessary to achieve steady-state detonative combustion. Calculations of specific thrust and specific fuel consumption as functions of flight Mach number are made for hydrogen and acetylene fuels. The results of this study indicate that some supersonic diffusion of the air is necessary even though supersonic combustion exists. It is concluded that the speed range of air-breathing engines may be materially extended. This work was sponsored by the U.S. Air Force under Contract AF 18(600)-1199.

Dunnam, M. P., FLUIDS FOR HIGH TEMPERATURE APPLICATIONS. pp. 87-110 in: North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, "Combustion and Propulsion". AGARD Colloquium, 5th, Braunschweig, April 1962. Oxford, Pergamon, 1963. 0235

This report deals with the timely area of advanced fluids for high temperature applications. A review is given of the source and nature of high temperature fuels, lubricants, hydraulic fluids, and electronic coolants problems, and the limitations of the more conventional fluids are discussed. Recent information on the types of advanced high temperature fuels, lubricants, hydraulic fluids and electronic coolants and data on their properties are included.

Dunnam, M.P., FLUIDS (FUELS, LUBRICANTS, HYDRAULIC FLUIDS, AND ELECTRONIC COOLANTS) FOR HIGH TEMPERATURE APPLICATIONS. U.S. Air Force, ASD-TDR 62-574, August 1962. 26 pp. (AD 284873). 0236

Advanced fluids for high temperature applications are discussed. A review of the source and nature of high temperature fuels, lubricants, hydraulic fluids, and electronic coolants is given and the limitations of the more conventional fluids are discussed. Recent information on the types of advanced high temperature fuels, lubricants, hydraulic fluids, and electronic coolants and data on their properties are included.

Dupree, M. T. and Ziebland, H., THE THERMAL CONDUCTIVITY OF KEROSINE D. ENG. R. D. 2495 BETWEEN 15° AND 325°C AT PRESSURES UP TO 200 ATM. Gt. Brit. Explosives Research and Development Establishment. ERDE 9/R/60, November 1960. 10 pp. (AD 247490). 0237

The thermal conductivity of Aviation Kerosine, Spec. No. D. Eng. R. D. 2495, was measured with a vertical, co-axial cylinder apparatus in the temperature range 15° to 325°C at pressures between 1 and 200 atm. The trend of these results, demonstrated by the influence of temperature and pressure on the thermal conductivity, is characteristic of normal, non-associating liquids. The experimental values were tabulated, and smoothed graphs showing the variation of thermal conductivity with pressure and temperature were prepared. At temperatures in excess of 280°C noticable thermal decomposition of kerosine took place, believed to be due to the catalytic effect of the material of the receiving cylinder, a 97/3 percent copper/nickel alloy. About 4 percent of toluene was detected after the kerosine had been exposed for about 7 days to temperatures between 280° and 320°C. No such decomposition took place in the same temperature interval after the receiving cylinder had been replaced by an all-silver one.

Eckert, E. R. G., Hartnett, J. P., and Irvine, T. F., Jr. (University of Minnesota), A REVIEW OF HEAT TRANSFER LITERATURE, 1958. Mechanical Engineering, 81, no. 7, 44-55 (1959). 0238

This review summarizes the results of research in the field of heat transfer which were published during 1958. Because of the large number of such publications the presentation is restricted to papers dealing strictly with heat transfer and does not include those which cover physical processes, even when they are intimately connected with energy transfer, like boundary-layer flow and thermal properties.

Eckert, E. R. G., Hartnett, J. P., Irvine, T. F., Jr. and Sparrow, E. M. (University of Minnesota), A REVIEW OF HEAT TRANSFER LITERATURE, 1959. Mechanical Engineering, 82, no. 8, 47-61 (1960). 0239

This review summarizes the results of research in the field of heat transfer which were published during 1959. It is divided into sections on conduction, channel flow, boundary layer flow, flow with separated regions, transfer mechanisms, natural convection, convection from rotating surfaces, combined heat and mass transfer, change of phase, radiation, liquid metals, low-density heat transfer, measurement techniques and heat transfer applications.

Eckert, E. R. G., Irvine, T. F., Jr., Sparrow, E. M. and Ibele, W. E. (University of Minnesota), HEAT TRANSFER, A REVIEW OF CURRENT LITERATURE. International Journal of Heat and Mass Transfer, 5, 1023-50 (1962). 0240

This review covers the results of research in the field of heat transfer which were published during the previous year. Because of the large amount of research activity in this field, the review includes only a selection of the papers which have been published. A more complete listing of papers in the field of heat and mass transfer is contained in the "Heat Transfer Bibliographies" published periodically in the same journal. One section of the review deals specifically with aircraft and space vehicle cooling.

Eckert, E. R. G., Irvine, T. F., Jr., Sparrow, E. M. and Ibele, W. E. (University of Minnesota), A REVIEW OF HEAT TRANSFER LITERATURE, 1960. PARTS 1 AND 2. Mechanical Engineering, 83, no. 7, 34-42 and no. 8, 50-7 (1961). 0241

This two-part review summarizes the results of research in the field of heat transfer which were published during 1960. It is divided into sections in conduction, channel flow, boundary layer flow, flow with separated regions, transfer mechanisms, natural convection, convection from rotating surfaces, combined heat and mass transfer, change of phase, radiation, liquid metals, low-density heat transfer, measurement techniques, heat transfer applications and thermodynamic and transport properties.

Eckert, E. R. G., Sparrow, E. M. and Ibele, W. E. (University of Minnesota), HEAT TRANSFER BIBLIOGRAPHY. International Journal of Heat and Mass Transfer, 5, 561-70 (1962) 0242

This extensive list of recent publications on heat transfer is divided into sections on: applications, books, boundary layer flow, change of phase, channel flow, conduction, flow with separated regions, low-density heat transfer, liquid metals, magnetohydrodynamics, measurement techniques, natural convection, properties, radiation, rotating surfaces, transfer mechanisms, and transpiration and mass transfer cooling.

Eckert, E. R. G., Sparrow, E. M., Ibele, W. E. and Goldstein, R. J. (University of Minnesota), HEAT TRANSFER BIBLIOGRAPHY. International Journal of Heat and Mass Transfer, 6, 91-112 (1963). 0243

This extensive list of recent publications on heat transfer is divided into sections on: applications, books, boundary layer flow, change of phase, channel flow, conduction, flow with separated regions, low-density heat transfer, liquid metals, magneto-hydrodynamics, measurement techniques, natural convection, properties, radiation, rotating surfaces, transfer mechanisms, and transpiration and mass transfer cooling.

Eckert, E. R. G., Sparrow, E. M., Ibele, W. E. and Goldstein, R. J. (University of Minnesota), HEAT TRANSFER BIBLIOGRAPHY. International Journal of Heat and Mass Transfer, 6, 231-42 (1963). 0244

This extensive list of recent publications on heat transfer is divided into sections on: applications, books, boundary layer flow, channel flow, change of phase, conduction, flow with separated regions, liquid metals, low-density heat transfer, magnetohydrodynamics, measurement techniques, natural convection, radiation, rotating surfaces, thermodynamic and transport properties, transfer mechanisms, and transpiration and mass transfer cooling.

Eckert, E. R. G., Sparrow, E. M., Ibele, W. E. and Goldstein, R. J. (University of Minnesota), HEAT TRANSFER BIBLIOGRAPHY. International Journal of Heat and Mass Transfer, 6, 621-41 (1963). 0245

This extensive list of recent publications on heat transfer is divided into sections on: applications, books, boundary layer flow, channel flow, change of phase, conduction, flow with separated regions, low density, liquid metals, magnetohydrodynamics, measurement techniques, natural convection, radiation, rotating surfaces, thermodynamic and transport properties, transfer mechanisms, and combined heat and mass transfer.

Eckert, E. R. G., Sparrow, E. M., Ibele, W. E., and Goldstein, R. J. (University of Minnesota), HEAT TRANSFER: A REVIEW OF CURRENT LITERATURE. International Journal of Heat and Mass Transfer, 6, 761-91 (1963). 0246

This review covers results of research in the field of heat transfer which were published during 1962. The number of papers in this field is so large that the review includes only a selection of the total. A more complete listing is contained in "Heat Transfer Bibliographies" published periodically in the same journal.

0247 Eckert, E. R. G., Sparrow, E. M., Ibele , W. E. and Goldstein, R. J. (University of Minnesota), HEAT TRANSFER BIBLIOGRAPHY. International Journal of Heat and Mass Transfer, 6, 971-86 (1963).

This extensive list of recent publications on heat transfer is divided into sections on: applications, books, boundary layer flow, channel flow, change of phase, combined heat and mass transfer, conduction, flow with separated regions, liquid metals, low density, magnetohydrodynamics, measurement techniques, natural convection, radiation, rotating surfaces, thermodynamic and transport properties and transfer mechanisms.

0248 Eding, H.J., ANALYSIS, STORAGE, AND HANDLING OF MAGNESIUM AND BORON SLURRIES. Stanford Research Institute, Report No. 16, Technical Report No. I, SRI Project No. CU-971, U.S. Air Force Contract AF 33(616)-2271, May 1955. (AD 66353). REPORT CLASSIFIED CONFIDENTIAL.

Satisfactory methods were developed for slurries of boron and of magnesium in hydrocarbon carrier, to determine total solids, total metal content, oxides, and impurities. Procedures are given in appendixes for the required methods. An acceptable sedimentation method for determining the size distribution of magnesium particles was developed. The heat of combustion of boron was determined, but the method requires further research to correct for boron carbide. Storage of boron slurry in different materials was satisfactory. Fire hazards and ignition requirements were determined for these slurries.

0249 Edwards, G. (British Aircraft Corp.), PROGRESS WITH THE CONCORD (PART I). Shell Aviation News, no. 310, 2-9 (1964).

The design problems and the philosophy of design used for the Concord are discussed in some detail. Fuel management to maintain trim and minimize overheating of fuel in tanks is treated. The use of the fuel as a coolant is mentioned in connection with air conditioning and passenger comfort systems. It is anticipated that with pressurized tanks, conventional kerosene fuels will meet requirements for the Concord.

Eggers, A. J. Jr., A DISCUSSION OF METHODS FOR REDUCING AERODYNAMIC HEATING IN SUPERSONIC FLIGHT. U. S. National Advisory Committee for Aeronautics, RM A55F21a, September 1955. 16 pp. 0250

It is pointed out that smooth, cooled surfaces shaped to give negative pressure gradients tend to reduce heating by providing larger amounts of laminar flow. The transpiration cooling system is discussed in relation to turbulent boundary layers. Then the desirability of blunting the noses of bodies and of blunting and sweeping the leading edges of wings to minimize local heating is treated. Finally the favorable effect of vortex cooling is discussed.

Eggers, A. J., Jr., SOME CONSIDERATIONS OF AIRCRAFT CONFIGURATIONS SUITABLE FOR LONG-RANGE HYPERSONIC FLIGHT. pp. 369-390 in: Collar, A. R. and Tinkler, J., eds., "Hypersonic Flow". New York, Academic, 1960. 0251

An exposition and discussion of configurations (aerodynamic) suitable for various types of hypersonic mission are presented in the paper. Aerodynamic heating is discussed as a limiting factor in the use of some configurations.

Eidus, Ya. T., Guseva, I. V., and Slovetskaya, K. I., CATALYTIC POLYMERIZATION OF OLEFINS. COMMUNICATION 5. COMPARATIVE STUDY OF THE ACTIVITIES OF NICKEL, COBALT, AND IRON CATALYSTS IN THE POLYMERIZATION OF PROPENE AND THE DEHYDROGENATION OF CYCLOHEXANE. Academy of Sciences (U. S. S. R.). Bulletin. Division of Chemical Sciences, 1960, 305-10. 0252

Nickel mounted on glass, alumina, and alumina-silicate was active for the dehydrogenation of cyclohexane at 350°C and low liquid hourly space velocity (0.1-0.3). Iron and cobalt on the same supports were inactive.

0253

Eisen, C.L., Gross, R.A. and Rivlin, R.J. (Fairchild Engine and Airplane Corp.), THEORETICAL CALCULATIONS IN GASEOUS DETONATION. U.S. Air Force, AFOSR TN 58-326, Contract AF 49(638)-15, March 1958. 93 pp. (AD 154230).

This study treats one dimensional steady flow combustion in the Mach number range of 0 to 10. Original data are presented for a wide variety of hydrocarbon fuels burning with air. Particular attention is given to the classical Chapman-Jouguet point. The results include the effect of dissociation and ionization. The effects of fuel-air ratio, initial temperature, and initial pressure are considered. Curves are presented which show not only the Chapman-Jouguet point, but the strong and weak detonation branches. These data were generated by the successful development of an automatic digital computer program. The program is applicable to any hydrogen, carbon, oxygen and nitrogen system.

0254

Elkonima, M. L., ed., FUEL FOR ENGINES. Moscow, Gosudarstvennyi Izdatel'stvo Standartov, 1960. 78 pp.

The collection of fuel standards for engines was compiled by the State Standards Publishing House and contains standards of 18 fuels which have been in effect since 1 Feb 1960 as well as their components and descriptions of their testing methods. There are no references.

0255

Elliott, M. A., Hurn, R. W., and Trimble, H. M. (Illinois Inst. of Technology), AUTOIGNITION OF FUELS IN A CONSTANT-VOLUME BOMB - EFFECTS OF OPERATING VARIABLES AND FUEL STRUCTURE. American Petroleum Institute. Proceedings, 35, no. 3, 361-73 (1955).

The ignition delays and minimum ignition temperatures of numerous pure hydrocarbons were determined in a constant-volume bomb at 250 psig and 650 psig at 8 temperatures between 500°F and 1,390°F. At low bomb temperatures, ignition delay decreased with increasing fuel-air ratio toward stoichiometric, but at higher temperatures it increased. Increased pressure shortened ignition delay above 800°F, but increased it for many fuels at temperatures approaching the minimum for autoignition. Ignition delay usually decreased with increasing temperature, but this behavior varied widely for different hydrocarbon structures. With some exceptions, the minimum ignition temperatures were in the relative order to be expected from ignition-delay data. A unique correlation of cetane number with ignition-delay measurements for fuels of widely varying structure could not be obtained.

Elperin, I. T., **HEAT AND MASS TRANSFER IN REACTION SYSTEMS.** International Chemical Engineering, 4, no. 2, 324-8 (1964).

0256

An analysis of transfer processes in homogeneous and heterogenous reacting systems using the phenomenological methods of the thermodynamics of irreversible processes is given. Gas-solids suspensions are considered and two methods of increasing the rate of heat and mass transfer are mentioned. These are the pulsating fluidised bed method and the counter-current jet method, both of which produce their benefits through an increase in relative velocity between the two phases.

Emerson, W. H., **PROGRESS IN HEAT TRANSFER--REVIEW OF CURRENT LITERATURE.** Chemical and Process Engineering, 44, no.8, 453-60, 472 (1963).

0257

The author has selected 105 recent papers which are of greatest usefulness to engineers engaged in the design and operation of heat transfer equipment. The article is divided into five sections, each one dealing with a major mode of heat transfer: conduction, radiation, free convection, forced convection and change of phase.

Eppi Precision Products, Inc., **EVALUATION OF THE CRC RESEARCH FUEL COKER.** Eppi Precision Products, Report 60-35, 1960.

0258

It is concluded that the CRC Research Fuel Coker has proven itself as a useful and versatile tool for exploring the high temperature performance of fuels. As the fuel reservoir temperature was increased, severity of the test was sharply increased. Temperature differences between the heated reservoir surface and the bulk fuel were always less than 10°F. When the fuel reservoir was nitrogen purged, fuel stability was improved, but not of the magnitude expected. Also reported is a series of runs made to determine whether or not improvement in stability could be made by common fuel treatments. Other interesting findings include the discovery that 304 type stainless steel caused more deposition than aluminum in the preheater and that even the more stable fuels may lose stability in prolonged storage.

Eppi Precision Products, Inc., **SUMMARY REPORT OF THE COOPERATIVE HIGH TEMPERATURE FUEL COKER PROGRAM, EQUIPMENT AND OPERATION PHASE.** Report No. 59-27, June 1, 1959. 6+ pp. 0259

A private cooperative program, sponsored by six companies, designed to explore the thermal stability of fuels at conditions of temperature beyond the range of the standard CFR Fuel Coker, has been established at Eppi Precision Products, Inc. The work to date has been directed toward studying the new equipment, its performance relationship to the standard CFR Fuel Coker, and the directional effect of several operational variables. This report summarizes the study of the equipment and its operation.

Epstein, A. and Hamilton, A. F. (Republic Aviation), **STUDY OF DESIGN PARAMETERS FOR STRUCTURE SUBJECT TO AERODYNAMIC HEATING.** U. S. Air Force ASD TR 61-95, Contract AF 33 (616)-7277, August 1962. 153 pp. (AD 286 454). 0260

Parameters are discussed that are significant in design of a structure subject to aerodynamic heating both for aircraft and for orbiting glide re-entry vehicles. These parameters include such items as load factor, speed, and time of exposure at any particular speed and load factor. Means for documenting the parameters, so that flight environmental criteria are adequately prescribed, are developed, and two examples illustrating use of this documentation are presented; one a 4M transport airplane, the other a manned orbiting glide re-entry vehicle. The suitability of the recommended parameters for use in structural design criteria specifications and for continuous cockpit display, as an indication of airframe flight limitations, is discussed. The feasibility of using flight simulators to identify critical flight environments from a structural point of view is also considered.

Esgar, J. B., Hickel, R. O., Stepka, F. S., **PRELIMINARY SURVEY OF POSSIBLE COOLING METHODS FOR HYPERSONIC AIRCRAFT.** U. S. National Advisory Committee for Aeronautics, RM E57L19, February 1960. 37 pp. 0261

Many methods of cooling the structure of an aircraft capable of flight speeds up to 18,000 feet per second were studied. Water and hydrogen stored in the liquid state appear very promising as both coolants and heat sinks. The storage and circulation of hydrogen throughout the aircraft need not be a hazard. Cooling the outer skin of the aircraft in high-equilibrium-temperature regions could probably be avoided by using a material such as silicon carbide. The internal structure could be cooled by use of a thin layer of balsa wood saturated with water. In this way tanks for storage of coolant would be avoided.

Esgar, J. B., Livingood, J. B. N., and Hickel, R. O. (Lewis Flight Propulsion Laboratory, NACA), RESEARCH ON APPLICATION OF COOLING TO GAS TURBINES. American Society of Mechanical Engineers. Transactions, 79, 645-51 (1957). 0262

The use of turbine cooling in gas-turbine engines can offer many performance benefits but, at the same time, it may result in added complication to the engine. The advantages that turbine cooling can offer to the engine designer and the results of some of the research that has been expended on the cooling of gas-turbine engines are discussed. The ultimate heat rejection method is not considered in the paper.

Evans, L. B. and Churchill, S. W. (University of Michigan), THE EFFECT OF AXIAL PROMOTERS ON HEAT TRANSFER AND PRESSURE DROP INSIDE A TUBE. Chemical Engineering Progress. Symposium Series, 59, no. 41, 36-40 (1963). 0263

The pressure drop and rate of heat transfer were measured for water flowing in a tube containing bluff-body promoters. Disks and streamline shapes of several sizes were mounted at various uniform spacings along a small, axially centered rod. Solid axial cores of various uniform diameters were also investigated. A uniform heat-flux density was imposed along the wall, and local heat transfer coefficients were determined from temperature measurements. The pressure drop and rate of heat transfer were both increased substantially by the streamline shapes and even more by the disks. Generalized empirical correlations are presented for the heat transfer coefficient and the effective drag coefficient or friction factor for disks, streamline shapes and annuli.

Fabuss, B. M., Borsanyi, A. S., Driscoll, J. L., Gudzinowicz, B. J., Lait, R. I., Smith, J. O., and Wurster, C. F., Jr. (Monsanto Chemical). EVALUATION OF MATERIALS AS ENDOTHERMIC AVIATION FUELS. U.S. Air Force, WADD TR 60-841, Part I, Contract AF 33(616)-6608, February 1961. 90 pp. (AD 267063). 0264

To determine the feasibility of using endothermic hydrocarbons as heat sink aviation fuels and to increase their heat absorption capacity, the endothermic thermal cracking of cetane was investigated. Experimental results showed that cetane can be used as an endothermic fuel. The heat sink capacity of cetane is 294 Btu/lb from its mp (68°F) to its atmospheric bp (550°F). From its melting point to the point of initial decomposition (706°F) it is 513 Btu/lb. When cracked endothermically to 60% conversion, its calculated heat sink capacity increased to 950, 1040, and 1130 Btu/lb at 1100, 1200, and 1300°F, respectively. The rate constants for the first-order cracking reaction of cetane were measured and relationships were developed for the calculation of the rate constant at a given temperature and pressure. The rates of formation of gas, high boiling polymeric material, aromatic material, and coke were determined and related to the degree of conversion. The burning characteristics of the cracked products were measured by Luminometer and Phillips Microburner.

Fabuss, B. M. Borsanyi, A. S., Duncan, D. A., Kafesjian, R. and Smith, J. O. (Monsanto Research), RESEARCH ON THE MECHANISM OF THERMAL DECOMPOSITION OF HYDROCARBON FUELS. U. S. Air Force, ASD TDR 63-102, Part 2, Contract AF 33 (657)-8193, August 1964. 155 pp. (AD 605 817). 0265

The decomposition and particle formation of 28 naphthenic and 8 paraffinic hydrocarbons were studies. The decomposition was approximately a first-order kinetic process, although self-acceleration was observed with most monocyclic hydrocarbons and self-inhibition was observed for polycyclic hydrocarbons. Pressure increased the decomposition rate. A detailed study of the effects of organosulfur contaminants was made. These contaminants inhibited the cracking of naphthenes and straight-chain paraffins and accelerated the cracking of branched paraffins. An increase in contaminant concentration and an increase in the number of methyl substituent groups on a hydrocarbon increased this effect. Several binary hydrocarbon mixtures were cracked. The component hydrocarbons did not crack independently. Nevertheless, the decomposition rate of the mixture could be predicted assuming no mutual interference in decomposition. The micro-coker, a new small-scale device for studying decomposition and deposit formation in a flow system, was developed.

Fabuss, B. M., Kafesjian, R., Fabuss, M. A., Borsanyi, A. S. and Smith, J. O. (Monsanto Research), RESEARCH ON THE MECHANISM OF THERMAL DECOMPOSITION OF HYDROCARBON FUELS. U. S. Air Force, ASD TDR 63-102, Part 1, Contract AF 33(657)-8193, January 1963. 143 pp. (AD 418 194). 0266

The rate of decomposition and rate of particle formation were investigated for 29 naphthenic and 3 paraffinic hydrocarbons at 800 F. The rate constants of particle formation were proportional of the rate constants of decomposition and characteristic for a homologous series. For the same rate of decomposition, the rate of particle formation increased in the following order: polycyclic hydrocarbons, decalins, cyclohexanes, hydridans, and cyclopentane derivatives. Olefins, dienes, polyunsaturates, color bodies, and polymeric materials acted as intermediates in particle formation. Preliminary results on the decomposition of two-component mixtures showed an additivity of the rate constants of decomposition. A study of the effect of O-, S-, and N- containing contaminants on the thermal stability of pure hydrocarbons showed highly specific interactions. Contaminants showed the same promoting or inhibiting effect on decomposition as on particle formation. A new microcoker unit was developed for fuel stability investigations.

Fabuss, B. M., Kafesjian, R., Smith, J. O., and Satterfield, C. N. (Monsanto Research), THERMAL DECOMPOSITION RATES OF SATURATED CYCLIC HYDROCARBONS. Industrial and Engineering Chemistry Process Design and Development, 3, no. 3, 248-54 (1964). 0267

A general correlation between decomposition rate and molecular structure has been developed from measurements at elevated pressures of thermal decomposition rates of 28 compounds, including cyclohexane, decahydronaphthalene, hydrindan, and their derivatives. Present and previous rate data on cyclohexane and decahydronaphthalene are discussed in detail. Some activation energies found are cyclohexane and derivatives, 61 to 63 kcal. per gram-mole; decahydronaphthalene, 64 kcal. per gram-mole; and methylhydrindan, 60 kcal. per gram-mole. This work was sponsored by the U. S. Air Force under contract AF 33(657)-8193.

Fabuss, B. M., Smith, J. O., Lait, R. I., Borsanyi, A. S., and Satterfield, C. N. (Monsanto Research), RAPID THERMAL CRACKING OF n-HEXADECANE AT ELEVATED PRESSURES. Industrial and Engineering Chemistry Process Design and Development, 1, no. 4, 293-9 (1962). 0268

The thermal cracking of pure (n-hexadecane) was studied in a flow reactor at 1100/ to 1300°F. and pressures of 200 to 1000 p.s.i. The product was analysed for individual paraffins and olefins, carbonaceous deposits, and diolefins and aromatics as a group. Initially polymerization reactions appeared to predominate, so that the liquid fraction of the product C_5 and higher) had an average molecular weight at low per cent conversions several times that of the initial cetane. Average molecular weight steadily dropped with increased per cent cracking. The amounts of carbonaceous deposits were far less than those previously reported for paraffin cracking, probably because of high flow rates. The rate of reaction was substantially limited by the rate of heat transfer. The first-order rate constants at a specified temperature were independent of pressure. The over-all results provide a quantitative picture of the complex interaction of polymerization and cracking phenomena of a typical pure high molecular weight paraffin at elevated pressures. This work was sponsored by the U. S. Air Force under Contract AF 33(616)-6608.

Fabuss, B. M., Smith, J. O., Lait, R. I., Fabuss, M. A., and Satterfield, C. N. (Monsanto Research), KINETICS OF THERMAL CRACKING OF PARAFFINIC AND NAPHTHENIC FUELS AT ELEVATED PRESSURES. Industrial and Engineering Chemistry Process Design and Development, 3, no. 1, 33-7 (1964). 0269

Six highly refined hydrocarbon jet fuels were thermally cracked in a flow reactor at a wall temperature of 1200°F (reaction temperature of 1070° to 1100°F) and pressures from 200 to 1000 psig. The calculated first order rate constants for highly paraffinic and highly naphthenic fuels containing negligible unsaturates were affected only slightly by pressure and were about twice as large as the value for pure n-hexadecane under the same conditions. At 500 psig, a paraffinic fuel containing 16 weight % olefins had a first-order rate constant approximately 2.5 times greater than those for fuels containing negligible olefins; however, this decreased rapidly with increased pressure. Product composition was determined as a function of the degree of reaction and the results were fitted to a kinetic model. This work was sponsored by the U.S. Air Force under Contract AF 33(616)-7845.

Fabuss, M. A., Borsanyi, A. S., Fabuss, B. M., and Smith, J. O. (Monsanto Research), THERMAL STABILITY STUDIES OF PURE HYDROCARBONS IN A HIGH PRESSURE ISOTENISCOPE. Journal of Chemical and Engineering Data, 8, no. 1, 64-9 (1963). 0270

Decomposition temperatures were determined in a high pressure isoteniscope for 80 naphthenic and 9 paraffinic saturated hydrocarbons. The effect of the number of rings, length of side chains, and number of side chains on thermal stability was studied. The naphthenic compounds investigated were 14 cyclohexanes, 7 hydrindans, 17 decalins, 26 nonfused dicyclohexanes, and 16 nonfused polycyclic hydrocarbons. The paraffinic hydrocarbons ranged from C_{12} to C_{19}. The decomposition temperature can be estimated with a precision of ±12.5°F as a function of the critical pressure by the equation $T_d = C + 8.31 P_c$, where C is a characteristic constant for each homologous series. This work was sponsored by the U.S. Air Force under Contract AF 33(616)-5799.

Fainman, M.Z., Krawnow, M.E., Kaufman, E.D., Reynolds, O.P., Thistlewaite, R. L., and Wolford, O.C. (Cook Electric Co.) THE BEHAVIOR OF FUELS AND LUBRICANTS IN DYNAMIC TEST EQUIPMENT OPERATING IN THE PRESENCE OF GAMMA RADIATION. U.S. Air Force, WADC TR 58-264, Contract AF 33(616)-3865, March 1958. 177 pp. (AD 155596). 0271

This report summarizes work conducted on a program designed to evaluate fuels, hydraulic fluids and lubricants for use in a nuclear-powered aircraft. 79 fuels and 41 lubricants were investigated. Results obtained clearly indicate that it is necessary to assess the effects of mechanical, thermal, and radiation stresses simultaneously. It has been observed that mechanical tests in a radiation environment often effect materials more drastically and at lower doses of radiation than the same tests conducted with statically irradiated samples without attendant radiation. Relative ratings of ten of the most promising fuels and six lubricants with the best performance characteristics are given. These ratings are based on performance in dynamic test machinery operated in a radiation environment.

Fan, S.S.T., Rozsa, R.B. and Mason, D.M. (Stanford University), HEAT TRANSFER IN REACTING SYSTEMS, EFFECT OF CHEMICAL KINETICS ON THE THERMAL CONDUCTIVITY OF GASES. Chemical Engineering Science, 18, 737-52 (1963). 0272

The effect of chemical kinetics on the conduction of heat through a reacting gas at rest between a pair of infinite parallel plates has been analyzed by solving the equations of change with the aid of an analog computer. For illustrative purposes the analysis has been applied to the case of purely homogeneous gas-phase reversible reactions with two quite different kinetic mechanisms being considered. Complete temperature equilibration of the gas with the solid walls was assumed. The temperature differences between the plates were not restricted to small values and thus the variation in reaction rate with position could not be neglected. The analysis leads to a dimensionless parameter consisting of the ratio of an effective diffusion time to an effective reaction time, the effective thermal conductivity of the gas increasing with an increase in this parameter.

Farr, W. K. (Farr Cytochemical Laboratories), CYTOCHEMICAL STUDIES OF FUNGI WHICH CONTAMINATE AIRCRAFT FUELS AND DETERIORATE MATERIALS. U. S. Air Force, Aerospace Medical Research Laboratores, TDR 62-132, Contract AF 33(616)-7891, November 1962. 77 pp. (AD 293226). 0273

Cytochemical analyses of the fungus, Aspergillus niger ATCC 6275, have revealed the presence of chitin in the longitudinal and cross walls of the hyphae, chitin in the primary lamellae, and both chitin and cellulose in the secondary lamellae of the walls of conidiophores, vesicles, and conidia. Similar analyses have shown the presence of chitin alone in the walls of the corresponding cells of the fungus, Myrothecium verrucaria ATCC 9095. Adaptations of standard cytochemical procedures to the identification of cell wall materials in the bacterium, Pseudomonas aeruginosa ATCC 13388, have indicated the probable presence of chitin in the primary, and cellulose in the secondary, wall lamellae. Attempts to identify cell wall materials in the bacterium, Escherichia coli K12 10798, have shown definite differences in the make-up of the primary and secondary wall lamellae and the possible presence of cellulose in the secondary deposits. These four organisms are among those which contaminate aviation fuels. Information concerning the nature and location of the resistant substances which make up their cell walls can be used in developing methods of treatment which will lead to their control.

Fehlner, T. P. and Koshi, W. S. (Johns Hopkins University). UNSTABLE SPECIES AND THE ISOTOPE EFFECT IN THE PYROLYSIS OF DIBORANE IN A SHOCK TUBE. American Chemical Society, Abstracts of Papers, 145th Meeting, September 1963, pp. 8N-9N.

0274

The pyrolysis experiments provided evidence for the presence of hexaborane-12 as an intermediate in the formation of hexaborane-10 and additional confirmation of the existence of heptaborane-11 and -13. The presence of a large normal isotope effect in the formation of tetraborane and hexaborane and an inverse isotope effect in formation of pentaborane-9 showed that the last compound is formed by a different path from that of the first two; the magnitude of this effect shows that tetraborane is intermediate in hexaborane formation. A 14-step mechanism, consisting of a series of competitive reactions and equilibria, is proposed which is consistent with the isotope effects and also with the product distributions obtained when shock waves were run through various mixtures of the volatile hydrides with and without hydrogen.

Feizkhanov, F. A., Panchenkov, G. M. and Kolesnikov, I. M., KINETIC EQUATIONS FOR HEPTANE REACTIONS UNDER CATALYTIC REFORMING CONDITIONS. Neftekhimiya 2, 716-22 (1962). (C. A., 58, abstr. 7768 C, 1963).

0275

Several simultaneous or consecutive reactions take part in the catalytic reforming of n-heptane. Three possible reaction schemes are suggested. For one of the proposed schemes, a detailed kinetic analysis is given, and the corresponding differential equations are derived. By examn. of the experimental data, the authors found close agreement between the observed course of reaction and the reaction scheme. Deviations from this scheme can, however, be expected for reaction conditions differing widely from those discussed. At 496° and 35 atm., hydrocracking predominated; at 468°, isomerization predominated.

Ferri, A., Ed., FUNDAMENTAL DATA OBTAINED FROM SHOCK-TUBE EXPERIMENTS. New York, Pergamon, 1961. 415 pp. (North Atlantic Treaty Organization. AGARDograph No. 41).

0276

This volume presents a collection of monographs in the fields of chemical, physical and thermodynamic problems investigated or investigable experimentally by shock-tube techniques. Of particular interest are the section on shock tube technology and design by H. T. Nagamatsu, that on carbon formation from hydrocarbons by S. S. Penner et al, and the section on gaseous detonations by H. Gg. Wagner.

0277 Ferri, A., SUPERSONIC COMBUSTION PROGRESS. Astronautics and Aeronautics, 2, no. 8, 32-8 (August 1964. Pt. I).

Progress on development of a supersonic combustion cycle air-breathing ramjet engine is reviewed. Attention is restricted to hydrogen as a fuel. The author concludes that progress to date on supersonic combustion clearly indicates that such processes can be used efficiently in a hypersonic ramjet of practical dimensions. Preliminary analysis of applications of this system also indicates that a practical engine with very promising performance can be structurally designed and therefore justifies larger developmental effort.

0278 Ferri, A., Libby, P. A. and Zakkay, V. (Polytechnic Institute of Brooklyn), THEORETICAL AND EXPERIMENTAL INVESTIGATION OF SUPERSONIC COMBUSTION. U. S. Air Force, ARL 62-467, Contract AF 33(616)-7661, September 1962. 117 pp. (AD291712).

A theoretical and experimental investigation of mixing and supersonic combustion is presented. A review of the problem is given. Then an analysis of inviscid flow fields with a finite rate chemistry for a hydrogen-air reaction is presented. Finally, an analysis of a turbulent mixing for flows with large density gradients with no chemical reaction is presented. The analysis is compared with the experimental results. The results of the experiments in supersonic combustion are presented.

0279 Fieldhouse, I. B. Hedge, J. C., Lang, J. I., Waterman, T. E. (Armour Research Foundation), THERMAL PROPERTIES OF HIGH TEMPERATURE MATERIALS. U. S. Air Force, WADC TR 57-487, Contract AF 33(616)-3701, February 1958. 79 pp. (AD 150954).

The purpose of this investigation was to measure the thermal conductivity, specific heat, and linear coefficient of thermal expansion of various materials from 1000 to 3000°F. The materials considered were: Stellite 21, Silicon Carbide, Hastelloy B, Hastelloy C, Stainless Steel type 17-7 P. H., Stainless Steel type 446, Beryllium, and 60-15 Cr (ASTM B83-46).

Findl, E., Braude, H., and Edwards, H. (Thompson Products), STUDY OF PHYSIOCHEMICAL PROPERTIES OF COMMERCIAL SAMPLES OF ISOPROPYLDICYCLOHEXYL AND DIETHYLCYCLOHEXANE. U.S. Air Force, WADD TR 60-766, Contract AF 33(616)-5587, November 1960. 46 pp. (AD 262104). 0280

Commercial samples of isopropyldicyclohexyl (IDH) and diethylcyclohexane (DCH) were studied in respect to density-temperature relationships over the range 0-500°F; liquid specific heats over the range 100-500°F; heats of vaporization; vapor pressure-temperature relationships; entropy-temperature relationships; and gross heats of combustion. (IDH) is quite similar to fuels meeting the RJ-1 specifications in most of its thermodynamic properties. The distillation range is considerably less for DCH than a JP-6H fuel.

Findl, E., Braude, H., and Edwards, H. (Thompson Products), STUDY OF PHYSIOCHEMICAL PROPERTIES OF SELECTED MILITARY FUELS. U.S. Air Force, WADD TR 60-767, Contract AF 33(616)-3729, December 1960. 216 pp. (AD 274623). 0281

Physical and thermodynamic properties were studied for MIL-F-5624C Grade JP-4, a MIL-F-25558 Grade RJ-1, MIL-F-25656 Grade JP-6-H, and Decalin (a commercial mixture of the cis and trans isomers). Properties evaluated were: Equilibrium solubility of air, nitrogen and ethane (JP-4 and RJ-1); effect of dissolved air, nitrogen, and ethane on viscosity (JP-4 and RJ-1); effect of dissolved ethane on density (JP-4 and RJ-1); thermodynamic properties of each of the four test fuels including specific heats, enthalpy, and entropy; vaporization characteristics of each of the test fuels including vapor pressure, equilibrium vaporization curves, minimum reflux curves, variation of vapor molecular weight during minimum reflux distillations, and variation of density during minimum reflux distillations; variation of liquid density as a function of temperature; and literature survey correlation compilation for the determination of physical and thermodynamic properties of petroleum fuels.

Findl, E., Braude, H. and Edwards, H., STUDY OF THE VAPORIZATION CYCLE AND THERMODYNAMIC PROPERTIES OF PETROLEUM TYPE FUELS. Thompson Products, Inc., Report No. Ing. ER. 206, U. S. Air Force Contract AF 33 (616)3729, January 1958. 111 pp. 0282

The three principal purposes of these studies were: (1) to determine the vaporization characteristics of a JP-4, a JP-6, and a Shell UMF Grade C Fuel as a function of pressure level; (2) to determine the enthalpy, entropy, specific heat, and heat of vaporization of the above three fuels as a function of temperature and pressure. As much of this information as possible was to be presented in the form of enthalpy-entropy diagrams; (3) to determine, by means of a literature survey, the availability of generalized thermodynamic information on hydrocarbon fuels. Where reliable information could be obtained it is presented as part of this report.

0283 Findl, E., Edwards, H. and Braude, H. (Thompson Ramo Wooldridge), CERTAIN PHYSIOCHEMICAL PROPERTIES OF COMMERCIAL SAMPLES OF DECAHYDRONAPHTHALENE, ISOPROPYLDICYCLOHEXYL AND DIETHYLCYCLOHEXANE. American Chemical Society. Division of Petroleum Chemistry. Preprints 4, no. 2, B 51-58 (April 1959).

A study was undertaken to investigate certain physiochemical properties of current and future possible aircraft fuels. Included in this group of fuels were a JP-4, a JP6-H, an RJ-1 and commercial samples of decahydronaphthalene, isopropyl dicyclohexyl and diethylcyclohexane. Considerable interest has been generated in the last three. They are possible replacements for the present JP, RP and RJ type fuels because of their good thermal stability characteristics. The physiochemical properties which were determined under this program were: Density-temperature relationships over the range 0° - 500°F, liquid specific heats over the range 100°-500°F, heats of vaporization at one atmosphere, ASTM distillation range, vapor pressure - temperature relationships, heats of combustion, and vapor chromatograms. Utilizing this experimental information and certain correlations, entropy-temperature charts were computed. Presented in this paper are the study results which were obtained for commercial samples of decahydronaphthalene (decalin), isopropyl dicyclohexyl and diethylcyclohexane.

0284 Finlay, I. C. (National Engineering Laboratory), PROGRESS IN HEAT TRANSFER - REVIEW OF CURRENT LITERATURE. Chemical and Process Engineering, Heat Transfer Survey 1964, 437-45.

This survey is selected from works on heat transfer published during 1963. The selected literature is classified under the broad headings of conduction, convection, radiation, and change of phase, which has been further subdivided into condensation, evaporation, boiling and two-phase flow. In addition, a section on dynamics of heat exchange systems has been included. 127 references.

0285 Finn, R. F. and Lifson, W. E., FACTORS AFFECTING THE WATER CONTENT OF AVIATION FUELS. Standard Oil Development Co. Esso Laboratories. Memorandum, September 21, 1953. 39 pp. (AD 36992).

The effects of temperature and composition on the solubility of water in aviation fuels and the rates of saturation of aviation fuels in contact with liquid water and humid air are discussed. A study was made of the effects on water loss of relative humidity, temperature, cooling rate, vent size, ratio of surface area to liquid height, and vapor space. The results of the study indicated that fuels may lose a considerable quantity of water when vented to a low temperature or low humidity atmosphere. The fuels become saturated when stored over water in a closed system. When the fuels are vented and are not contacting water, the water content depends upon the absolute humidity of the atmosphere. The water content will be increased when a dry fuel is vented to a humid atmosphere. Henry's law may be used to predict the equilibrium water content. Conditions which will affect these phenomena are the vent area, the vapor space above the fuel, the surface area and the height of the fuel, and the cooling rate. Solubility data are given for water in JP-4, kerosine, and aviation gasolines.

Fiock, E. F. and Dahl, A. Z. (U.S. National Bureau of Standards), THE MEASUREMENT OF GAS TEMPERATURE BY IMMERSION-TYPE INSTRUMENTS. American Rocket Society Journal, 23, no. 3, 155-64, (1953). 0286

Available methods and instruments for measuring the temperatures of gases in turbines and jet engines by means of sensing elements immersed in the working medium are reviewed and intercompared. Means for reducing and evaluating the effects of radiation and gas impact upon the performance of the instrument are shown to be of considerable importance in such applications. For purposes of engine control and protection, the rate of response to sudden changes in temperature is also of particular interest. These characteristics, together with ranges of applicability and methods of construction and insulation required to withstand engine-operating conditions, are discussed for bare, sheathed, shielded, and aspirated thermocouples, for resistance-type elements, and for several pneumatic or thermodynamic systems.

Fiorello, S.C. and Collick, C.J., THERMAL DEGRADATION OF JET FUELS. U.S. Naval Air Engineering Center, NAEC AEL 1749, October 1963. 15 pp. (AD 421 485). 0287

Depolarization of a JP-5R fuel improves its thermal stability. The concentration of the individual polar fractions can significantly affect the amount of solid thermal decomposition products. The amount of JP-5R thermal decomposition products depends upon: (1) the temperature to which the fuel is heated, (2) the time at a given temperature, (3) the type of material in contact with the heated fuel and (4) the quantity of a given material in contact with the heated fuel.

Fishburne, E. S., Bergbauer, D. M. and Edse, R. (Ohio State Univ.), CHEMICAL KINETICS AND THE REFLECTED SHOCK WAVE. Physics of Fluids, 7, 1391-2 (1964). 0288

The authors compare experimentally the rates of decomposition of nitrous oxide behind incident and reflected shock waves. They find the rate somewhat faster behind the reflected wave. This is attributed to a vibrational excitation achieved at the lower temperature of the incident wave which precedes the reflected wave. Although the effect was not large for this reaction, it was distinct and raises a question regarding the validity of measurements of kinetics or ignition delays behind reflected shock waves.

Fisher, L. B., Terpugova, M. P., and Kotlyarevskii, I. L., DEHYDROGENATION OF DISUBSTITUTED BUTANES (STUDY OF FIRST STAGE OF DEHYDROGENATION OF 2,3-DIMETHYLBUTANE). Akademiya Nauk SSSR. Sibirskoe Otdelenie, Izvestiya, 1958, no. 9, 32-8. (C. A., 55, 245241, 1961). 0289

The first stage of the dehydrogenation of $(Me_2CH)_2$ was studied over different catalysts in a quartz tube. $CH_2:CMeCMe_2$, $(Me_2C:)_2$, and $(CH_2:CMe)_2$ were formed. Introduction of Me groups in the 2,3-positions sharply increased the ability of this system to form conjugated double bonds. Mixed Al-Cr catalyst (in which 50% of the Al_2O_3 was replaced by kaolin) was less active than an Al-Cr catalyst prepared from active Al_2O_3 and Cr salts.

Fletcher, E. A., Dorsch, R. G. and Allen, H., Jr. (Lewis Research Center, NASA), COMBUSTION OF HIGHLY REACTIVE FUELS IN SUPERSONIC AIRSTREAMS. ARS Journal, 30, 337-44 (1960). 0290

The feasibility of adding heat to supersonic airstreams by combustion was studied in a small wind tunnel. Aluminum borohydride, pentaborane, hydrocarbon-aluminum borohydride mixtures, several alkyl aluminum compounds, alkylboranes and vinylsilane were tested. The first three ignited easily and burned well; the others either failed to ignite or burned only in the diffuser. Gross effects on flow were studied by observation of shock patterns and water sprays injected from the tunnel walls. Examples are given which illustrate the use of these techniques in aerodynamic studies in larger wind tunnels.

Flowers, M. C. and Frey, H. M., THE THERMAL DECOMPOSITION OF BICYCLOPROPYL. PART I. Chemical Society (London). Journal. 1962, 1689-94. 0291

The thermal decomposition of bicyclopropyl in the temperature range 408-474°C. was investigated. In this temperature range bicyclopropyl underwent a series of parallel first-order reactions to give cyclohexene, butadiene and ethylene, and four cyclopropylpropenes. The overall rate of decomposition was accurately fitted by the Arrhenius equation $k = 10^{15.36}\exp(-60,710/RT)\sec^{-1}$. Cyclopropenes formed initially underwent isomerization to various C_6 dienes at rates comparable with those of the primary reactions which lead to complex mixtures of at least 17 products.

Fluendy, M. A. D. (Oxford University). CALCULATION OF CYCLIZATION PROBABILITIES AND OTHER CONFIGURATION PROPERTIES OF ALKANE-TYPE CHAINS BY A MONTE CARLO METHOD. Faraday Society. Transactions, 59, no. 8, 1681-94 (1963).

0292 In computations of thermodynamic properties which could be compared with previously obtained activation energies for intramolecularly catalyzed proton transfers in keto acids, the numerical parameters were chosen to provide a good model for a simple unbranched chain alkane. This makes the model sufficiently general to be of wide application. Tables, graphs, and 10 references.

Fochtman, E. G., Bitten, J. F., and Katz, S. (I.I.T. Research Institute), PREPARATION OF A MAGNESIUM-JP-4 SLURRY FUEL. Industrial and Engineering Chemistry Product Research and Development, 2, no. 3, 212-6 (1963).

0293 A potentially useful fuel consisting of magnesium powder suspended in JP-4 fuel has been prepared by use of surfactants which induce compatibility between solid metal and the liquid phase. Both vapor process and ball-milled slurries were studied with various surfactants. Viscosities and ageing and redispersion characteristics were measured for slurries containing about 50%w metal and about 2-3%w dispersion agent in JP-4. Ball-milling 200 mesh magnesium in the JP-4 containing a wetting agent was found to be an effective method of slurry preparation.

Foreman, K. M., TERRESTRIAL HYPERSONIC FLIGHT PROPULSION, PHASES I AND II. Republic Aviation Corp., Report No. RAC 964 (Plasma Propulsion Lab, PPL-TR-62-2), September 1, 1962. 37 pp. (AD 291434).

0294 Phase I of this report is a preliminary study of two detonative processes for sustained hypersonic propulsion using the terrestrial atmosphere. The processes are evaluated in the light of their energy production and flight energy requirements. The regimes of flight are defined and roughly delineate the areas of interest for further investigation. The energy released by the stationary and moving detonation processes is computed and compared with propulsion requirements. Phase II evaluates several proposed hypersonic air-breathing propulsion system applications, including electrical augmentation.

Fowler, J. M. and Warner, C. F. (Purdue University), MEASUREMENT OF THE HEAT TRANSFER COEFFICIENTS FOR HYDROGEN FLOWING IN A HEATED TUBE. ARS Journal, 30, 266-7 (1960).

0295 This note presents a portion of the results obtained during an investigation of forced convective heat transfer and the related frictional pressure drop for gaseous hydrogen flowing through a smooth electrically heated tube. During the experiments the ratio of the average absolute wall temperature to average absolute gas bulk temperature was varied from 1.17 to 2.47 for average gas bulk Reynolds numbers ranging from 3670 to 62,200 and test section gas pressures from 40 to 100 psia. The average heat transfer coefficients were in good agreement with other recent data. Friction factor data for isothermal flow are in good agreement with the von Karaman line, but the data for diabatic heating are in poor agreement. This work was sponsored by the U. S. Navy under Contract Nonr 1100 (14).

Fowler, R. G., A THEROETICAL STUDY OF THE HYDROGEN-AIR REACTION FOR APPLICATION TO THE FIELD OF SUPERSONIC COMBUSTION. Heat Transfer and Fluid Mechanics Institute. Proceedings, 1962, 279-94.

0296 Current interest in the subject of supersonic combustion focuses attention on the combustion process of hydrogen and oxygen in the presence of nitrogen under conditions where wall effects are not significant. In this paper the process is represented by seven simultaneous reactions consisting of an initiating reaction, three shuffle reactions and three three-body recombinations. Forward reaction rates were selected from shock tube and theoretical studies, with reverse rates calculated from the equilibrium constants. It was concluded that in the range of conditions of interest for supersonic combustion the overall reaction time is largely determined by the three-body recombination rates. A single effective reaction equation is derived for use in fluid dynamic studies and compared with experimental observations of flame phenomena.

Frank, C. E. and Blackham, A. U., INVESTIGATION OF HYDROCARBON IGNITION. U. S. National Advisory Committee for Aeronautics, TN 2549, January 1952. 33 pp.

0297 Accurate spontaneous ignition temperatures were determined for over 50 pure organic compounds including paraffins, olefins, aromatic hydrocarbons, alcohols, ethers, and esters. The effects of a wide variety of additives and of eight selected metals on the spontaneous ignition temperatures of these compounds were observed. Results are correlated with chemical structure and with antiknock characteristics where known; the more fundamental aspects of the possible chain-breaking and chain-branching reactions involved are also considered.

Frank, C. E. and Blackham, A. U., REACTION PROCESSES LEADING TO SPONTANEOUS IGNITION OF HYDROCARBONS. U. S. National Advisory Committee for Aeronautics, TN 2958, June 1953. 27 pp. 0298

The vapor-phase oxidation of isooctane at 500°C under conditions leading to rapid quenching of the reaction yields hydrogen peroxide, diisobutylene, and isobutylene as the major reaction products. As the reaction time increases, the formation of acetone and formaldehyde becomes of primary importance. Under otherwise similar conditions, n-heptane is attacked at 350°C to yield a mixture of organic peroxides as the major initial product. The next phase of reaction develops with extreme rapidity, leading mainly to the formation of a mixture of aldehydes and ketones (principally formaldehyde). The marked differences between the oxidation behavior of these two hydrocarbons are interpreted on the basis of the temperature required for oxidative attack and of the thermal stability of the alkyl and peroxy radicals obtained. Preliminary results on the oxidation of isobutane and 2, 2, 5-trimethylhexane afford additional evidence for these generalizations.

Frank-Kamenetskii, D. A., DIFFUSION AND HEAT EXCHANGE IN CHEMICAL KINETICS. Princeton, Princeton University Press, 1955. 370 pp. 0299

It has become recognized that combustion processes and the rapid chemical reactions of industry are complex, and that analytical treatment requires knowledge of chemistry, fluid dynamics and heat transfer. An extensive literature has been developed in this area of applied science in the U.S., Europe, and in Russia. This volume brings conveniently to hand phases of Russian work to 1947 (the date of Russian publication). Mathematical treatments of reaction ignition, quenching and periodic processes in chemical kinetics and related topics for flames, combustion of solids and chemical reactions, together with experimental comparison, comprise the subject of this book.

Franklin, J. L. and Nicholson, D. E. (Humble Oil and Refining), A KINETIC STUDY OF THE DECOMPOSITION OF HYDROCARBONS BY SILICA-ALUMINA CATALYSTS. Journal of Physical Chemistry 60, 59-62 (1956). 0300

The kinetics of the catalytic decomposition of four n-paraffins, three isoparaffins and one cycloparaffin over silica-alumina catalysts have been studied in a static system with product compositions being determined from mass spectrograph analyses. Pressure dependence measurements indicated fractional orders for the rate of disappearance of n-butane and n-pentane. Rates were also followed as a function of time with constant initial pressures. Activation energies have been estimated for the eight hydrocarbons investigated and the results discussed in terms of ionic reactions on solid surfaces. The rapid decrease in activation energy with increase in molecular weight of the n-paraffins parallels the changes in ionization potentials for these compounds; however, 2,2-dimethylpropane, having a lower ionization potential than either 2-methylpropane or 2-methylbutane, is very resistant to catalytic decomposition. Some evidence is presented which suggests that the cracking reaction may have an induction period.

Frehling, E., RECHERCHES SUR L'OXYDATION ET L'AUTO-INFLAMMATION DES HYDROCARBURES, PARAFFINIQUES EN PHASE GAZEUSE. ETUDE PARTICULIERE DES MELANGES HEXANE NORMAL-AIR. Paris. Institute Francais du Petrole, Revue, 10, no. 10, 1224-79; no. 12, 1543-1610, (1955); 11, no. 1, 134-57 (1956). 0301

Results of an experimental study of oxidation processes in hexane-air mixtures are reported. Most of the experiments utilized static (constant volume) methods. Ignition temperatures were measured as a function of pressure and composition (air/fuel ratio). Ignition delays and preignition reaction rates were measured for both cool flames and normal flames. The final section is a discussion of the mechanisms of oxidation in both the low and high temperature regions.

Fridshtein, I. L. and Zimina, N. A., THE INFLUENCE OF REDUCTION AND OXIDATION ON THE ACTIVITY OF CHROME-ALUMINA CATALYSTS. II. OXIDATION OF THE CATALYSTS. Kinetics and Catalysis (U.S.S.R.), 4, no. 2, 247-53 (1963). 0302

The regeneration of chrome-alumina catalysts was studied. It has been shown that the activity of the regenerated catalysts depends on their Cr^{6+} content. By controlling the oxygen concentration during regeneration, it is possible to vary the activity of the catalyst. For catalysts promoted by different oxides, it has been shown that the activity changes in the same sense as the Cr^{6+} content.

Fried, L. (University of California), PRESSURE DROP AND HEAT TRANSFER FOR TWO-PHASE, TWO-COMPONENT FLOW. Chemical Engineering Progress. Symposium Series, 9, 47-51 (1954). 0303

Pressure drop and heat transfer for an air-water mixture flowing in a horizontal 0.737-inch I.D. pipe were investigated at water rates of 2-26 gal/min and air rates of 2-45 SCFM, where the flow of both phases was always turbulent. When compensated for kinetic-energy changes, Martinelli's correlation for isothermal pressure drop is applicable to non-isothermal flows. Heat transfer coefficients can be predicted from plots of the ratio of the two-phase to liquid phase heat transfer coefficient against the ratio of the two-phase to the liquid phase pressure drop.

Friedman, L., Womeldorph, D. E. and Stevenson, D. H., HOUDRY DEHYDROGENATION FOR OLEFIN PRODUCTION. American Petroleum Institute. Proceedings, 38, Section III, 203-12 (1958). 0304

A commercial process for converting n-butane to butadiene or butylenes over a chromia on alumina catalyst is described.

Friedman, R. and Grover, J. H. (Atlantic Research Corp.), COMBUSTION, I/EC UNIT PROCESSES REVIEW. Industrial and Engineering Chemistry, 53, 1020-4 (1961). 0305

A section of this annual review is devoted to the subject of supersonic combustion. In this section, 12 references are given.

Fritz, W., GRUNDLAGEN DER WÄRMEÜBERTRAGUNG BEIM VERDAMPFEN VON FLÜSSIGKEITEN. Chemie-Ingenieur-Technik, 35, no. 11, 753-64 (1963). (International Aerospace Abstracts, 4, no. 4, 216, abstr. A64-11651, 1964). 0306

A survey of the present status of heat transfer in vaporization. Following an outline of the basic physicalprinciples of the vaporization process, the formation and the life of a vapor bubble are described. The significance of the corresponding relations with respect to a clear understanding of the heat transfer processes involved, and the establishment of general relations for their calculation are noted. A discussion of the boiling curve leads to a compilation of results concerning the magnitude and behavior of the heat transfer coefficient as a function of pressure for water and some liquids of practical importance. Presented are data and diagrams for the maximum heat transfer per unit surface, which permit evaluation of this quantity for any arbitrary case.

0307 Fultz, J. R., FUTURE AIR FORCE REQUIREMENTS FOR HYDROCARBON FUELS. U. S. Air Force, ASD TR 61-728, May 1962. 17 pp. (AD 277953).

The two hydrocarbon structures exhibiting the most promise as candidate high temperature fuels are the alkyl-substituted monocyclics and the alkyl-substituted condensed bicyclics. For specialized fuels, the isoparaffin structure best suits the requirements for a weight-limited fuel application whereas for an extreme high density fuel the condensed tricyclic structure exhibits the best compromise of properties. The preliminary results of a vapor fuels study indicate that the basic condensed bicyclic structure once again offers the most promise for an advanced vapor fuel. Research has indicated that a vapor fuel will extend the flight speed of advanced systems beyond mach 5. For greater speeds or for desirable additional cooling below mach 5, a type of endothermic fuel will be required. The primary contribution of the endothermic fuels program is that the feasibility of conducting this type of reaction under conditions to be encountered in advanced air-breathing systems is established and that the reaction products will perform satisfactorily in the combustor.

0308 Gaertner, R. F., POPULATION OF ACTIVE SITES IN NUCLEATE BOILING HEAT TRANSFER. Ph. D. Dissertation, University of Illinois, 1959. 165 pp. (Dissertation Abstracts, 20, 3234, 1960).

Counts of active bubble-producing sites were determined throughout most of the nucleate region for boiling on a horizontal, flat surface. The technique for determining active sites consisted of electroplating a thin layer of nickel on the copper surface while simultaneously boiling a nickel salt solution. During electroplating the bubbles forming at the active sites pushed away the plating solution and caused macroscopic pin holes which were subsequently counted to obtain the population of active sites at a specified heat flux. The largest population obtained in this manner, 1130 sites per square inch, occurred at a heat flux of 317,000 Btu/hr. sq. ft. and a Δt of 53.2°F. For this system the linear relationship between the number of active sites and the heat flux, as suggested by Jakob, is non-existent. The heat flux was proportional approximately to the square root of the number of active sites.

0309 Galich, P. N., Golubchenko, I. T., et al, APPLICABILITY OF SYNTHETIC ZEOLITES AS CARRIERS AND CATALYSTS FOR DEHYDROGENATION AND CRACKING OF NORMAL PARAFFINS. pp. 260-2 in: Akad. Nauk SSSR, Otd. Khim. Nauk, "Sinteticheskie Tseolity, Poluchenie, Issledovanie i Primenenie". Moscow, Izdatelstvo Akademiya Nauk SSSR, 1962. (CA, 58, 12344b).

Dehydrogenation and cracking of n-dodecane were studied on the synthetic zeolites Ca A, Ca X, and Na X. With CaA at optimal conditions of 500° and 0.3 vol./vol./hr., 64.5%w catalysate (39.5 Br no.), 26.2%w gas (isobutene and propylene 3.82, butene 27.4, C_2H_4 13.14, H 10.14, satd. hydrocarbons 45.5%), and 9.3%w coke and loss were obtained. In no case were aromatic hydrocarbons obtained. Different products were obtained with Ca X, Na X, and aluminosilicates. Cr_2O_3, V_2O_5, Pt, and Ni catalyst (1-5%) on Ca A zeolite had dehydration properties without cyclization.

Garmon, R. C., Longo, A., and Wolf, R. L., COMBUSTION OF BORON. Experiment, Inc., Final report TM-571, U. S. Air Force, Contract AF 33 (038)-12633, November 1952. 16 pp. (AD 22428). 0310

An investigation of the combustion of B solid fuels in a ramjet burner was made. Primary interest was in the development of a burner system for slurries of B in hydrocarbon fuels. The effect of fuel composition, burner design, and operational variables on burner performance was examined. Impulse efficiencies approaching the theoretical values were obtained. As a result of the very high experimental impulse values, a portion of the investigation resolved into a study of methods for the determination of air specific impulse. Several methods are presented. Good agreement was obtained with each. A 6-in. diameter burner was designed, built, and assembled for free jet testing of slurry fuels. The development of solid fuel grains for burning from a fixed mounting in the air stream was also investigated. Satisfactory and efficient techniques for burning this material as solid fuel grains were not developed. However, burning of some solid fuel grains resulted in better than 80% impulse efficiency.

Garmon, R. C., Longo, A. and Wolf, R. L., COMBUSTION OF BORON. Experiment, Inc., Final Report TM-728, U. S. Air Force, Contract AF 33(616)-2241, March 1955. 33 + pp. (AD 66717). 0311

Work was done on determination of the combustion properties of boron slurry fuels and some few other selected high energy compounds. The first phase of the program was a study of the combustion properties of boron slurry fuels at sea level conditions. Evaluation of types of boron and of various burner components was carried out in a two-inch combustor. Some performance data were also obtained in a four-inch non-piloted burner, and considerable data were obtained with a six-inch diameter burner under free-jet test conditions with both kerosene and boron slurry fuels. High combustion effeciencies were obtained over a wide range of equivalence ratios. The second phase of the program was the determination of combustion properties of boron slurry fuels at simulated altitude. Most of this work was done in a two-inch burner, and high air specific impulses were obtained. Finally some tests were made to evaluate the possible benefits of using smaller particle size, higher purity boron. There was no noticeable improvement.

Garrett, W. D. and Krynitsky, J. A., DETERMINATION OF WATER IN JET FUELS AND HYDROCARBONS. U.S. Naval Research Laboratory, NRL Report 4997, September 1957. 14 pp. (AD 143376). 0312

A procedure for the determination of dissolved and suspended water in jet fuels and hydrocarbons has been developed. The method uses readily available apparatus and chemical reagents and can be performed without extensive preparation. It is based on the principle of water exchange between liquids and dry air. The contained water is transferred from the fuel to solid potassium hydroxide by blowing with dry air and is determined gravimetrically. The method has been used extensively at the Naval Research Laboratory for the determination of dissolved and cloud-like suspended water in various jet fuel samples and has proven to be very satisfactory.

Gaydon, A. G. and Hurle, I. R. (Imperial College), MEASUREMENT OF TIMES OF VIBRATIONAL RELAXATION AND DISSOCIATION BEHIND SHOCK WAVES IN N_2, O_2, AIR, CO, CO_2, AND H_2. pp. 309-18 in: "Symposium (International) on Combustion, 8th, California Institute of Technology, August 28 - September 3, 1960." Baltimore, Williams and Wilkins, 1962. 0313

The shock tube is especially valuable for studying detonation-type reactions and for following the rate of attainment of equilibrium in high-intensity combustion and in rocket nozzles. The authors have recently adapted the sodium-line reversal method of measuring temperature, so that time-resolved studies can be made behind shock fronts produced in a conventional shock tube. This paper reports additional results for various gases regarding the time lags associated with vibrational or dissociational equilibration of molecules following their subjection to a shock front.

Gaydon, A. G., Hurle, I. R. and Kimbell, G. H., TEMPERATURE MEASUREMENTS OF SHOCK WAVES AND DETONATION BY SPECTRUM-LINE REVERSAL. IV. DEVELOPMENT OF DETONATION. Royal Society (London). Proceedings, A273, 291 (1963). 0314

The temperature distribution behind shock fronts and detonations through mixtures of oxygen with hydrogen, methane, methanol, ethylene, and carbon monoxide has been measured by the method of spectrum-line reversal; simultaneously, measurements were made of pressures and shock speed. The spectrum and time history of the light emitted by the detonating gases were also examined. The reasons for an apparent hypervelocity region are discussed. Measurements of shock speed have yielded ignition temperatures for the particular mixtures studied.

Gaynor, A. J., Platz. G. M., and Hersh, C. K. (Armour Research), DEHYDRATION OF JP-4 FUEL. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, C117-23 (September 1960). 0315

The presence of water in jet aircraft fuel in a serious problem. Cooling of the fuel results in a settling out of this water, which can then freeze in the fuel lines and cause a flame-out of the jet engine through fuel starvation. To prevent this occurrence, a system for the dehydration of jet fuel has been developed in which a filter/separator unit is used to remove emulsified water, and Linde molecular sieves (sodium aluminosilicates) are used as the desiccant to remove dissolved water. The dehydration system, containing 2100 pounds of molecular seives, is capable of dehydrating approximately 500,000 gallons of fuel at an average rate of 300 gallons per minute, reducing the dissolved water concentration from an initial 100 to 200 ppm to less than 10 ppm. Scale-up factors for the dehydration unit indicate that an efficient system employing dehydration beds in series can be constructed for continuous operation, as laboratory studies have shown that the water-saturated desiccants can be regenerated to their initial absorptive capacity by means of heated air.

Gaziev, G. A., Krylov, O. V., Roginskii, S. Z., Fokina, E. A., and Yanovskii, M. I., THE DEHYDROGENATION OF CYCLOHEXANE OVER SOME CARBIDE, BORIDE, AND SILICIDE CATALYSTS. Academy of Sciences (U.S.S.R.). Proceedings, Physical Chemistry Section, 140, 737-40 (1961). 0316

The dehydrogenation of cyclohexane was studied over carbides, silicides, and borides in a pulse reactor at 300°-650°C. Under these reaction conditions activities comparable to those obtainable with transition metals are claimed.

George, M. E., DETECTION OF MICROBIAL CONTAMINANTS IN JP-4 FUEL. U. S. Air Force, Aerospace Medical Research Laboratories, AMRL M-26, January 1963. 5 pp. (AD 290 089). 0317

A qualitative method for the detection of living micro-organisms in JP-4 fuel based on the measurement of CO_2 produced by cellular respiration is described. Methods of quantitation are being investigated but have not yet proved satisfactory.

Germain, J. E. and Maurel, R., CATALYSE. - CINÉTIQUE DE LA DÉSHYDROGÉNATION DU TRIMÉTHYL-1.1.3 CYCLOHEXANE SUR PLATINE - ALUMINE. Comptes Rendus des Seances de l'Academie des Sciences (Paris), 247, 1999-2001 (1958). 0318

The dehydrogenation of trimethyl-1,1,3 cyclohexane over platinum-alumina up to 320° is a first-order reaction. The activation energy (34.2 kcal) is clearly higher than that for dehydrogenation of cyclohexanes without quaternary carbons.

Germain, J. E. and Maurel, R., CATALYSE. - LOI HYPERBOLIQUE DE DÉSACTIVATION D'UN CATALYSEUR PLATINE - ALUMINE. Comptes Rendus des Seances de l'Academie des Sciences (Paris), 247, 1854-6 (1958). 0319

The activity of platinum-alumina catalysts for the dehydrogenation of trimethyl-1,1,3 cyclohexane decreases with time according to a hyperbolic law. This is interpreted as a second-order polymerization reaction at the surface of the catalyst.

Gibbons, L.C., PRELIMINARY DISCUSSION OF FUEL TEMPERATURES ATTAINED IN SUPERSONIC AIRCRAFT. U. S. National Advisory Committee for Aeronautics, RM E55A25, March 1955. 8 pp. 0320

Aerodynamic heat loads are described for three mission profiles including one for a missile with a three hour flight at Mach 3 and 70,000 ft. JP-4 and JP-5 fuels are considered with a maximum fuel tank prssurization of 5 psi. For this most severe case, in uninsulated tanks fuel would reach 310° F. from aerodynamic heating alone. Tank insulation appeared to provide a practical solution to the severe in-tank heating and consequent large boil-off losses calculated.

Gibbons, L. C., Barnett, H. C., and Gerstein, M. (NACA, Lewis Flight Propulsion Laboratory), EFFECT OF MOLECULAR STRUCTURE ON COMBUSTION BEHAVIOR. Industrial and Engineering Chemistry, 46, no. 10, 2150-9 (1954). 0321

Paper reviews available information on the effect of fuel molecular structure on some combustion properties including: critical ignition energy, spontaneous ignition temperature, ignition delay, flammability limits, quenching distance, flame velocity, and smoke formation. In addition, the qualitative relationships between fundamental combustion properties and performance in a gas turbine combustor are shown for five hydrocarbons.

Gibbons, L.C. and Jonash, E.R. (Lewis Flight Propulsion Laboratory, NACA), THE EFFECT OF FUEL PROPERTIES ON THE PERFORMANCE OF THE TURBINE ENGINE COMBUSTOR. American Society of Mechanical Engineers, Paper No. 48-A-104, 1948. 22 pp. 0322

Examination of fuel performance on turbojet combustors has indicated the following results. At sea-level operating conditions all of the fuels examined gave good combustion efficiencies, but at altitude conditions increasing the boiling temperature of fuels gave decreasing combustion efficiencies. At adverse conditions of inlet-air temperature, pressure, and velocity, low boiling temperature fuels gave limits of temperature rise. High boiling temperature fuels allowed higher altitude operational limits than low boiling temperature fuels. Improved combustion efficiencies may be obtained by improved fuel-spray configurations or by nozzles that will maintain optimum injection pressure over a wide range of fuel flows. Carbon deposition tendency of fuels may be correlated with average boiling temperature and hydrogen-carbon ratio of fuels.

Gibson, M. M. (Northern Research and Engineering Corp.), A SIMPLE MODEL FOR HEAT ADDITION TO SUPERSONIC STREAMS. "Symposium (International) on Combustion, 10th, Cambridge, England, August 17-21, 1964." Pittsburgh, Combustion Institute, 1964. 0323

This work describes a simple analysis of a flame spreading from the center of a two-dimensional constant-area duct containing a shock-free supersonic stream of premixed combustible gases. With the aid of some simplifying assumptions, the flame width is expressed as a function of the mass fraction burned. The flame length is established by formulating an entrainment law based on the growth rate of a turbulent wake. A maximum possible stagnation temperature ratio for complete combustion is found. Flame lengths are calculated for initial free-stream Mach numbers of 2,3,5, and 7. When the combustion is complete these are found to be of the order of 50 to 100 duct widths.

Gilmour, C. H. (Union Carbide Chemicals), NUCLEATE BOILING--A CORRELATION. Chemical Engineering Progress, 54, no. 10, 77-9 (1958). 0324

A correlation of existing data on nucleate boiling is presented. The proposed simple expression is similar in form to the equations used for sensible heat transfer or for condensing. The data used in the correlation were for nucleate boiling from disks, although some data for wires have been plotted in accordance with the relationship obtained. The latter are not in good agreement with the plotted curve, probably because of the small diameter of the wire relative to that of a vapor bubble, and the material and surface condition of the wires.

Gladrow, E. M., and Kimberlin, C. N., Jr., (Esso Research), SOME COKE-FORMING REACTION MECHANISMS IN CATALYTIC CRACKING. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, B61-9 (September 1960). 0325

Catalytic cracking of hydrocarbons was studied over mixed oxide type catalysts with respect to the mechanism of coke deposition on the catalyst. Experimental evidence is presented to illustrate two mechanisms for coke production: the degradation of an aromatic ring compound to coke by means of a hydrogen transfer reaction, in which the aromatic serves as a hydrogen donor, and dehydrogenation of aromatic rings by the catalyst to yield coke. The latter route is enhanced if the catalyst contains small amounts of metal poisons picked up through use and if aromatic ring compounds are present in the hydrocarbon feed. Additional evidence is provided to show that aromatics are precursors of coke.

Glass, G. P., Kistiakowsky, G. B., Michael, J. V. and Niki, H., (Harvard University), THE OXIDATION REACTIONS OF ACETYLENE AND METHANE. "Symposium (International) on Combustion, 10th, Cambridge, England, August 17-21, 1964." Pittsburgh, Combustion Institute, 1964. 0326

The high temperature oxidation reactions of acetylene and methane were studied in shock waves using two techniques. A time-of-flight mass spectrometer was used to determine the concentration of reactants, intermediates, and products at 50 microsecond intervals. In another apparatus the chemiluminescent radiation emitted by CH and C_2 and the ionization accompnaying the oxidation were monitored. The oxidation of methane is characterized by an induction period which is followed by fast chain branching reactions. The duration of the induction period is controlled by the rate of production of oxygen atoms. A mechanism involving a straight chain reaction to produce an intermediate which itself takes part in chain branching reactions is suggested.

Glawe, G.E., Krause, L.N. and Johnson, R.C. (Lewis Research Center), A STEADY-STATE, STAGNATION POINT, HEAT-TRANSFER-RATE MEASURING DEVICE. U. S. National Aeronautics and Space Administration, TN D-1704, May 1963. 16 pp. 0327

A sensing device is described that is used to measure steady-state convective heat-transfer rate in high-temperature, high-velocity gas streams. The device uses the measurement of axial heat conduction through a cylindrical plug, with one end of the plug at the stagnation point of a hemispherically shaped body exposed to the gas stream. Experimental tests of three identical probes run through a subsonic Mach number range from 0.2 to 0.8 and a supersonic Mach number range of 2.8 to 3.5 established a correlation factor for the probes with a standard deviation of ±5 percent. The heat input range was 0.7 to 70 (Btu) (ft^{-2}) (sec^{-1}).

Gollis, M. H., Belenyessy, L. I., Gudzinowicz, B. J., Koch, S. D., Smith, J. O. and Wineman, R. J. (Monsanto Research), EVALUATION OF PURE HYDROCARBONS AS JET FUELS. Journal of Chemical and Engineering Data, 7, no. 2, 311-16 (1962). 0328

Saturated monocyclics were indicated to be the most promising compromise fuel based on over-all consideration of all properties determined. Typified by diethylcyclohexane, this class has high thermal decomposition stability, high heat of combustion, and low luminosity; but also somewhat deficient heat capacity and thermal conductivity. Condensed bicyclies are outstanding with respect to thermal decomposition temperature, but are quite deficient in heat capacity. Thermal decomposition temperature, heat capacity, thermal conductivity, net heat of combustion, luminometer number, viscosity, freezing point, H/C ratio, and molecular weight are tabulated for 38 hydrocarbons of 93.5 to 100% purity.

Gollis, M H., Belenyessy, L. I., Gudzinowicz, B. J., Koch, S D., Smith, J. O., and Wineman, R. J. (Monsanto Chemical), PREPARATION AND EVALUATION OF PURE HYDROCARBON FUELS. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, C19-29 (September 1960). 0329

The synthesis and evaluation of various classes of pure saturated hydrocarbons have been undertaken to determine those candidates possessing the high heat sink capacity required for supersonic jet fuel use. The requirements for such fuels are thermal stability, good combustion characteristics, closely defined properties, and good low temperature properties. The compounds under study were selected as representative of the following classes: acyclics, monocyclics, bicyclics, and polycyclics. Generally, they were synthesized by commercially feasible methods from readily available raw materials. In the evaluation program the following properties were determined: thermal decomposition temperature, heat capacity, thermal conductivity, heat of combustion, luminosity, viscosity, and freezing point. The results show that no one class excelled in all aspects of the evaluation. The saturated monocyclics, however, appear to offer the best compromise candidates for supersonic jet fuel application.

Goneim, F. B., Balandin, A. A. and Slovokhotova, T. A., THE DEHYDROGENATION AND HYDROGENOLYSIS OF CYCLOHEXANE ON A RUTHENIUM-SILICA CATALYST. Academy of Sciences (U. S. S. R.). Bulletin. Division of Chemical Sciences, 1963, 1101-6. 0330

The dehydrogenation and hydrogenolysis of cyclohexane were investigated with 5% ruthenium on silica catalyst. The temperature dependence of the rate of these reactions showed a discontinuity in the region of 300-330°. The activation energy for the dehydrogenation of cyclohexane was 9.2 kcal/mole at 250-300°, and 16.65 kcal/mole at 320-350°; for the hydrogenolysis of cyclohexane the activation energy was 12 kcal/mole at 250-300° and 26.6 kcal/mole at 330-350°. Relative adsorption coefficients of benzene were determined during the dehydrogenation of cyclohexane in the temperature range 250-300°.

Goodger, E. M. (University of New South Wales, Australia), AVIATION FUEL PROBLEMS: A REVIEW OF THE MAJOR PROBLEMS ARISING FROM THE USE OF AVIATION FUELS AT HIGH ALTITUDES AND HIGH AIRCRAFT SPEEDS AND SOME PRACTICABLE SOLUTIONS. Aircraft Engineering, 35, March, 60-4, April, 102-5. (1963). 0331

The papers discuss problems associated with fuel system capacity, low pressure and temperature environment at altitude, ice formation, wax formation, high temperature fuel stability, and flammability hazards. Some mention is made of kinetic heating of the fuel in the tanks.

Goodger, E. M., SPONTANEOUS-IGNITION DATA OF HYDROCARBONS AND AVIATION FLUIDS. Cranfield, England. College of Aeronautics. Note No. 68, Sept. 1957. 13 pp. 0332

The standard A. S. T. M. method has been used to determine comparative spontaneous-ignition characteristics of 29 hydrocarbons and aviation fluids. Reasonable correlation is found with results from more precise methods. Ignition temperature levels are similar in the case of paraffins, olefins, and naphthenes, but are slightly higher with alcohols, and much higher with aromatics. Ignition temperature of petroleum-based aviation fluids show a general reduction with increase in specific gravity.

Goodwin, T.C. and Nichols, O.D., LUBRICANTS AND LUBRICATION. A REPORT BIBLIOGRAPHY. U.S. Defense Documentation Center. AD-336 707, June 1963. REPORT CLASSIFIED CONFIDENTIAL. 0333

No Abstract.

Gordon, A. S., A REVIEW OF THE KINETICS AND MECHANISM OF THE PYROLYSIS OF HYDROCARBONS. pp. 111-37 in: North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, "Combustion and Propulsion". AGARD Colloquim, 5th, Braunschweig, April 1962. Oxford, Pergamon, 1963. 0334

The paper reviews the kinetics and mechanisms of the pyrolysis of saturated hydrocarbons, including cycloalkanes, and of unsaturated hydrocarbons, olefins and aromatics. It also deals with the effects of pyrolysis inhibitors and catalysts, and with the influence of surfaces on pyrolysis reactions.

Gossage, T.L. (Wright Air Development Center). "OBJECTIVES OF HIGH TEMPERATURE FUELS PROGRAM AND AIR FORCE REQUIREMENTS", presented at the Ninth Meeting of the working group on Fuels, Advisory Panel on Fuels and Lubricants, Office of the Director of Defense Research and Engineering Development, December 10-11, 1959. 8 pp. 0335

The paper presents the research objectives and Air Force requirements for high temperature hydrocarbon fuels for air-breathing systems in the range of Mach 3 and Mach 4. Included are discussions of future requirements of thermal stability, heat sink capacity, heating value, density, low temperature properties, distillation range, combustion properties, contamination, cost and availability. Some of the physical properties of promising hydrocarbon fuels (JP-6, JP-150, decalin, dimethanodecalin, pinane, cyclic blends a high density petroleum cut, etc.) are given and discussed.

Gould, G., THE LIMITING SURFACE TEMPERATURES FOR SPONTANEOUS IGNITION OF FUEL VAPOUR/AIR MIXTURES IN HIGH SPEED AIRCRAFT. Gt. Brit. Royal Aircraft Establishment, RAE-TN-Mech. Eng.-339, August 1961 8 pp. (AD 267556). 0336

Whereas in the past the temperature of aircraft tank walls or structures enclosing fuel or vapour were well below the spontaneous ignition temperature, as aircraft speeds approach Mach 3 this is no longer the case, and it is essential to know with certainty the risks of ignition. Critical spontaneous ignition temperature of JP-1 and JP-4 type fuels as determined by several authorities for conditions of varying altitude and mixture movement are set out to enable designers to estimate and minimize ignition risks. Although there is considerable disagreement between certain authorities, it looks as if an increase in the permissible wall temperature (above 200°C) may be possible at high altitudes, because of the reduced pressure of the atmosphere. There seems to be a useful easement when mixture movement is present, and there is likely to be some due to partial heating of the surface, but more research on these aspects is required. Also there seems some prospects of developing fuel additives which will raise the temperature

0337 Gouse, S.W., Jr., AN INDEX TO THE TWO-PHASE GAS-LIQUID FLOW LITERATURE. PART I. M.I.T., Department of Mechanical Engineering Report No. DSR 8734-1, U.S. Navy Contract Nonr 1841(73), May 1963.

The report presents a bibliography of two-phase flow literature arranged by sub-topics.

0338 Gouse, S.W., Jr. and Hwang, Cheng-Chieh, VISUAL STUDY OF TWO-PHASE ONE-COMPONENT FLOW IN A VERTICAL TUBE WITH HEAT TRANSFER. M.I.T. Department of Mechanical Engineering Report No. 8973-1, June 1963.

This report presents results of a visual study with film heated glass tubes, containing boiling n-pentane. Conclusions are restricted to a flow-regime analysis and some correlation between pressure drop and flow behavior. Both forced and natural convection were studied. The study covered relatively low heat fluxes, of the order of 5500 Btu/hr-ft^2.

0339 Grane, H. R., Connor, J. E., and Masologites, G. P. (Atlantic Refining), THE BEHAVIOR OF METAL CONTAMINTANTS IN CATALYTIC CRACKING. American Petroleum Institute. Proceedings. Section III, 41, 241-6 (1961).

Coke deposition on cracking catalyst due to trace metal contaminants was determined. This "contaminant coke" was then related to metal concentration and silica-alumina surface. Repeated catalyst regeneration reduces coke deposition due to metal contaminants.

Graves, R. A., Jr., FREE-FLIGHT TEST RESULTS ON THE PERFORMANCE OF CORK AS A THERMAL PROTECTION MATERIAL. U. S. National Aeronautics and Space Administration, TN D-2438, September 1964. 40 pp. 0340

A series of flight tests was initiated by the Langley Research Center for the purpose of testing ablative cork as a lightweight thermal protection material. These flight tests were conducted aboard NASA flight vehicles in the low-heating-rate environment of the afterbody regions. The test conditions covered a range of altitudes to 482,000 feet and velocities to 17,900 feet per second. The test results show that cork can provide adequate thermal protection for a long-time, low-heating-rate environment.

Greenberg, H. J. and Zysk, E. D. (Engelhard Industries), APPLIED RESEARCH, FABRICATION AND TESTING OF 2300°F THERMOCOUPLE FOR AIR-BREATHING PROPULSION SYSTEMS. U. S. Air Force, ASD TDR 62-891, Contract AF 33(616)-7825, January 1963. 85 pp. (AD 400470). 0341

Development work on two thermocouple systems for use in aircraft jet engines to temperatures of 2300°F is reported. The two couples involved are the palladium vs. platinum 15% iridium previously investigated under USAF contract No. AF 33(600)-32302, and Platinel 2, a proprietary material produced by Engelhard Industries, Inc. Reliability of the latter thermocouple in the jet-engine environment is shown. Fabrication techniques for manufacture of four basic thermocouple geometries as well as performance data for same are presented.

Greenfield, S. (North American Aviation), AN EXPERIMENTAL EVALUATION OF ROCKET PROPELLANT DATA. pp. 169-227 in: Penner, S. S. and Ducarme, J., eds., "The Chemistry of Propellants, a meeting organised by the AGARD Combustion and Propulsion Panel, Paris, France, June 8-12, 1959", Oxford, Pergamon, 1960. 0342

Liquid hydrocarbon rocket fuels, including JP-5 an N-paraffin, an iso-paraffin, and naphthenic, aromatic, and olefinic fuels were evaluated with respect to combustion stability, heat transfer and coolant properties, specific impulse, and fuel-rich combustion behavior. For fuels with similar physical properties paraffinic fuels are more resistant to acoustic instability, followed by naphthenes and by unsaturates. Heat transfer film coefficient was measured for n-heptane and for RP-1 in an electrically heated test apparatus at supercritical pressure. A region of vibration and increased heat transfer was observed. (Work done under Air Force sponsorship during 1954-1957).

0343 Greensfelder, B. S. (Shell Development), THEORY OF CATALYTIC CRACKING. pp. 137-64 in: Brooks, B. T., Boord, C. E., Kurtz, S. S., Jr. and Schmerling L., eds., "The Chemistry of Petroleum Hydrocarbons, vol. II", New York, Reinhold, 1955.

The theory of catalytic cracking is extensively discussed. A detailed mechanism for the reaction is presented by means of which product distributions using a given starting material may be calculated. For catalytic cracking of cetane the calculated values of the product distribution (carbonium ion mechanism) are in close agreement with the values obtained by experiment.

0344 Greensfelder, B. S. and Voge, H. H. (Shell Development), CATALYTIC CRACKING OF PURE HYDROCARBONS. CRACKING OF NAPHTHENES. Industrial and Engineering Chemistry, 37, no. 11, 1038-43 (1945).

Cracking of eleven naphthenes containing 6 to 18 carbon atoms was studied over a silica-zirconia-alumina catalyst. The naphthenes were quite susceptible to the action of the catalyst, and both the ring and any side chains contributed to the total cracking. The rate of cracking increased rapidly with increased molecular weight. Secondary reactions of isomerization and saturation play an important part in determining the final products. Catalyzed cracking at 500°C proceeds at about one thousand times the rate of thermal cracking, and there are significant differences in the product distributions.

0345 Greensfelder, B. S. and Voge, H. H. (Shell Development), CATALYTIC CRACKING OF PURE HYDROCARBONS. CRACKING OF OLEFINS. Industrial and Engineering Chemistry, 37, no. 10, 983-8 (1945).

Cracking over a silica-zirconia-alumina catalyst at 350-500°C. of seven aliphatic olefins, two diolefins, two cyclic olefins, and two aromatic olefins was studied. The principal conversions of aliphatic mono-olefins were isomerization, cracking, saturation and formation of higher-boiling materials and coke. Diolefins and aromatic olefins were extensively saturated and transformed to high-boiling materials and coke. Catalytic and thermal cracking of olefins at 400-500°C are compared. The catalyzed reactions, which are of the order of 1,000 to 10,000 times as fast, yield larger fragments, involve much more isomerization, and lead to greater saturation of product.

Greensfelder, B. S. and Voge, H. H. (Shell Development), CATALYTIC CRACKING OF PURE HYDROCARBONS. CRACKING OF PARAFFINS. Industrial and Engineering Chemistry, 37, no. 6, 514-520 (1945).

0346

The behavior of paraffin hydrocarbons ranging from propane to wax was studied under catalytic cracking conditions. A silica-zirconia-alumina catalyst was used in a small, fixed-bed cracking unit. It was observed that carbon-carbon bond ruptures are selective to give fragments of three or more carbon atoms. Secondary reactions include isomerization of olefins, saturation of olefins, and production of aromatics. A comparison with thermal treatment shows catalytic cracking is five to sixty times as rapid, is accelerated more for the large than for the small paraffins, and gives considerably different products.

Greensfèlder, B. S., Voge, H. H., and Good, G. M. (Shell Development), CATALYTIC AND THERMAL CRACKING OF PURE HYDROCARBONS. Industrial and Engineering Chemistry, 41, no. 11, 2573-84 (1949).

0347

The primary cracking of pure hydrocarbons both with and without catalysts has been studied in terms of the distribution by carbon number of the cracked fragments to allow arriving at a mechanism of molecular disintegration. The secondary reactions of the cracked fragments have been followed by analysis of the product fractions to allow a further definition of the nature of the cracking system. On the basis of this work, cracking systems are assigned to two fundamental classes; each class is described by a set of characteristic reactions covering both the primary cracking and the secondary reactions. Correspondingly, two types of reaction mechanisms are proposed, one a free radical (thermal type) mechanism based on the Rice-Kossiakoff theory of cracking, the other a carbonium ion (acid-activated type) mechanism derived from the work of Whitmore and others on the properties of carbonium ion systems. Cracking catalysts are available for either type of reaction mechanism; those which accelerate free radical type reactions are nonacidic, and those which accelerate carbonium ion type reactions are acidic. Commercial acid-treated clay and synthetic silica-alumina cracking catalyst belong to the latter class.

Grigull, U., WÄRMEÜBERTRAGUNG. Fortschritte der Verfahrenstechnik, 4, 153-94 (1958/59).

0348

This review article is devoted principally to the general fundamentals of conduction, convection and radiation. Specific applications are discussed only in exceptional cases, since they are treated in other sections of this journal.

0349

Gross, R.A. (Fairchild Engine and Airplane Corp.), EXPLORATORY STUDIES OF COMBUSTION IN SUPERSONIC FLOW. I. PLANE DETONATION WAVES. II. OBLIQUE DETONATION WAVES. U.S. Air Force, AFOSR TN 59-587, Contract AF 49(638)-15, June 1959. 56 pp. (AD 216769).

Methods for releasing chemical energy in supersonic flow were investigated. A study was made of (1) standing-stable detonation waves, both strong and Chapman-Jouguet types, (2) standing-stable oblique detonation waves, (3) combination in a boundary layer on a flat plate immersed in a supersonic stream, (4) combustion behind a wedge-shaped flame holder in supersonic flow, and (5) thermal ignition properties of mixtures of hydrogen with air and methane with air.

0350

Gross, R. A. (Fairchild Engineering Division), RESEARCH ON SUPERSONIC COMBUSTION. ARS Journal, 29, 63-4 (1959).

A mixture of hydrogen and air has been passed through a small normal Mach reflected shock in the Mach 3 section of a steady flow supersonic combustion research tunnel under conditions which previous research indicated should cause thermal ignition. Combustion did occur, resulting in a new, steady detonation wave pattern in the test section. The test conditions have been repeated numerous times resulting in the same shock to detonation wave transformation. Numerous schlieren photographs, schlieren motion pictures and some centerline probe data have been obtained. All information to date strongly indicates that this supersonic combustion wave is a strong detonation. It is stable, steady, reproducible and obtainable over a wide fuel-air ratio as long as the Mach number of the approach flow is greater than the Chapman-Jouguet Mach number for that fuel-air ratio. Schlieren data indicate that the chemical reactions are completed in less than 1/4 inch, or less than 20 microsec.

0351

Gross, R. A. (Univ. of California), A STUDY OF COMBUSTION IN SUPERSONIC FLOW. Research, 12, 381-9 (October/November 1959).

This paper describes an exploratory experimental search to learn what phenomena are actually encountered when releasing chemical energy in supersonic flow. Steady, stable, standing plane and oblique detonations were produced for the first time in the laboratory. A new ignition hysteresis phenomenon which has important theoretical consequences was observed. Measured wave properties were compared with theoretical predictions for hydrogen-air and methane-air detonations.

Gross, R.A. (Fairchild Engine and Airplane Corp.), **SUPERSONIC COMBUSTION TUNNEL.** U.S. Air Force, AFOSR TN 57-677, Contract AF 49(638)-15, October 1957. 38pp. (AD 136667). 0352

The major features incorporated in a supersonic combustion-research tunnel which was designed to permit experimental exploration of chemical energy release in supersonic flow are summarized. The tunnel, which is designed for steady-state operation, accelerates a homogeneous mixture of fuel and air to a test section at about M = 3. The tunnel is of fixed geometry, and the test section has an axial gradient from M = 3.0 to 3.5. Inlet stagnation temperature in the tunnel can be varied from 300° to 1200°F, and inlet stagnation pressure can be varied from ambient to 140 psia. Test area in the tunnel is about 5 by 3 in.; the throat is about 1 by 3 inches.

Gross, R. A. and Chinitz. W. (Fairchild Engine and Aircraft), **A STUDY OF SUPERSONIC COMBUSTION.** Journal of the Aerospace Sciences, 27, 517-24 (1960). 0353

Steady, stable, plain, and oblique detonation waves were created in a high-temperature, steady flow supersonic tunnel. Ignition conditions and properties across the wave were measured. The local-wave fluid-dynamic properties agree well with detonation theory. Experimental data are presented in detail and compared with other studies and theory. Experimental behavior of these detonations and their possible utility are discussed. This work was supported by the U.S. Air Force under Contract AF 49(638)-15.

Gross, R. A. and Nicholls, J. A., **STATIONARY DETONATION WAVES.** pp. 169-77 in: North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, "Combustion and Propulsion". New York, Pergamon, 1961. 396 pp. 0354

This paper comprises a selective and critical review of the work, both theoretical and experimental, on supersonic combustion. Particular emphasis is placed upon work carried out in the United States with hydrogen-oxygen systems. Twenty-eight references are given.

0355 Gross, R.A. and Oppenheim, A.K., (Fairchild Engine and Airplane Corp.), RECENT ADVANCES IN GASEOUS DETONATION. U.S. Air Force, AFOSR TN 58-893, Contracts AF 49(638)-15 and AF 49(638)-166, January 1959. 7pp. (AD 204131). Reprint from ARS Journal, 29, 173-9 (1959).

A review of recent work in gaseous detonation is presented. Early work is briefly mentioned and treatises listed. Recent studies of the interior of a detonation wave are presented. Standing detonation wave research, detonation limits, two-dimensional detonations, spectra, ionization and magnetohydrodynamic treatments are brought to the reader's attention. A qualitative description of the development of a flame to a detonation is presented. Experimental observations are examined and recent theoretical attempts to explain these observations are reviewed.

0356 Grossman, J. R., A CLOSED-LOOP HEAT TRANSFER TEST APPARATUS. U. S. Army, Picatinny Arsenal, Liquid Rocket Propulsion Laboratory, Technical Memorandum 1119, October 1962. 15 pp. (AD 296 017 L).

The ability of a propellant to regeneratively cool is limited by the values of heat flux at the upper limit of nucleate boiling. A closed-loop test apparatus to determine the heat transfer characteristics of high-energy monopropellants has been designed and operated. Included are details of the flow circuit and calculations used to determine heat flux values. Verification of the system was accomplished in two ways: (1) comparing test data to a theoretical standard, and (2) comparing consistency of similar data. Test results using white fuming nitric acid (WFNA) compare within 15% of theoretical predicted by the Sieder and Tate equation for turbulent flow through tubes, which is typical of forced convection nonboiling heat transfer measurements. Slopes and inception of nucleate boiling for two different tests under similar conditions were identical. At burnout there were no detonations or explosions which demonstrates the adequacy of the system relative to safety precautions.

0357 Grumer, J., Harris, M.E., and Rowe, V.R., FUNDAMENTAL FLASHBACK, BLOWOFF, AND YELLOW-TIP LIMITS OF FUEL GAS-AIR MIXTURES. U.S. Bureau of Mines, Report of Investigations 5225, July 1956.

Fundamental flashback, blowoff and yellow tip limits were measured for premixed fuel-air flames. Various fuel gases and gas mixtures flowing through single upright burner ports in free air, at room temperature and pressure, were used in the studies. The mechanism of stabilization of a stationary flame on a burner port is discussed through introduction of the concept of the critical boundary velocity gradient, a fundamental physical parameter for representating flashback and blowoff characteristics of a fuel gas. Theoretical foundations and data for the constant and non-constant yellow-tip limits, the effect of port depth and shape on flashback, blowoff, and yellow tipping, and the effect of preheat are presented. A special bibliography cites Bureau of Mines publications on fundamental combustion characteristics of fuel gases.

0358 Gudzinowicz, B. J., Campbell, R. H. and Adams, J. S. (Monsanto Research), SPECIFIC HEAT MEASUREMENTS OF COMPLEX SATURATED HYDROCARBONS. Journal of Chemical and Engineering Data, 8, No. 2, 201-4 (1963).

Specific heats of complex saturated hydrocarbons were measured from 100° to 400°F. Major hydrocarbon groups investigated were cyclohexanes, bicyclohexyls, tercyclohexyls, decalins, and hydrindans. A differential heating method employing twin thermal cells was used. The cells were charged with 25 ml. of test fluid and 25 ml. reference fluid (diphenyl ether), respectively, and suspended in air in identical bronze cylinders. These cylinders were, in turn, welded in place to the circular metallic cover of a silicone fluid bath regulated to ±0.02°F. from 80° to 420°F. The samples were stirred magnetically and the rate of heating of each was followed using Chromel-Alumel thermocouples connected to a precision potentiometer. Calorimetric cell constants were previously obtained with fluids of known specific heats. The over-all accuracy of the method at two temperatures, 104° and 212°F., was determined by measuring fluids of known specific heats. Density and viscosity data obtained by standard techniques are included for each fluid.

0359 Gudzinowicz, B. J., Campbell, R. H. and Adams, J. S., Jr., (Monsanto Research), THERMAL CONDUCTIVITY MEASUREMENTS OF COMPLEX SATURATED HYDROCARBONS. Journal of Chemical and Engineering Data, 9, no. 1, 79-82 (1964).

Thermal conductivities of complex saturated hydrocarbons were measured from 145° to 316°F. Major hydrocarbon groups investigated were cyclohexanes, bicyclohexyls, tercyclohexyls, decalins, and hydrindans. A hot-wire method was used, and, in some instances, results using this apparatus were compared with those obtained by instruments of three other basic types - disk, cylinder, and sphere. For seven determinations of diethylcyclohexane at 145°F the relative standard deviation was 1.9% using the hot-wire technique. The results obtained for all compounds at all temperatures may be summarized as 0.068 ± 0.008 Btu/hr-ft^2-F/ft. This work was sponsored by the U. S. Air Force under Contract AF 33(616)-5799.

0360 Guerin, J. T., Carroll, J. G., Bolt, R. O., and Bert, J. A. (California Research), NUCLEAR RADIATION AND THE THERMAL STABILITY OF JET FUELS. Areospace Engineering 18, no. 1, 27-31 (1959).

Samples of JP-4 and JP-5 from several sources, and samples of RP-1 were irradiated at dosages up to 10 x 10^8 roentgen. A CFR Fuel Coker was used to determine if changes in thermal stability resulted. On the basis of filter plugging low dosage levels (10^4 - 10^8 r) reduced thermal stability. Above 5 x 10^8 r fuel thermal stability usually was unchanged or improved. The effect of irradiation on preheater deposits was not well defined.

Guinet, M., **INFLUENCE OF ADDITIVES ON THE IGNITION OF HYDROCARBON-AIR MIXTURES AT REDUCED PRESSURE.** La Recherche Aeronautique (Paris), no. 67, 43-52 (1958). (CA, 53, 11796i). 0361

Low-pressure ignition limits are determined on propane-air and kerosine-air mixtures in 3 types of apparatus. One apparatus is for static gas mixtures, one for static liquid mixtures, and one for low-pressure flow systems. Forty-seven additives are used. Most do not exhibit any marked promoting or inhibiting effects. Four do show a marked promoting effect. These four are BEt_3, $Al(BH_4)_3$, $AlEt_3$, and $Al\ Me_3$. Mixtures with these 4 additives exhibit very short ignition delays and exceptional low-pressure ignition limits.

Gureev, A. A. and Sablina, Z. A., EVALUATION OF THE HEAT STABILITY OF FUEL UNDER DYNAMIC CONDITIONS. Novosti Neftyanoi Tekhniki, Neftepererabotka, 1959, no. 2, 21-4. (CA 55, 5909h). 0362

A description is given of a laboratory apparatus for the determination of the stability of fuels at high temperatures, simulating the fuel system of a turbo-engine. The criteria used for the evaluation were the time elapsed from the moment of heating of the fuel to the time at which a given temperature was reached, and until the moment of filter clogging and the quantity of tars formed and deposited in the apparatus up to the filter element. Additional criteria are the change in the properties of the fuel after the experiment (quantity of tars, acidity, etc.) and the weight of the residue on the filter and its composition. A descritpion and flow-sheet of the apparatus and the procedure and some results of the experiments are given.

Gureev, A. A., Sablina, Z. A., Silishchenskaya, N. M., Sobolev, Ye. P., Livshits, S. M. and Subbotin, A. P., NEW OXIDATION INHIBITOR FOR FUELS CONTAINING UNSATURATED HYDROCARBONS (USSR). Khimiya i Tekhnologiya Topliv i Masel, 1962, no. 12, 55-9. (CA 58, 5430f). 0363

Phenols from wood tar pyrolysis inhibit oxidation and gum formation in kerosene during oxidation and storage. Addition of pyrolysate to fuels raises their acidity, but does not increase corrosiveness or tendency to deposit or carbon residue formation.

Hacker, D. S. and Wilson, L. N. (Armour Research Foundation), SHOCK TUBE RESULTS FOR HYPERSONIC STAGNATION HEATING AT VERY LOW REYNOLDS' NUMBERS. Contract with U. S. Advanced Research Projects Agency, September 1962. 25+ pp. (AD 437526). 0364

Results of recent measurements made in the shock tube at the stagnation point of a sphere are reported. The investigation was made in the range of Reynolds numbers from 50 to 104, based on the viscosity behind the shock. Considerations of departure from chemical equilibrium behind the incident shock and flow non-uniformities indicate that non-equilibrium chemical effects do not appreciably affect measured convective heat transfer parameters for a cold wall. The experimental heat transfer data agree with the predictions of VanDyke, using second-order boundary layer effects. For the cold wall, neglect of both slip and temperature jump are in agreement with the data.

Haensel, V., Donaldson, G. R., and Riedl, F. J. (Universal Oil Products), MECHANISMS OF CYCLOHEXANE CONVERSION OVER PLATINUM-ALUMINA CATALYSTS. International Congress on Catalysis, 3d, Amsterdam, 1964. Preprints, Section I, Preprint 9. 10 pp. 0365

Gas-liquid chromatographic analysis of the products of methylcyclopentane (MCP) conversion in a bench-scale Platforming unit on a platinum-alumina-halogen catalyst at 520°C and 300 psig with a 24:1:3 hydrogen-MCP-benzene ratio showed that the product distribution shifted markedly toward methylcyclopentene as the liquid hourly space velocity increased from 10 to 120. The absence of the very much more reactive cyclohexene in the products was explained by experiments which showed that cyclohexene was an intermediate in cyclohexane conversion at high liquid hourly space velocities up to 32,000 on a platinum-alumina catalyst; as the cyclohexene accumulates and is not converted to benzene it will undergo isomerization to methylcyclohexene, particularly when the catalyst is poisoned by sulfur. The addition of nitrogen compounds inhibits the effect of sulfur. A reaction mechanism is proposed.

Haldeman, R. G. and Botty, M. C. (American Cyanamide), ON THE NATURE OF THE CARBON DEPOSIT OF CRACKING CATALYSTS. Journal of Physical Chemistry, 63, 489-96 (1959). 0366

Regeneration kinetics, x-ray diffraction, low temperature nitrogen adsorption, and light and electron microscopical studies were used to characterize the carbon (coke) deposit of silica-alumina catalysts. A technique in electron microscopy was developed which permits examination of identical fields before and after regeneration. These studies indicate that the carbon deposit is a finely divided, highly dispersed phase present within the ultimate pore structure of the catalyst. X-ray diffraction studies indicate that the coke deposit consists largely of pseudo-graphitic structures together with considerable amounts of poorly organized carbonaceous material. A model of the coked structure is proposed which is consistent with observed regeneration kinetics.

Hall, J. W. and Rase, H. F. (University of Texas), CARBONACEOUS DEPOSITS ON SILICA-ALUMINA CATALYST. Industrial and Engineering Chemistry Process Design and Development, 2, no. 1, 25-30 (1963). 0367

Coked silica-alumina cracking catalyst removed from a commercial fluid cracking unit has been studied using electron microscopy and differential thermal analysis. Endothermic decomposition of the deposit in the absence of air was observed above 800°C. Since mixtures of carbon black and fresh catalyst were not affected by high temperature treatment, it is suggested that the endotherm observed was caused by cracking of the deposit into volatile fragments. Oxidation characteristics of the coked catalyst were studied and kinetic data obtained. Sufficient oxygen is apparently adsorbed on the catalyst to support oxidation, since rapid reaction was not appreciably hindered by substituting a helium atmosphere for air. Pretreatment with hydrogen of fresh catalyst prior to coking in the laboratory seemed to prevent formation of one type of coke observed with the untreated sample.

Hand, W. H. (North American Aviation), COMPATIBILITY CONSIDERATIONS FOR A SUPERSONIC TRANSPORT ENGINE PERFORMANCE SPECIFICATION. American Society of Mechanical Engineers. Paper 62-AV-29, 1962. 8 pp. 0368

This paper views the nature of a Mach 3 supersonic transport propulsion system and points out some of the unique considerations involved in the preparation of an engine-performance specification. The development represents a significant change in current technology. It is now indicated that a new engine will be required and that it cannot be derived directly from military predecessors. The Mach 3 environment and inlet system impose many unique requirements and compatibility considerations that must be recognized in developing an engine for the supersonic transport. In the current research and development effort, emphasis should be directed toward definition not only of the engine cycle but of many other relatively new factors, some of which are discussed in this paper.

Hangen, W. J., PROPERTIES OF JP-5 FUEL. Chrysler Corporation Missile Operations Field Artillery Guided Missile System Redstone, Technical Memorandum MT-M44J, December 1957. 22 pp. (AD 291128). 0369

This memorandum documents the physical properties of MIL-F-5624C (JP-5) fuel and gives the compatibilities of various engineering materials with this fuel. Evidence is contained to support the recommendation for the qualification of individual vendor's elastomer compounds for specific missile fuel application through controlled immersion tests. Properties data are largely taken from Barnett, H. C. and Hibbard, R. R., PROPERTIES OF AIRCRAFT FUELS, U. S. NACA TN-3276, August 1956. (AD 105 026).

Hansford, R. C., Myers, C. G., and Sachanen, A. N. (Socony-Vacuum), CONVERSION OF AROMATICS. ALKYL GROUP TRANSFER IN THE PRESENCE OF SILICA-ALUMINA CATALYSTS. Industrial and Engineering Chemistry, 37, no. 7, 671-5 (1945). 0370

The conversion of alkylaromatic hydrocarbons over petroleum cracking catalysts has been studied. Xylene was converted to toluene and trimethylbenzenes by disproportionation of methyl groups. Trimethylbenzenes were converted to toluene, xylene and polymethylbenzenes, and methylnaphthalene was converted to naphthalene and polymethylnaphthalenes by the same mechanism. Diethylbenzene was converted to ethylbenzene and ethylene, no triethylbenzenes were detected in the products. In the presence of benzene, alkyl groups from alkylbenzenes were transferred to this hydrocarbon with the formation of higher yields of monoalkylbenzene than in the disproportionation reaction. Methyl groups were not, however, transferred from methylnaphthalene to benzene.

Hara, T., THE MECHANISM OF NUCLEATE BOILING HEAT TRANSFER. International Journal of Heat and Mass Transfer, 6, no. 11, 959-69 (1963). 0371

In nucleate boiling a bubble created at nucleation site on a heating surface grows, leaves the surface and rises. The fluid motion induced in the thermal boundary layer during this process is calculated and the heat flux carried by this liquid motion to a nucleation site is obtained. The heat flux thus calculated is equal to that transferred from the heating surface to the liquid by conduction and to the latent heat carried away by the bubble per unit time. From these relations the following formula is obtained. $\Delta\theta = 0.114n^{-1/4}q^{2/3}$ where $\Delta\theta$ is a temperature difference between the temperature of heating surface and the saturation temperature, n is the number of nucleation sites per unit area and q is average heat flux. This closely resembles in form the following experimental formula which was obtained through measurement by Nishikawa: $\Delta\theta_{exp} = 0.448n^{-1/6}q^{2/3}$. The numerical values computed from these two formulas are in fairly good agreement with each other.

Hatch, V. O., INVESTIGATION OF VARIOUS METAL PROTECTIVE COATINGS ON THE GUM FORMATION AND OXIDATION STABILITY OF GASOLINE. U. S. Army, Aberdeen Proving Ground, CCL Report No. 28, June 1957. 36 pp. (AD 137784; PB 131738; CA, 54, 11449f). 0372

The effect of coating materials on gasoline gum formation and oxidation stability of the gasoline was investigated, as was the corrosion protection to steel afforded by the coatings. Forty-six coatings, including 5 commercial coatings, were evaluated for the protection of steel in the presence of gasoline and moisture at 150°F. for a maximum of 500 hours. Some butadiene-acrylonitrile copolymers and phenolic resins were suggested for field testing.

Hatcher, J. B., HIGH-FLUX HEAT TRANSFER AND COKE DEPOSITION OF JP-3 FUEL MIXTURE. Jet Propulsion Laboratory (California Institute of Technology), Progress Report 20-157, U. S. Army, Contract DA-04-495-Ord 18, February 1952. 33 pp. 0373

In the general program of studies of heat transfer to fluids at high heat fluxes at this laboratory, data have been obtained on the heat transfer to the hydrocarbon-fuel mixture known as JP-3, which had the former specification AN-F-58 or the present MIL-F-5624. The data provide local heat-transfer coefficients for fluid flow inside a tube over the range of 8 to 80 ft/sec at pressures of 50 to 500 psia for heat fluxes up to 7 Btu/sq in. sec, as well as the maximum flux conditions in nucleate boiling. The fluid was found to deposit coke on the heat-transfer surface at a high rate. Some general observations on the coking behavior are made, together with a detailed treatment of coking rates and their application to the correction of heat-transfer data in order to give heat-transfer coefficients for clean-tube conditions. The heat-transfer behavior of JP-3 in forced convection is in good agreement with that which would be predicted from the usual correlation equations. The complete lack of fundamental studies on the nucleate boiling of multicomponent fluids of known properties makes any correlation of JP-3 behavior in nucleate boiling of very limited significance.

Hazzard, G. F. (Defence Standards Laboratory, Australia), CONTRIBUTION TO DISCUSSION AT SOCIETY OF AUTOMOTIVE ENGINEERS, AUTOMOTIVE ENGINEERING CONGRESS, DETROIT MICHIGAN, JANUARY 14th-18th, 1963, 18 January 1963, 8 pp. (AD 298175). 0374

Fuel samples taken using proper sterile techniques indicate the presence of fewer fungal types than have previously been thought to occur in aircraft fueling systems. Fungus may provide the environment necessary for subsequent bacterial development. Fuel tank corrosion has been brought under control through inspection, cleanout, and changes in sealant materials. Several references.

Hazzard, G. F., and Kuster, E. C., FUNGAL GROWTHS IN AVIATION FUEL SYSTEMS. PART 2. TEST METHODS. Australia. Defence Standards Laboratories, Report 252, December 1962. 13 pp. (AD 298174). 0375

Test methods for obtaining samples from a fuel system, determining fungal growths in petroleum fractions, and evaluating the resistance of membranes or films to fungal penetration are presented.

Hearth, D.P., Brema, A. and Hedman, P., FINAL SUMMARY REPORT, HYPERSONIC RAMJET ENGINE PROGRAM, VOL. I. The Marquardt Corporation, Astro Division, Report No. 25,020, U.S. Air Force Contract AF 33(600)-37921, March 1960. (AD 324804-L). REPORT CLASSIFIED CONFIDENTIAL. 0376

No abstract.

Heaston, R. J. (WADC, USAF), BORON - HYDROGEN - CARBON. SAE Journal, 66, no. 6, 39 (1958). 0377

The paper discusses alkylboranes as high energy fuels. Specific compounds are not described but a typical HEF is compared with JP-6 for thermal stability, density, heating value and reactivity. The HEF is an outstanding fuel on these specifications. The author points out that because of cost (65 cents to $1/pound) these fuels would be limited in application to highly specialized missions.

Hedenburg, J. F., INHIBITION OF AUTOXIDATION BY SUBSTITUTED PHENOLS. Industrial and Engineering Chemistry Fundamentals, 2, no. 4, 265-7 (1963). 0378

Type and position of substituent phenol groups have a marked effect on the ability to inhibit autoxidation. A theory is presented which correlates the inhibitor factors of alkyl phenols, and the theory is reduced to mathematical form.

0379

Hendey, N. I., **OBSERVATIONS ON THE "KEROSENE FUNGUS" AND ITS POSSIBLE ROLE IN THE CORROSION OF ALUMINUM ALLOY FUEL TANKS.** Gt. Brit. Admiralty Materials Laboratory, Report A/9 (C), July 1962. (AD 290648).

The history of the occurrence of the 'kerosene fungus' in AVCAT stowage tanks and the fuel tanks of aircraft is reviewed and the taxonomy and some of the physiological requirements and reactions of the causative organism are examined. Experiments are described showing that the fungus probably produces metabolites that are capable of attacking aluminium. A number of references to inspection studies of tankage on aircraft carriers and in aircraft are given.

0380

Hendricks, R. C., Graham, R. W., Hsu, Y. Y. and Medeiros, A. A. (NASA, Lewis Research Center), **CORRELATION OF HYDROGEN HEAT TRANSFER IN BOILING AND SUPERCRITICAL PRESSURE STATES.** ARS Journal, 32, 244-52 (1962).

The use of hydrogen as a working fluid in both chemical and nuclear propulsion systems necessitates convective heat transfer information over a broad range of fluid states. Current heat transfer correlation schemes available in the literature are discussed in terms of their applicability to hydrogen heat transfer. Similarities in the subcritical and supercritical (pressure) heat transfer mechanisms and associated experimental data are reported. Summarized are correlation schemes formulated from heated tube data which apply to: 1) film boiling of liquid hydrogen; 2) hydrogen at supercritical pressure just above and below critical temperature; and 3) low temperature hydrogen (150° to 250°R) above the critical pressure. Parts 1 and 2 have required correlation schemes that depart from the conventional convective pipe flow concepts. It does appear that the conventional pipe flow heat transfer theory can be applied to part 3.

0381

Hendrickson, Y. G. and Guerin, J. T., **THERMAL STABILITY OF GAS TURBINE FUELS.** California Research Corp., Summary report, U. S. Air Force, Contract AF 33(616)-3123, May 1956. 24 pp. (AD 101164).

A study was made of the thermal stability characteristics of aircraft gas-turbine fuels. Four JP-4 jet fuels, one JP-5 jet fuel, and highly refined kerosene were separated by elution chromatography on silica gel into nonpolar (low boiling) and polar fractions. The polar fractions constituted less than 0.5% of the fuels. The insoluble deposits formed by the whole fuels and blends of nonpolar and polar fractions were measured in a hot plate tester. Results showed that the thermal stability of jet fuel is a complex function of its composition and depends on (1) the quantity and composition of the polar fraction (2) the composition of the nonpolar fractions; (3) the interactions among the nonpolar fractions; and (4) the interactions between the polar and nonpolar fractions. The polar fractions caused the formation of more insoluble gums/volume than the nonpolar fractions. The chemical composition of the polar materials varied from fuel to fuel Most of the deposits caused by the polar fraction are attributed to neutral components which comprise about 80% of the polar materials. For whole fuels, the hot plate test correlated reasonably well with the rate of filter plugging in the Erdco fuel coker test.

Henery, R. B. (ASTIA), COMPILATION OF REFERENCES ON MICROBIOLOGICAL CONTAMINATION OF FUELS. AD 266000, November <u>1961</u>. 42 pp. 0382

This compilation was prepared by ASTIA in response to an inquiry concerning the Microbiological Contamination of Fuels. Material is indexed by the following categories to provide several cross referenced appraoches: agencies, individuals, magazines, meetings patents, and reports. Key people were contacted in an effort to obtain as comprehensive a survey of the literature as possible. Not all references listed are readily available-others may contain proprietary information and may not be released by the controlling office. All references with AD numbers are available from ASTIA to qualified users of ASTIA services. Appendices contain also a list of contractors (and contract nos.) doing work on effect of fuels on fuel systems, and a Bu Weps instruction concerning fuel quality and contamination standards.

Henry, J. C., PROPERTIES OF JP-4 JET FUEL. U.S. Air Force, WADD TR 60-57, January <u>1960</u>. 20 pp. (AD 238922). 0383

During the period from January 1958 through May 1959 a total of 167,841,925 barrels of JP-4 fuel were analyzed by various Quality Control Laboratories. This report presents a statistical analysis of these data for 25 specification properties (gravity, smoke point, potential gum content, freezing point, vapor pressure, aniline point, etc.). Frequency distribution curves, 90% limits, maxima, minima, and mean values of fuel properties are given, as well as mean property values of fuels purchased from four U.S. areas.

Herrington, L. P., THE BIOTECHNICAL PROBLEM OF THE HUMAN BODY AS A HEAT EXCHANGER. American Society of Mechanical Engineers. Transactions, <u>80</u>, 343-6 (<u>1958</u>). 0384

The paper demonstrates that a large body of calorimetric data on the human heat exchanger can be summarized in statistically derived empirical equations. These equations obviate the need for special physiological knowledge of the engineer who would make such computations from the classical equations of heat loss. A metabolic heat production rate of 91.5 Kcal/hr is given for a mature male subject, seated posture, normal clothing.

0385

Hibbard, R. R., EVALUATION OF LIQUIFIED HYDROCARBON GASES AS TURBOJET FUELS. U.S. National Advisory Committee for Aeronautics, RM E56I21, December 1956. 44 pp. (AD 117780).

Liquified methane, ethene, and propane and four normally liquid hydrocarbon fuels (an isopentane-isohexane blend, aviation gasoline, JP-4, and JP-2) are considered in this analytical report. It is shown that the lower molecular weight hydrocarbons are much superior to current jet fuels as heat sinks and may be required with cooled-turbine engines. The low-molecular-weight fuels are also attractive in regard to aircraft range, availability, and cost. Tank insulation requirements and low-temperature handling factors are discussed for the normally gaseous fuels. The relatively short times that aircraft can be held between fueling and take-off are shown to be a severe disadvantage with some fuels.

0386

Hibbard, R. R. (NASA Lewis Research Center), LOW MOLECULAR WEIGHT HYDROCARBONS AS JET FUELS. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, C5-17 (September 1960).

Liquid methane, ethene, and propane along with normally liquid hydrocarbon fuels are considered in this report. It is shown that the lower-molecular weight hydrocarbons are much superior to current JP-type fuels as heat sinks and that these more volatile fuels may be required for very high-speed flight. It is also shown that aircraft range will not necessarily suffer from use of low-molecular weight fuels even though their density is low. The normally gaseous fuels would have to be handled at low temperatures, and the tank insulation requirements and handling factors are discussed herein. The relatively short times that aircraft can be held between fueling and take-off is a severe disadvantage with some fuels. Some of the lower-molecular weight hydrocarbons are readily available at low cost.

0387

Hibbard, R.R. and Evans, A. (Lewis Research Center), APPLICATION OF GAS ANALYSIS TO COMBUSTOR RESEARCH. U. S. National Aeronautics and Space Administration, Memo 1-26-59E, February 1959. 22 pp.

Gas analysis has been studied as a means for determining the performance of turbojet and ram-jet combustors. Samples taken at the outlet of a production-model turbojet combustor operating over a range of conditions have efficiencies which, in general, agreed with those determined by bare-junction thermocouples. Samples taken at the outlet and at two upstream stations were used to calculate local fuel-air ratios, efficiencies, and heat-release rates. These data and those taken from two ram-jet combustors permit estimates to be made of the nature of the rate-limiting processes in the practical combustion of hydrocarbons in air. It was found that kinetic processes are rate-limiting at low pressures and physical processes are rate-controlling at high pressures.

Hibbard, R.R., Metzler, A.J. and Scull, W.E., LOW PRESSURE PERFORMANCE OF EXPERIMENTAL PREVAPORIZING TUBULAR COMBUSTOR USING APPROXIMATELY STOICHIOMETRIC ADMISSION OF FUEL-AIR MIXTURE INTO THE PRIMARY ZONE. U. S. National Advisory Committee for Aeronautics, RM E54F25a, August 1954. 38 pp. 0388

To evaluate the precept of prevaporized, stoichiometric mixture addition to the primary zone of a combustor, an experimental tubular combustor was developed which utilized the outer surface of the flame tube as a fuel vaporizer. The experimental combustor gave higher efficiencies than those obtained with a production model at all conditions and indicated a low tendency to form carbon. However, operation of the experimental combustor was limited by the flash-back into the vaporizing area at low air velocities or high pressures.

Hillenbrand, L. J., THE EFFECT OF NUCLEAR RADIATION ON HYDROCARBON FUELS. Battelle Memorial Institute. Radiation Effects Information Center. Technical memorandum 11, U.S. Air Force, Contract AF 33(616)-5171, November 1958. 12 pp. (AD 207702). 0389

This memorandum summarizes the information available at the Radiation Effects Information Center on the radiation stability of hydrocarbon fuels. The extent to which various radiation doses will affect the usual physical and chemical properties of fuels has been measured. No simple relationship seems to exist between the effects of irradiation upon thermal stability and upon other fuel properties. However, both the thermal-stability tests and the fuel-properties determinations indicate that dehydrogenation, polymerization, and degradation occur. The changes in thermal stability caused by irradiation (as measured in a fuel coker) tend to disappear after several months of storage. Preirradiated fuels frequently produce very different results when tested for thermal stability in the presence of radiation than in the absence of radiation. The combination of preirradiation and irradiation during testing can produce either an increase or decrease in the thermal-stability rating of a fuel compared with the original rating, and these changes usually cannot be predicted from the effect of pre-irradiation alone. The nature of the end use, and the expected sequence of performance and radiation exposure, must be used in planning the test procedure for fuel evaluation.

Hines, W. S. (Rocketdyne), HEAT TRANSFER TO RP-1 KEROSENE IN TURBULENT FLOW UNDER ASYMMETRIC HEATING CONDITIONS. Chemical Engineering Progress. Symposium Series, 59, no. 41, 193-200 (1963). 0390

Forced-convection heat transfer to RP-1 kerosene was investigated under asymmetric heating conditions similar to those in a single coolant passage of a liquid-rocket-thrust chamber. The experimental technique was to electroplate a copper heating strip to one side of a 0.50- by 0.319-in. rectangular cross-sectioned stainless steel tube of 0.010-in. wall thickness. When electrical current was passed along the tube, approximately 95% of resistance heating occurred in the copper strip and adjacent tube wall, producing an asymmetric heat input to the fluid. Data were gathered at liquid velocities to 120 ft./sec. and heat fluxes to 2.36 B.t.u./(sq. in.) (sec.). A reduction in heat transfer coefficient was observed from symmetric heating conditions if the usual equivalent diameter was employed in dimensionless correlations.

0391

Hines, W. S., Seader, J. D. and Gerstley, J. G., STUDY OF AN ENDOTHERMIC FUEL FOR THE ATLAS ROCKET MOTOR. Rocketdyne, RM 1084/262, U. S. Air Force, Contract AF 04(611)-9721, First Quarterly Progress Report, September 1964, 26 pp.

Effort on "Study of an Endothermic Fuel for the Atlas Rocket Motor" was directed toward both analytical and experimental studies. The analytical studies examined the use of tetraisobutylene (TIB) as a replacement for RP-1 in an Atlas type engine with FLOX as the oxidizer. Performances of the two fuels were compared, as well as the coolant jacket pressure drops and coolant temperature rises. Assumptions of varying amounts of gas-side carbon deposition were made. Because of its inferior transport properties, TIB appeared to be an inferior coolant to RP-1 under conditions where its greater heat sink was not required. The experimental effort was directed toward the prearation of an apparatus to perform forced convection heat transfer studies with TIB. An existing closed-loop hydrocarbon flow system was rebuilt and a flow bench and tubular test sections were constructed. Buildup was completed and the apparatus checked out under non-heating conditions at the end of the quarterly period.

0392

Hines, W. S. and Wolf, H. (Rocketdyne), PRESSURE OSCILLATIONS ASSOCIATED WITH HEAT TRANSFER TO HYDROCARBON FLUIDS AT SUPERCRITICAL PRESSURES AND TEMPERATURES. ARS Journal, 32, 361-6 (1962).

Heat transfer experiments are described which were conducted with RP-1 and diethylcyclohexane (DECH) flowing turbulently in round, thin walled, electrically heated tubes at supercritical pressures and supercritical wall temperatures. Under these conditions a vibration, intense enough to be audible, emanated from the test sections. The vibration was accompanied by a sharp increase in heat transfer without a corresponding increase in wall to fluid temperature differential, a result similar to that obtained with nucleate boiling. The vibration was also found to be very destructive to the thin walled tubing. Measurements of amplitude and frequence of the fluid pressure oscillations were made with a flush mounted SLM crystal transducer positioned at the end of the heated protion of the test section. Frequencies in the range from 1000 to 10,000 cps and amplitude as high as 380 psi peak to peak were measured. The results of the heat transfer experiments with and without vibration are presented in tabular and graphical forms.

0393

Hirsch, E. and Ryason, P. R., COMBUSTION DELAY SURFACES IN THE OXIDATION OF HYDROGEN. Journal of Chemical Physics, 40, 2050 (1964). (Erratum: ibid. 41, 901, 1964).

In a study of the important reactions and species in the induction period of the oxidation of hydrogen, various reaction schemes and sundry rate constants were investigated. A mechanism of elementary reactions was set up and the system of kinetic equations integrated on a 7090 computer using a Runge-Kutta scheme. Results for computed induction times were compared with the experimental results of Schott and Kinsey.

Hirschfelder, J. O. (University of Wisconsin Naval Research Laboratory), HEAT TRANSFER IN CHEMICALLY REACTING MIXTURES. I. Journal of Chemical Physics, 26, no. 2, 274-81 (1957). 0394

If a chemically reacting mixture is confined between two parallel plates, one hot and the other cold, the temperature and the chemical composition at a point, as well as the over-all heat flux, depend upon the rates of both the homogeneous reactions in the gas phase and the heterogeneous reactions on the surfaces. However, if the reaction rates are fast in either the forward or the reverse direction, the assumption of local chemical equilibrium (which is equivalent to the thermodynamics of irreversible processes) is found to be very good. Under such conditions the heat conductivity behaves as though the reacting gas mixture were a pure substance with an effective coefficient of thermal conductivity. A simple equation is given for this effective coefficient of thermal conductivity. Detailed examples are given for a unimolecular rearrangement $A \rightleftarrows B$ and for the dissociation of oxygen, $O_2 \rightleftarrows 2O$. The analysis applies equally well to liquid and to gaseous mixtures. This work was sponsored by the Office of Naval Research under Contract N7 onr-28511.

Hirschler, A. E. and Schneider, A. (Sun Oil), ACID STRENGTH DISTRIBUTION STUDIES OF CATALYST SURFACES. Journal of Chemical and Engineering Data, 6, no. 2, 313-18 (1961). 0395

The acidities of silica-alumina cracking catalysts and platinum on alumina reforming catalysts were measured by non-aqueous butylamine titration. Product distributions from commercial feedstocks were compared for catalysts of varying acid strengths.

Hitzman, D. O., Shotton, J. A., and Alquist, H. E. (Phillips Petroleum), BIOCIDAL EFFECTS OF PFA 55 MB. Society of Automotive Engineers. SAE Paper 683D, April 1963. 0396

The components of jet fuel anti-icing additive PFA 55 MB (98%w ethylene glycol monomethyl ether and 2%w glycerol) were found to be individually and collectively biocidal to all the microbiological growths tested (fungi and bacteria). Biocidal concentration (≥10%w) will exist in discrete water phases such as at the bottom of fuel tanks if the fuel has been treated with about 0.05%w PFA 55 MB.

0397

Hoff, N. J. (Polytechnic Institute of Brooklyn), HIGH TEMPERATURE EFFECTS IN AIRCRAFT STRUCTURES. Applied Mechanics Reviews, 8, no. 11, 453-6 (1955).

A review of the problems of aerodynamic heating both for aircraft (air breathing) and missiles on reentry is presented. Primary emphasis is on structural problems resulting from heating.

0398

Hoff, N. J., ed. HIGH TEMPERATURE EFFECTS IN AIRCRAFT STRUCTURES. New York, Pergamon, 1958. 357 pp. (North Atlantic Treaty Organization. AGARDograph No. 28).

Sixteen papers are included, dealing primarily with the structural consequences of high temperatures resulting from aerodynamic heating in supersonic flight. Both manned aircraft and rocket missiles are considered. The first two papers, an introduction and a discussion of external sources of heat, describe the magnitude of aerodynamic heat effects.

0399

Holbeche, T. A. and Spence, D. A. (Royal Aircraft Establishment, U.K.), A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF TEMPERATURE VARIATION BEHIND ATTENUATING SHOCK WAVES. Royal Society (London). Proceedings, A279, 111-28 (1964).

Temperatures in the range 2000 to 2700°K have been measured behind shock waves in nitrogen and oxygen, by means of the sodium-line-reversal technique. Early tests at low initial pressures in nitrogen in which a significant time was required for molecular vibrational equilibrium behind the shock front, showed discrepancies of the order of 290°K between the equilibrium temperatures then obtained and those inferred from the measured speed of the shock. These are explained as being due to attenuation, as a result of which the particles at the head of the relaxation zone are raised to lower temperatures than those at the rear, which passed through the shock earlier in its flight.

Holloway, P. F. and Sterrett, J. R., EFFECT OF CONTROLLED SURFACE ROUGHNESS ON BOUNDARY-LAYER TRANSITION AND HEAT TRANSFER AT MACH NUMBERS OF 4.8 AND 6.0. U. S. National Aeronautics and Space Administration, TN D-2054, April 1964. 44 pp. 0400

A systematic investigation has been conducted to determine the effects of various size spheres alined in a row equidistant from the leading edge on boundary-layer transition and heat transfer for a sharp-leading-edge two-dimensional flat plate. The results indicate that both the Reynold's number for natural transition and the critical roughness Reynolds number increase with increasing Mach number (above a Mach number of approximately 3.5 to 4.0). Calculations of the heat-transfer distributions based on simple flat-plate theory are shown to give a reasonably good prediction of the experimental results.

Hope, J., SUPERSONIC TRANSPORT PROPULSION. Institute of the Aerospace Sciences. Paper 63-8, 7 pp. (International Aerospace Abstracts, 3, no. 4, 163, abstr. A 63-11362). 0401

Discussion of engine-evaluation and component-research programs aimed at a choice of an engine type (and its development) to meet the requirements of a supersonic transport (SST). The aircraft is to carry a payload of 32,000 lb over 3,200 nautical miles at a cruising speed of M = 3. The progress in engine design ensuing from these programs is noted in terms of component efficienies, thrust-to-weight ratio, and turbine-inlet temperature. The SST-engine cycle studies, conducted on the basis of the improved levels of component technology on 12 types of engine, show that the turbofan and turbojet engines perform best.

Horrocks, J. K. and McLaughlin, E. (Imperial College), TEMPERATURE DEPENDENCE OF THE THERMAL CONDUCTIVITY OF LIQUIDS. Faraday Society. Transactions, 59, 1709-16 (1963). 0402

The important factor in controlling the temperature dependence of the thermal conductivity of a liquid is shown to be the coefficient of thermal expansion. Expressions for the temperature dependence of thermal conductivity are derived on the harmonic oscillator and rectangular cell potential models of the liquid. It is found, that in the limit of high densities, the cell model results agree with the statistical theories which are based on a distribution function approach. A comparison of the relative sensitivities of viscosity and thermal conductivity to changes in temperature and structure is made.

Horstman, W.W., GAS TURBINE FUELS. Shell Oil Company, Wood River Research Laboratory, Report 1345, Summary Report, U.S. Air Force Contract W-33-038-ac-9813-(14169), June 15, 1950. 23 pp. plus figures. 0403

Research under the contract was conducted on single burner tubes from General Electric J-31 and J-33 turbojet aircraft engines supplemented by studies of low temperature spray nozzle performance and low temperature filtering problems. The deleterious effects of carbon and other materials formed in the full-scale units prompted studies of various fuels and operating conditions with primary effort on deposition tendency. In addition, studies of combustion efficiency and flame stability with various fuels, and ignition tests with fuels at sub-zero temperatures were performed. The carbon deposition ratings obtained in a single burner tube appeared to correlate with full scale engine results. Engine operating conditions influenced the rate of carbon deposition in the combustors, the deposition tendency decreasing as the output or the inlet air temperature was increased. Volatility and aromatic content were the major fuel factors affecting carbon deposition in the liner.

Horstman, W.W. and Jackson, J.L., (Shell Oil Co.), "COMBUSTION CHARACTERISTICS OF SPECIAL HYDROCARBON JET FUELS". U.S. Air Force Contract AF 33 (616)2686, October 1955. (AD 89977). REPORT CLASSIFIED CONFIDENTIAL. 0404

No Abstract

Horstman, W.W. and Jackson, J.L. (Shell Oil Co.) , "COMBUSTION CHARACTERISTICS OF SPECIAL HYDROCARBON JET FUELS". U.S. Air Force, WADC TR 58-437, Contract AF 33(616)-3693, April 1958. (AD 155 801). REPORT CLASSIFIED CONFIDENTIAL. 0405

No Abstract

Horstman, W. W. and Jackson, J. L. (Shell Oil), COMBUSTION CHARACTERISTICS OF SPECIAL HYDROCARBON JET FUELS. U. S. Air Force, ASD TDR 62-682, Contract AF 33(616)-8059, July 1962. 81 pp. (AD 290395). 0406

A single combustor from a J-79 engine was used to evaluate combustion efficiency, flame radiation, fuel consumption, and altitude relight characteristics of 12 hydrocarbon fuels potentially useful in supersonic aircraft gas turbine engines. The relative combustion efficiency was approximately constant for all fuels at a given test condition; but increased about 9% as the combustion intensity was increased from 82,000 to 295,000 Btu/cu ft/min. Combustor metal temperature was directly proportional to the combined effect of heat conduction and convection and flame radiation. At a given test condition, differences in fuel composition caused variations in liner temperature and flame total radiation which became greater as the combustion intensity increased. At high heat release rates, liner temperatures were reduced significantly with paraffinic type fuels. The liner temperatures correlated equally well with H/C ratio and with Luminometer Number. Ease of relight at simulated altitude conditions increased with decreasing ASTM 10% distillation temperature and with increasing paraffin content of the fuel.

Horstman, W. W. and Jackson, J. L., FUEL REQUIREMENTS OF PRE-VAPORIZING TYPE GAS TURBINE COMBUSTORS MATERIALS SECTION. Shell Oil Co., Wood River Research Report No. 1451, U. S. Air Force, Contract AF 33(616)-76, July 1954. 40 pp. (AD 52263). 0407

Tests were performed in a Mamba (pre-vaporizing) combustor to investigate the effect of fuel properties on carbon deporition, combustion efficiency and stability, and low temperature starting. Fuels used were Kerosine, JP-3, JP-4, Aviation Gasoline, and a series of specially blended fuels, some with synthetic gum added.

Horstman, W. W., Jackson, J. L., Sorem, S. S., and Coit, R. A. (Shell Oil), COMBUSTION CHARACTERISTICS OF SPECIAL HYDROCARBON JET FUELS. U.S. Air Force, WADD TR 60-850, Contract AF 33(616)-5622, November 1960. 137 pp. (AD 274620). 0408

The combustion performance of potential hydrocarbon fuels for supersonic aircraft jet engines was evaluated in a J-79 engine combustor. The combustor test conditions simulated full-scale engine operation at high altitudes and supersonic speeds. As the inlet air pressure decreased, the combustion efficiency decreased. Differences in combustion efficiency were noted between 8 fuels at the various operating conditions. A comparison of the fuel flow requirement for a constant burner temperature rise (thrust) at two test conditions indicated lowest fuel flow on a weight basis for a paraffinic fuel and a production type JP-6 fuel; lowest fuel flow on a volume basis was indicated for a naphthenic fuel and isopropylbicyclohexyl. At a more severe operating condition the isopropylbicyclohexyl indicated a low fuel flow requirement on both a weight and volume basis. The effect of fuel preheat on combustion efficiency was negligible. Combustor liner temperatures were not affected appreciably by fuel differences. The carbon deposits were very light for all fuels. The fuels with the higher ASTM initial and 10% boiling points had higher ignition requirements at simulated altitude relight test conditions.

Horstman, W.W. and Schramm, M.E., G.E. I-16 JET PROPULSION BURNER TESTS. Shell Oil Company, Wood River Research Laboratory, Report 1266, U.S. Army Contract W-33-038-ac-9813(14169), April 28, 1946. 24 pp. 0409

Test work on the contract was conducted on a single burner of a General Electric I-16 turbojet aircraft engine to study the performance of the unit under various operating conditions. The deleterious effects of carbon and other materials formed in the full-scale units during operation, prompted studies of various fuels and operating conditions; primary effort was placed on their effect on deposition tendency. In addition, some preliminary investigations were made employing water injection, and some modifications were made in the apparatus to facilitate the studies.

Horstman, W.W. and Smialek, J.J., GAS TURBINE FUELS. Shell Oil Company, Wood River Research Laboratory, Report 1386, Final Report, U.S. Air Force Contract AF 33(038)-17444, February 8, 1952. 26 pp. 0410

A Reichhelm Gasifier borrowed from the Navy was used in a J-33 single burner tube for an investigation of the effects of prevaporized fuel on burner deposits, combustion efficiency and stability and ignition or starting. Various fuels used for the tests included a JP-3, JP-4 and a grade 115/145 aviation gasoline. Steam ejectors were installed to provide exhaust conditions at altitudes up to 60,000 ft. For starting tests at simulated arctic conditions, a means for cooling the burner inlet air was provided. The use of prevaporized fuel produced less deposits in the J-33 burner tube liner than did the use of pressure atomized fuel when burning kerosine. The deposit forming tendency of JP-3 was higher than that of kerosine when using the gasifier. In the standard J-33 single burner tube with pressure atomized fuel, kerosine formed heavier deposits than did JP-3. The effect of fuel characteristics on general burner performance was not appreciable in the simulated normal operating range with the gasifier.

Hosek, J., WHAT WILL BE THE DEVELOPMENT OF AIR TRANSPORTATION UNTIL 2000. Letecky Obzor, 1961, no. 10, 334-5. 0411

The author speculates on the likely development of wingless aircraft. Aircraft will have a minimum of four lift engines and two propulsion engines. The propulsion engines will also be capable of producing lift and thus enable the aircraft to continue its flight or land should one or more of the lift engines fail. It can be presumed that the wingless aircraft will be more efficient and economical, and its maintenance less expensive than that of conventional aircraft. Aerodynamic heating, attaining a value of several thousand degrees Kelvin at hypersonic speeds, will play an important part in the design of future aircraft. The aircraft will have to be protected against this heat by a suitable thermal insulation, artificial cooling, e.g., forced circulation of a coolant (the use of fuel for this purpose is also possible), transpiration, ablation shields or by magnetic cooling. It will even be possible to burn fuel on the entire aircraft surface as a protection against still higher temperatures of aerodynamic heating. As regards the power plants, piston and turboprop engines will be completely superseded by jet and rocket engines. The turbojet and ramjet engines will eventually use nuclear energy.

Hostetler, K.E., LaFleur, F.M., and Mell, C.W., ADVANCED HEAT TRANSFER FLUIDS. Hughes Ground Systems, Fullerton, Calif., Seventh Quarterly Report, U.S. Air Force Contract AF 33(616)-7109, July 1962. 86 pp. 0412

The objective of the program is to find, study and develop advanced heat transfer fluids to be circulated through electrical modules, controlling component temperatures within the temperature range for fluids of -65 to 650°F.

Hostetler, H. F. and Powers, E. J. (Standard Oil, Ohio), BUGS, SURFACTANTS, AND WOES. American Petroleum Institute. Proceedings, 43, Section III, 122-43 (1963). 0413

Distillate fuel contaminants such as water, rust, dirt, surfactants, and microorganisms can cause fuel handling problems for the petroleum supplier and serious operational problems for the consumer. This paper describes fuel filtration and water separation problems which are caused by surfactants. Problems of fuel filter plugging, coked burner nozzles, dirty diesel fuel injectors, aircraft fuel gage fouling, and tank corrosion are associated with microbiological fuel contamination and are also discussed. The examples cited illustrate the seriousness of surfactant and microbial fuel contamination. Many operational problems can be minimized through the use of improved housekeeping practices and fuel microbicides. 37 references are given.

Howard, F.G., HEAT TRANSFER ON UNSWEPT AND 38° SWEPT CYLINDRICALLY BLUNTED WEDGE FINS IN FREE FLIGHT TO MACH NUMBER 4.11. U.S. National Aeronautics and Space Administration, TN D-2386, August 1964. 48 pp. 0414

Heat transfer was investigated on the leading edge and along the midspan chord to a Reynolds number of 16.5×10^6 per foot, and a comparison of experimental heating rates with theoretical heating rates is presented for both swept and unswept fins. These results indicate that the flow on the unswept fin is laminar at the stagnation line but becomes completely turbulent on the aft portion of the wedge section. The flow on the swept fin is shown to be turbulent at the stagnation line during the entire heating period.

0415 Hudson, C. R., TECHNICAL NOTE ON SPECIFICATION MIL-F-25656(USAF), GRADE JP-6, FUEL. U.S. Air Force, WADC TN 57-121, March 1957. 6 pp. (AD 118173).

The need for a fuel of higher thermal stability than JP-4 for use in supersonic aircraft is discussed, and the specification requirements for JP-6 compared to JP-4 are presented. Availability of component petroleum distillate stocks for the production of JP-6, storage and handling needs, and estimated properties (density, viscosity, heat of combustion, specific heat, distillation curve, vapor pressure, mol weight, characterization factor, heat of vaporization and flash point) are included.

0416 Hughes Aircraft Company, CONTROL DATA REQUIREMENTS INVESTIGATION FOR OPTIMIZATION OF FUEL ON SUPERSONIC TRANSPORT VEHICLES. Phase I Report, Volume I, HAC Report No. 63 M-0193/9299, U.S. Air Force Contract AF 33 (657)-8822, January 1963. (AD 333 861), REPORT CLASSIFIED CONFIDENTIAL.

This report is issued for the purpose of documenting the accomplishments achieved during the Phase I period of Contract No. AF 33(657)-8822, Project No. 9056, "Control Data Investigation for Optimization of Fuel on Supersonic Transport Vehicles." It covers the period from 1 June 1962 through 31 December 1962. In the contractual Statement of Work, the major work area in Phase I was defined as the creation of an IBM 7090 computer program designed to allow a comprehensive study of optimum flight profiles. Phase II, presently scheduled to run from 1 January 1963 through 1 May 1963, will be devoted to a quantitative study of optimum fuel procedures and techniques. Volume I deals with the overall development and status of the fuel optimization study. Volume II contains considerable detail on the particulars of the IBM simulation program. The basic program for studying SST fuel consumption has been written and checked out. Not only can optimum flights be run, but also flights under constraints of ATC, emergency conditions, and nonstandard atmospheric conditions may be studied. Present SST data available for quantitative Phase II study are one fixed geometry canard-delta configuration supplied by NASA/Ames and one variable sweep configuration supplied by NASA/Langley.

0417 Hurd, C. D. and Macon, A. R. (Northwestern University), PYROLYTIC FORMATION OF ARENES. IV. PYROLYSIS OF BENZENE, TOLUENE AND RADIOACTIVE TOLUENE. American Chemical Society Journal, 84, 4524-6 (1962).

Toluene-α-^{14}C, on decomposition at 825°, gave rise to benzene, naphthalene, phenanthrene and other products. The benzene was 3.2% as radioactive as the original toluene, showing that not all of it could have come by simple scission of the methyl group. The naphthalene was 17.0% as radioactive. Both the phenanthrene and anthracene were nearly twice as radioactive as the starting toluene. Infrared analysis confirmed the fact that naphthalene was not a pyrolytic product of benzene.

Hurn, R. W. and Hughes, K. J. (U. S. Bureau of Mines), **IGNITION ACCELERATORS AND AUTOIGNITION ENVIRONMENT.** Industrial and Engineering Chemistry, 48, no. 10, 1904-8, (1956). 0418

The effectiveness of several additive compounds in reducing the ignition delay times of cetane and a secondary diesel reference fuel were tested. All of the additives were thermally unstable materials which presumably decomposed to generate radicals. While these additives gave significant reductions in delay times when present in concentrations of the order of 1 percent none appeared to significantly decrease the minimum ignition temperature of the reference fuel.

Husa, H. W. and Runes, E. (American Oil Co.), **HOW HAZARDOUS ARE HOT METAL SURFACES?.** Oil and Gas Journal, 61, no. 45, 180-2 (1963). 0419

Experiments showed that the temperature of a bare metal surface must be hundreds of degrees above the accepted minimum ignition temperature in order to ignite an unconfined flammable hydrocarbon-air mixture. Tests were performed in large beakers and in open-air tests where evaporation from large pans of fuel provided the fuel vapor.

Huyghe, J. and Mondin, H., **HEAT TRANSFER TO A GAS-LIQUID MIXTURE IN FORCED TURBULENT FLOW WITH WEAK VAPORIZATION OF THE LIQUID PHASE.** Commission Energie Atomique (France), Report 2196, 1962. 82 pp. (CA 59, 14911h). 0420

An experimental study was made of heat transfer to a turbulent flow of CO_2 carrying suspended drops of a eutectic mixture of Dowtherm A. The ratio of the mass flow of liquid to gas was 0.2-4. The heat transfer coefficient increased 20 times when compared at the same gas Reynolds number and 8 times when compared at the same total mass rate. Negligible liquid evaporation took place and the increased heat transfer is ascribed to favorable hydrodynamic conditions. Little increase in pressure drop accompanied the increased heat transfer.

Hyatt, A. (Department of the Navy), SOME EFFECTS OF HIGH ENERGY FUELS ON AIRCRAFT PERFORMANCE. Aerospace Engineering 17, no. 12, 45-50 (1958). 0421

Theoretical considerations of the effects on range and payload of the use of fuels with energies of combustion (per unit wt) 30-50% greater than that typical of jet kerosenes (18,000 Btu/lb) are presented.

Ibele, W., ed. MODERN DEVELOPMENTS IN HEAT TRANSFER. New York, Academic, 1963. 493 pp. 0422

The book presents a collection of fourteen papers or lectures from the August, 1961, International Heat Transfer Conference. The papers treat specific subjects in the forefront of heat transfer research. Of particular interest are D. B. Spalding's paper on "Heat Transfer from Chemically Reacting Gases" and W. M. Rohsenow's review on "Heat Transfer with Boiling".

Innes, W. B., CLASSIFICATION OF HETEROGENEOUS CATALYTIC VAPOR PHASE REACTIONS. pp. 1-103 in: Emmett, P. H., ed., "Catalysis, vol. II", New York, Reinhold, 1955. 0423

Vapor phase catalytic reactions including dehydrogenation and dehydrocyclization of hydrocarbons are discussed. Catalysts used for various reactions with literature references of the original work are tabulated.

International Air Transport Association, SYMPOSIUM ON SUPERSONIC AIR TRANSPORT. 14th Technical Conference, Montreal, April 17-21, 1961. Vol I, Report of Discussions, 215 pp and Vol II, Working Papers. 0424

The symposium proceedings consist of 54 working papers given in volume II and the discussions of these papers given in volume I. The papers deal with many subjects associated with the design and operation of supersonic air transports. Although the subject of fuels for the supersonic transport was but one of many subjects treated it was probably one of the most controversial items discussed during the Symposium. In this discussion, topics brought up included: acceptability of current fuels, possibilities of a single fuel, thermal stability, physical properties specifications, time/temperature history of the fuel, cooling and insulation, venting, inerting and pressurizing, heat sink requirements, fire hazard, system contamination, vaporization before burning, and fuel storage in aircraft.

Irving, J. P. and Smith, J. M. (Northwestern University), HEAT TRANSFER IN A CHEMICALLY REACTING SYSTEM (NITROGEN TETROXIDE-DIOXIDE). A. I. Ch. E. Journal, 7, no. 1, 91-6 (1961). 0425

The effect of chemical reaction on heat transfer was investigated analytically for the dissociating system $N_2O_4 \rightleftharpoons 2NO_2$ in turbulent pipe flow. The Reynolds, Colburn, and Deissler analogies were adapted to reacting systems to determine local values of h'/h, the ratio of the heat transfer coefficient for a reacting system to that for the same system under frozen nonreacting conditions. The coefficient h' was determined by using effective thermal conductivities and heat capacities composed of a frozen and a reacting contribution. The equations for the effective properties, derived in this paper from heat transfer considerations, are in agreement with those developed from thermodynamics and statistical mechanics. The effective properties vary significantly with temperature. Hence, Deissler's analogy, which was originally developed to consider the radial variation of physical properties across the pipe radius for an inert system, would be expected to give the most reliable results in this reacting system. In the range of variables studied it is found that the heat transfer coefficient for a reacting system may be as much as eighteen times that for a similar, frozen system. The results from the analogies using constant physical properties yield maximum values of h'/h of about 9.

Ismailov, R.G., Korneev, M.I., et al, HIGH TEMPERATURE REFORMING OF LIGROIN ... A FEEDSTOCK FOR COMMERCIAL CHEMISTRY. Izvestiya Vysshikh Uchebnykh Zavedenii, Neft i Gaz, 6, no. 7, 49-54 (1963). 0426

The reforming of straight-run ligroin at 9-11 atm inlet pressure in a pilot tube reactor gave the highest total yield (9.2%) of ethylene, propylene, and butylene at 625°C outlet temperature and 10 sec residence time. The same conditions were optimal for producing the maximum amount each of ethylene and propylene, and for the optimum yield (50%) 74.6 octane number gasoline. The butylene yield was optimum at 610°C, and the total gas yield was 13-27%, increasing with outlet temperature (605°-625°C), compared with 5-7% obtained by conventional thermocracking of a residuum-solar oil blend. The poor stability of the gasoline produced was improved by addition of 0.1% antioxidant (wood tar); blending it with straight run- or natural gasoline is recommended.

0427

Ivanov, K. I. and Vilyanskaya, E. D., EFFECT OF ANILINE ON VARIOUS AUTOXIDATION PHASES OF HYDROCARBONS. Trudy po Khimii i Khimicheskoi Tekhnologii, Nauchno-Issledovatel'skii Institut Khimii Gosudarstvennogo Universiteta im. N. I. Lobachevskogo, 4, 629-34 (1962). (CA, 58, 435g).

Aniline (or toluidine), 3% by weight, added prior to the oxidation of paraffin oil acts as an inhibitor; added to the oil already subjected to the oxidation, it acts as an accelerator. Apparently aniline forms a compound with the intermediate products of the oxidation phase (which are absent prior to the oxidation) and this compound acts similarly to the ROO radical. Its action is unaffected by the presence of p-hydroxydiphenylamine but it is destroyed by 4,4'-diaminodiphenyl disulfide. The oxidation of Vaseline oil, initiated by Me radicals, hydroperoxides, or peroxide radicals, is inhibited by the addition of aniline, but it is accelerated by it if the oxidation initiators are radicals obtained by the decomposition of cumene hydroperoxide 0.3% in the presence of Cu naphthenate 0.01% by weight.

0428

Ivanov, K. I. and Vilyanskaya, E. D., ON THE INTERACTION OF INHIBITORS OF THE AUTOOXIDATION OF HYDROCARBONS WITH ALKYL AND PEROXIDE RADICALS. Academy of Sciences (U. S. S. R.), Proceedings. Chemistry Section, 121, 509-12 (1958).

Three classes of oxidation inhibitors are discussed. Experimental results in white oil are presented for representative examples of these: p-hydroxydiphenylamine (Group I), 4,4'-diaminodiphenyldisulfide (Group II), and 2,6-di-tert-butyl-4-methylphenol (Ionol) (Group III). Groups I and III inhibitors are shown to be effective in tying up alkyl radicals, while Group II inhibitors are effective in destroying peroxy radicals and hydroperoxides. Inhibitor mechanisms are presented for all three groups. The effect of $\cdot CH_3$ and $\cdot RO_2$ radicals in accelerating oxidation rates is also shown.

0429

Jablonka, S., Mazonski, T., and Taniewski, M., PYROLYSIS OF n-HEPTANE, n-OCTANE, AND n-DODECANE IN A TUBULAR REACTOR. Przemysl Chemiczny, 41, 254-6 (1962) (C. A., 58, 11199a, 1963).

n-C_7H_{16} (I), n-C_8H_{18} (II), n-$C_{10}H_{22}$ (III), and n-$C_{12}H_{26}$ (IV) were pyrolyzed in a quartz tube 29.9 mm. in diam. at 750° and at a contact time of 1.3-17.2 sec. Reaction yields were recorded sep. for $CH_2:CH_2$ (V) and for all gaseous products (CH_4, C_2H_6, C_3H_8, C_4H_{10}, and V). The optimum contact time was 2.5-3.2 sec. In expts. using the 2.7-sec. contact time, the results were as follows (hydrocarbon, over-all yield, and V yield given): I, 58.7, 36.6; II, 59.8, 38.4; III, 56.9, 36.3; IV, 54.4, 34.8%.

Jack, John R., and Diaconis, N.S., HEAT-TRANSFER MEASUREMENTS ON TWO BODIES OF REVOLUTION AT A MACH NUMBER OF 3.12. U. S. National Advisory Committee for Aeronautics, TN 3776, October 1956. 0430

Local rates of heat transfer were obtained from a cone cylinder and a parabolic-nosed cylinder at a Mach number of 3.12. Data were obtained for Reynolds numbers up to $12x10^6$ based on body length for heated and cooled surfaces. The laminar-heat-transfer coefficients obtained from the conical portion of the cone cylinder agree closely with theory at all temperature levels when corrected for the axial temperature distribution. Experimentally and analytically, there seems to be no significant effect of temperature level on the heat-transfer coefficient. The laminar data obtained from the parabolic-cylinder model agree closely with theory when the axial pressure distribution is considered and the data are corrected for the axial temperature distribution.

Jackson, R.G. and Sharp, J.G., CARBON DEPOSITION IN FULL-SCALE AERO GAS TURBINE COMBUSTION CHAMBERS. Shell Thornton Research Centre, Report No. M.38/49, U.K. Ministry of Supply Contract No. 6/Gen/653 FC 14(b), September 1949. 17 pp. 0431

Carbon deposition experiments were performed on three different combustion chambers of the spray type. The work carried out included investigations into the effects on deposits of variations in running time, combustion chamber air pressure and fuel atomization, and comparative tests on a variety of fuels covering a wide range of features of practical interest.

Jacobs, J.M., HEAT TRANSFER AND FLUID FLOW. A BIBLIOGRAPHY OF SELECTED REPORT LITERATURE. U.S. Atomic Energy Commission, TID-3305 (Supplement 1), June 1958. 0432

A total of 2519 annotated references to the unclassified report literature is presented. Subjects covered under heat transfer and fluid flow include radioinduced heating; boiling; boiler, evaporators, pump, and heat exchanger design; hydrodynamics; coolants and their properties; thermal and flow instrumentation; high temperature materials; thermal properties of materials; and thermal insulation. Subjects covered less completely include thermodynamics; aerodynamics; high temperature corrosion; corrosion specific to heat transfer systems; erosion; mass transfer; corrosion film formation and effects; coolant processing and radioactivity; radiation effects of heat transfer materials; and pertinent data of thermonuclear processes. Subject, report number availability, and author indexes are given.

Jamison, R. R., ADVANCED AIR-BREATHING ENGINES. Royal Aeronautical Society. Journal, 66, no. 11, 683-9 (1962). 0433

This paper presents a brief survey of the capabilities and techniques of advanced air-breathing engines in which their principal fields of application are seen to be (1) military airborn missiles with a wide range of capabilities from short range defense to long range bombardment, altitudes to well over 100,000 ft and speeds reaching to possible half orbital velocity (Mach 10). (2) long range transport aircraft probably multistaged. (3) power units for space boosters. The author states it appears that air-breathing engines will thus have roles both in terrestrial transport, civil and military, and as space boosters. Many intense technical problems will present themselves. Nonetheless, the feasibility of hypersonic propulsion is being established and is yielding to research in the fields of chemical kinetics, heat transfer, structures and materials. The author discusses the various environmental constraints as a function of altitude and flight Mach number and the effect of these on aircraft and engine design, including the possibilities of using supersonic combustion in the hypersonic region.

Jamison, R. R., HYPERSONIC AIR BREATHING ENGINES. pp. 391-428 in: Collar, A. R. and Tinkler, J., eds, "Hypersonic Flow". New York, Academic, 1960. 0434

Overall consideration is given to the problems of hypersonic aircraft, with emphasis on requirements for passenger-carrying craft at about Mach 7. Ramjet engines, with and without supersonic combustion and with either internal or external burning are discussed. Fuel is mentioned primarily from the point of view of combustion performance.

Jamison, R. R. and Lane R. J. (Bristol Siddeley Engines Ltd.), ENGINES FOR SUPERSONIC AIR LINERS. Royal Aeronautical Society. Journal, 64, no. 597, 507-34, (1960). 0435

This paper presents a survey of some of the results of studies which have been made into the power plant requirements for long range, high speed transport aircraft. This whole subject is made most complex by the interplay of many technical, economic and operational factors and to sharpen the focus of such an enquiry it pays to concentrate on a specific objective. This objective has been taken to be a commercial transport aircraft suitable for the Atlantic stage.

Jeffs, G. W., **FUEL VAPORIZATION IN LONG-RANGE RAM-JET MISSILES.** North American Aviation Inc., Aerophysics Laboratory, AL-1005, March 1950. 12 pp. (ATI 77364).

0436

The fuel vaporization problem in long-range ram-jet missiles was investigated. The general differential equation of heat transfer from the boundary layer to the fuel was set up, and simplifications were incorporated that permit its solution. The time of flight at which the fuel reaches its boiling point and then the amount of fuel vaporized can be predicted for any particular case. The study includes the effects of insulation, sloshing, fuel pressurization, internal geometry, and flight path on fuel vaporization. It is concluded that the fuel vaporization increases rapidly for higher velocity cruising up to a moderately high supersonic Mach number, even though cruising altitudes are generally higher and flight times shorter. Beyond this Mach number to a high supersonic Mach number, the curve of fuel vaporized vs Mach number is very flat. Kerosene shows lower vaporization than AN-F-58.

Jenkins, G. I. and Scruton, M. R., **IDENTIFICATION AND ESTIMATION OF WATER SOLUBLE ANTI-ICING ADDITIVES IN HYDROCARBON FUELS BY INFRA-RED SPECTROMETRY.** Institute of Petroleum. Journal, 49, no. 474, 176-9 (1963).

0437

The method studied consists of extracting the water-soluble additive from 100 ml of fuel with 1 ml of water. Infra-red analysis of the aqueous extract gives identification and quantity estimate of the additive. Analysis of a single sample takes about 30 minutes, but requires also calibration curves which depend on fuel, additive, and temperature of extraction. Isopropanol and hexylene glycol in gasoline and cellosolve in kerosine were used in the method development. The method is suitable for use with alcohols up to a 1% additive level, although it is primarily intended for additives used at 0.1% level.

Jiji, L. M. and Clark, J. A., **BUBBLE BOUNDARY LAYER AND TEMPERATURE PROFILES FOR FORCED CONVECTION BOILING IN CHANNEL FLOW.** American Society of Mechanical Engineers. Transactions. Series C. Journal of Heat Transfer, 86, 50-8 (1964).

0438

The inception of bubbles for forced convection flow over a heated plate in a pressurized channel and their consequent mutual interaction to form a "bubble boundary layer" was investigated. Photographs and temperature profile measurements were obtained for forced convection boiling of water at pressures of 200 to 1000 psia, velocities of 1 to 6 ft/sec, subcooling of 50-300°F. Experimental data on the bubble boundary-layer thickness were correlated to within ±20 percent by a single equation covering the range of variables investigated.

Johannesen, N.H., FURTHER RESULTS ON THE MIXING OF FREE AXIALLY-SYMMETRICAL JETS OF MACH NUMBER 1.40. Great Britain, Aeronautical Research Council, ARC R/M-3292, 1962. 28 pp. 0439

An axially-symmetrical supersonic fully-expanded jet of diameter 0.75 in. was investigated by pitot- and static-tube traverses in the region from the exit to 100 diameters downstream. The investigation is supplementary to that reported by Johannesen. In the jet discussed in this report the initial internal disturbances were weak, as compared with those in the jet investigated previously. The structures of the mixing regions in the initial parts of the two jets showed substantial differences. Further downstream the jet with weak internal disturbances showed a very slow approach to self-preserving flow. This was clear from the curves of the jet width and of the reciprocal of the centreline velocity plotted against distance from the exit approaching straight lines only slowly, but was particularly clearly indicated by the static-pressure distributions. The ratio of static pressure to dynamic pressure showed no tendency to become constant on the axis, even at the last station of measurement. It is shown that if the classical corrections to the readings of pitot and static tubes are adequate, the errors in the deduced structure of the jets ignoring these corrections may be very considerable.

Johannesen, N.H., THE MIXING OF FREE AXIALLY-SYMMETRICAL JETS OF MACH NUMBER 1.40. Britain, Aeronautical Research Council, ARC R/M-3291, 1962. 33 pp. 0440

Axially-symmetrical, supersonic, fully-expanded jets of diameter about 0.75 in. and of Mach number 1.40 issuing into an atmosphere at rest were investigated by schlieren and shadow photography and by pressure traversing. The development of the jets was found to depend critically on the strength of the shock waves in the core of the jet at the nozzle exit. With strong shock waves present the jet spread very rapidly and was very unsteady. The jet did in some cases break up into large eddies of the same size as the diameter of the jet. When no disturbances were present in the core of the jet the spreading was far more gradual and the jet showed only slight unsteadiness. The turbulent mixing region of the first part of the jet with strong shock waves was investigated in detail by pitot tubes. The first inch was found to correspond to a two-dimensional half-jet. The velocity profiles were similar and well represented by the error integral. The rate of spreading was only half the value for low-speed flow. By integrations across the mixing region the entrainment and the loss of kinetic energy were determined. These quantities were found to agree well with the values estimated by assuming an error-integral velocity profile.

John, R. R. and Summerfield, M. (Princeton University), EFFECT OF TURBULENCE ON RADIATION INTENSITY FROM PROPANE-AIR FLAMES. Jet Propulsion, 27, 169-75, 178-9 (1957). 0441

The effect of turbulence on flame radiation intensity was measured, and considered relative to the interaction of the fuel/air mixing process and chemical reaction. Turbulence reduced the radiation intensities of CO (4500 Å), C_2 (5150 Å) and CH (4300 Å), as observed with a standardized photomultiplier and suitable filters. CO was most affected.

Johns, I. B., McElhill, E. A. and Smith, J. O. (Monsanto Research), THERMAL STABILITY OF SOME ORGANIC COMPOUNDS. Journal of Chemical and Engineering Data, 7, No. 2, 277-81 (1962). 0442

An extensive study of the thermal stability of various types of organic compounds has been made, to determine those types that should be most useful for the sythesis of stable fluids. The data obtained are presented here, together with some correlations between thermal stability and chemical structure.

The methods are designated by V. G. H. and D. The first or vapor phase method gives the temperatures at which decomposition can be detected by evolution of gas. The other three methods employ the sample in the liquid or solid state. For them, the decomposition point is that temperature at which the compound decomposes at the rate of 1 mole % per hour.

Johnson, C. J., HOT FUEL FOR A HOT AIRCRAFT. Materials Research and Standards, 3, no. 4, 300-1 (1963). 0443

A brief description of the problems associated with the fuel requirements of the commercial SST is given. Specifications for JP-4, JP-6, and an "advanced hydrocarbon refinery cut" with a projected cost of 21¢/gallon are summarized.

Johnson, C. J., SUPERSONIC TRANSPORT FUELS AND LUBRICANTS. U. S. Air Force, ASD TDR 62-761, October 1962. 14 pp. (AD 290 571). 0444

The Air Force has the responsibility for research and development of potential fuels and lubricants for Supersonic Transport. Thermal stability requirements of fuels are the most difficult to meet because of the severe operational limitations they impose on the fuel system. This report is a discussion of the potential problems and their elimination. Contractual and in-house effort by the Air Force in studying the causes of thermal instability of fuels is discussed. The responsibility of the Coordinating Research Council, Inc., in conducting large scale Mach 3 simulator tests under Air Force contract is included. The programs discussed will evaluate potential fuels and lubricants with varying capabilities and varying costs. This will allow the aircraft and engine designers a degree of latitude in their design and the selection of the optimum fuels hardware combination.

Johnson, C. R., Fink, D. F., and Nixon, A. C. (Shell Oil), STABILITY OF AIRCRAFT TURBINE FUELS. Industrial and Engineering Chemistry, 46, no. 10, 2166-73 (1954). 0445

This review paper deals with various aspects of fuel stability for existing and projected jet aircraft requirements. Storage stability, filterability, and high temperature stability are discussed.

Johnson, C. R. and Little, W. S., EVALUATION OF FUELS FOR COMMERCIAL TURBINE POWERED AIRCRAFT. Shell Oil Company, Aviation Department and Products Application Department, P.A.D. Report No. S-64, October 1, 1953. 9 pp. 0446

The report discusses the fuel variables and those design, operating and maintenance factors which are directly influenced by fuel characteristics.

Johnson, H. A. (University of California), HEAT TRANSFER AND PRESSURE DROP FOR VISCOUS-TURBULENT FLOW OF OIL-AIR MIXTURES IN A HORIZONTAL PIPE. American Society of Mechanical Engineers. Transactions, 77, 1257-64 (1955). 0447

Heat transfer and static pressure drop for two-phase, two-component flow of oil and air were measured for flow in a steam-heated horizontal 15-ft length of 3/4-inch extra heavy copper pipe. Tentative correlations are presented and used in a comparison of oil-air and water-air results for heat transfer and nonisothermal pressure drop in the same test system.

Johnson, J. H., FULL SCALE ENGINE TESTS OF SPECIAL FUEL F 54-19. U. S. Air Force, WADC TN 56-330, November 1955. 5+ pp. (AD 97153). 0448

The use of F54-19, a high-density fuel, in a J-65 engine resulted in heavy carbon deposits in the combustion chamber and severely damaged primary air and fuel tubes over a ten hour test period. The J-47 combustion section contained a very small amount of carbon deposits after a ten hour test period. Fewer gallons of F54-19 were required for the same amount of thrust than of JP-4 in the J47-GE-25 and J65-B-3 engines. In as much as single can prevaporazing burner tests and full scale prevaporizing engine tests have shown that fuels of type F54-19 cause heavy carbon deposits and tube damage, it is recommended that no further consideration be given to the adoption of this type fuel as a standard for the present engines of the Air Force.

Johnston, R. K., Anderson, E. L. (Southwest Research), REVIEW OF LITERATURE ON STORAGE AND THERMAL STABILITY OF JET FUELS. U. S. Air Force, RTD-TDR 63-4270, Contract AF 33 (657)-11246, January 1964. 30 pp. 0449

A selective review has been made of the technical literature on storage and thermal stability of jet fuels, in order to provide background for a current experimental program on the effect of additives on JP-6 fuel deterioration. The literature review and also the experimental program are directed primarily toward information on deterioration of thermal stability during normal storage. The subjects reviewed include thermal stability test methods, storage stability and deterioration of thermal stability, additives for improvement of thermal and storage stability of jet fuels, and special storage problems.

Johnston, R. K. and Cuellar, J. P., Jr. (Southwest Research Institute), EFFECT OF JET FUEL ADDITIVES ON FILTERABILITY AND WATER SEPARATION CHARACTERISTICS. U.S. Air Force, ASD TR 61-345, Contract AF 33(600)-39425, June 1961. 67 pp. (AD 264607). 0450

The effect of corrosion inhibitors on filtration and water separation characteristics of JP-4 fuel was studied in a single-element filter-separator test facility, using five types of commercial elements and housings designed to simulate full-scale flow conditions. Standard coarse A/C dust and water were the major contaminants studied, with some work on iron oxides. Adverse effects of the corrosion inhibitors varied widely, and the element types differed in efficiency and modes of failure. The CRC water separometer, a bench-scale apparatus, gave a general correlation with the single-element results. Interaction of additives with fuel constituents caused difficulty in early work, but otherwise the separometer repeatability was satisfactory. Several fuels in addition to the JP-4 were used in the separometer tests in an effort to find a suitable reference fluid.

Johnston, R.K. and Shamblin, J.E., HIGH TEMPERATURE FUELS RESEARCH AND TEST METHOD DEVELOPMENT. Southwest Research Institute, Report No. RS-309 (Supplementary Report to WADC TR 59-716 (I)), U.S. Air Force Contract AF 33(616)-5702, February 1960. 56 pp. 0451

The development of thermal stability evaluation methods and their application to high-temperature hydrocarbon fuels has been continued. Further use was made of the CRC research fuel coker in rating fuels at various conditions of temperature and time. The critical effect of bulk fuel heating on subsequent thermal stability has been confirmed for a number of fuels. A brief study of methods for rating filter plugging indicated significant advantages for an "induction period" rating. It was shown that gas evolution in the research coker is caused by fuel cracking, probably by an oxidation mechanism. Studies were continued on the use of electron microscopy for rating the extent of fuel deterioration, and semiquantitative methods have been devised for comparison of fuels. The method in its present form is useful in cataloging new fuels using only minute sample quantities.

Johnston, R. K. and Shamblin, J. E. (Southwest Research Institute), JET FUEL THERMAL STABILITY STUDIES BY ELECTRON MICROSCOPY. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, C81-91 (September 1960). 0452

Small-scale techniques are needed to study thermal stability of hydrocarbon fuels of limited availability. Using 3-ml fuel samples, techniques were developed for preparing specimens and rating by electron microscopy, comparing size, type, and quantity of insoluble partices. Data are presented showing that the ratings are in general agreement with conventional fuel coker ratings and that the hydrocarbons evaluated were more stable than the petroleum-based fuels. The technique is also well suited for studying effects of variables and of fuel additives, giving direct information on the formation of insolubles that is not available from other small-scale test.

Johnston, R. K., and Shamblin, J. E. (Southwest Research Institute). JET FUEL THERMAL STABILITY STUDIES BY ELECTRON MICROSCOPY. Institute of Petroleum. Journal, 47, no. 451, 241-50 (1961). 0453

A technique has been developed for rating fuel thermal stability by electron microscope examination of the particles formed in fuel samples after heating. The present technique permits the use of 3-ml samples. Thus, experimental materials which are available only in research quantities may be examined for possible utility as high-temperature fuels. Semi-quantitative methods have been developed for rating particle shape, size, and frequency. Results for a given material are expressed in terms of a "break-point" temperature, which has been shown to correlate with break-points determined in a larger flow-type apparatus, the CRC research fuel coker. Data are presented for various HTF and JP-4 type fuels. This work was sponsored by the U.S. Air Force under Contract AF 33(616)-5702.

Johnston, R.K., Shamblin, J.E., Weatherford, W.D., Jr., Schneider, K.H. and Cueller, J.P., Jr., (Southwest Research Institute), HIGH-TEMPERATURE FUELS RESEARCH AND TEST METHOD DEVELOPMENT, VOL. I - THERMAL STABILITY, COMBUSTION AND LOW-TEMPERATURE STUDIES. U.S. Air Force, WADC TR 59-716(I), Contract AF 33(616)-5702, October 1959. 250 pp. 0454

Hydrocarbon fuels of current interest for high-performance aircraft have been used as the basis for the development of test methods for thermal stability, combustion characteristics, and low-temperature properties. The program on thermal stability included investigation of a high-temperature research fuel coker, which is basically an extension of the current CFR fuel coker to a higher temperature range. A smaller-scale flow apparatus known as the hot-tube fuel coker has been designed and built, and has been used to rate fuels on a different basis from that of the CRC fuel coker. A 200-ml bomb test has been developed as a useful screening test for fuel thermal stability. In addition, a 3-ml bomb test has been developed for research purposes, using the electron microscope to detect fuel deterioration. The combustion studies, using a modified Phillips microburner, included development of suitable procedures for rating deposition characteristics.

Johnston, R.K. and Wisdom, W.P. (Southwest Research Institute), HIGH TEMPERATURE FUELS RESEARCH AND TEST METHOD DEVELOPMENT, VOL. II- INSPECTION TESTS. U.S. Air Force, WADC TR 59-716(II), Contract AF 33(616)-5702, October 1959. 65 pp. 0455

Standardized tests used on current aircraft fuels have been examined critically in their application to a group of high-temperature hydrocarbon fuels of current interest. Several deficiencies are pointed out, particularly in the tests for low-temperature behavior and water-separating characteristics. Other tests needing modification or further study are those for distillation, aromatics and olefins, and gum content.

Jonas, J. (Northrop Aircraft), EFFECT OF AERODYNAMIC HEATING ON FUEL SYSTEMS. SAE Transactions 61, 320-8 (1953). 0456

The increasing importance of aerodynamic heating at elevated Mach number in relation to aircraft system design is illustrated in this paper, which is a study of the effects of aerodynamic heating on aircraft fuel systems. The fundamental physical behavior of fuel at elevated temperatures and relative effects on fuel system components are discussed. Differentiation is made between steady-state and transient aerodynamic heating of the fuel. A broad correlation is established between airplane performance and transient heating, and the general severity of the problem is established as a function of Mach number and fuel system parameters.

Jonash, E.R, Wear, J.D., and Cook, W.P., EFFECT OF FUEL VARIABLES ON CARBON FORMATION IN TURBOJET-ENGINE COMBUSTORS. U. S. National Advisory Committee for Aeronautics, Report 1352, October 1957. 0457

An investigation of the effects of fuel properties and fuel additives on carbon deposition of JP-3 and JP-4 type fuels in turbojet-engine combustors gave the following results: 1) At operating conditions simulating an engine with compressor pressure ratio of 4 at 20,000 ft. altitude and zero flight speed, carbon deposits and exhaust gas density correlated with SVI, smoke point and NACA K factor, but more closely with the latter two. 2) Single combustor data at the preceding condition also correlate reasonably well with limited full-scale engine deposit data, 3) A number of fuel additives, including organo-metallics, commercial additives, and oxygenated compounds significantly reduced carbon deposits, 4) Limited tests showed marked variations of effectiveness of additives with properties of the base fuel.

Jones, G. W., Zabetakis, M. G., Richmond, J. K., Scott, G. S., and Furno, A. L. (U.S. Bureau of Mines), RESEARCH ON THE FLAMMABILITY CHARACTERISTICS OF AIRCRAFT FUELS. U.S. Air Force, WADC TR 52-35, Contract AF 33(038)-50-1293E, June 1952. 92 pp. (AD 5805). 0458

The results of limit of flammability, limit of ignitibility, and ignition temperature tests conducted on aircraft fuel vapor-air mixtures are presented. Two aviation gasolines grades 100/130 and 115/145, and two jet fuels grades JP-1 and JP-3, were investigated. A limited amount of work was done on the ignitibility of JP-1 mists and sprays, and on the ignition temperatures of aircraft hydraulic fluid AN-0-366. In addition, sections are included on definitions and theory, and apparatus used for the investigation is described. The bibliography contains numerous references on flammability limits, and combustion of sprays and mists.

Jones, G. W., Zabetakis, M. G., Scott, G. S., and Furno, A. L. (U.S. Bureau of Mines), RESEARCH ON FLAMMABILITY CHARACTERISTICS OF AIRCRAFT FUELS. U.S. Air Force, WADC TR 52-35, suppl. 1, Contract AF 18(600)-151, January 1954. 57 pp. (AD 27722). 0459

Results are presented on limit of ignitibility, limit of flammability, and ignition temperature tests on aircraft fuel vapor-air mixtures, with various quantities of added N and CO_2. Two aviation gasolines (grades 100/130 and 115/145) and 3 jet fuels (grades JP-1, JP-3, and JP-4) were used. The minimum energy required for ignition of various paraffin hydrocarbon-air mixtures was very nearly constant at the same temperature and pressure. The composition corresponding to the minimum ignition energy shifted toward the combustible-rich side as the C to H ratio increased. The spark energy necessary to ignite a flammable mixture was a function of mixture composition, temperature, pressure, and spark duration. The minimum spontaneous ignition temperature of a combustible in air at atmospheric pressure depended on the time of contact between the mixture and the heated body. The region of self-propagation of flame in a spray at atmospheric temperature and pressure depended on the fuel droplet size distribution and spray stream velocity. The minimum quantity of O required for flame propagation through a quiescent vapor-air-inert gas mixture depended on temperature, pressure, inert gas, and on the combustible for paraffin hydrocarbon members below propane.

Jones, G. W., Zabetakis, M. G., Scott, G. S., and Furno, A. L. (U.S. Bureau of Mines), RESEARCH ON THE FLAMMABILITY CHARACTERISTICS OF AIRCRAFT FUELS. U.S. Air Force, WADC TR 52-35, suppl. 2, Contract AF 18(600)-151, August 1954. 36 pp. (AD 47525). 0460

The minimum spontaneous ignition temperatures of individual paraffin hydrocarbons and mixtures of these increase with altitude under static conditions; at a fixed altitude, the spontaneous ignition temperatures of these fuels increase with increasing flow rate past a hot object. The quantity of inert gas mixture needed to prevent flame propagation for a given combustible vapor-air composition varies linearly with the inert gas composition. At low pressure, the optimum spark ignition electrode gap width is a function of mixture composition, velocity, temperature, pressure and apparatus. Ignition of a combustible mixture at low pressures may be achieved more easily with a hot-body ignitor. The lower concentration limits of flammability of the paraffin hydrocarbons above butane are nearly constant at atmospheric and reduced pressure when expressed in terms of the fuel-air ratio (weight basis). The upper limits increase with increasing molecular weight. Raoult's law and currently available limit-of-flammability data may be used to calculate the lower limits of flammability of mixtures of paraffin hydrocarbons in air at atmospheric and reduced pressures.

Jones, G. W., Zabetakis, M. G., Scott, G. S., and Furno, A. L. (U.S. Bureau of Mines), RESEARCH ON THE FLAMMABILITY CHARACTERISTICS OF AIRCRAFT FUELS. U.S. Air Force, WADC TR 52-35, suppl. 3, Contract AF 18(600)-151, February 1955. 21 pp. (AD 63284). 0461

The results of limits of flammability, limit of propagation and ignition temperature tests on aircraft fuel components in air are presented. One aircraft oil and a number of pure paraffin and aromatic hydrocarbons were used in the investigations. The minimum spontaneous ignition temperatures and critical compression ratios of the aromatics may be correlated with molecular structure using a parameter that depends on the total number of carbons and their positions in the molecule. Spark ignition of both static and flowing combustible gas mixtures at low pressures occurs in two concentration regions separated by a region in which the flames are extinguished because of rapid oscillatory motion. Conditions are then changed sufficiently in the resultant mixture to produce uniform flame propagation upon passage of a spark one to 15 minutes later. The minimum pressure at which a particular combustible gas mixture will propagate flame decreases as the confining explosion chamber diameter increases. However, due apparently to convection currents, a reversal occurs for combustible-lean mixtures thus causing the minimum pressure at which a flame propagates to be lower for a 4-inch tube than for a 6-inch tube.

Just, T. and Wagner, H. G. (Göttingen), MESSUNG DER INDUKTIONS - UND REAKTIONSZEITEN VON KNALLGAS UND KOHLENWASSER STOFF - SAUERSTOFF - GEMISCHEN IN DETONATIONSVORGÄNGEN UND STOSSWELLEN. Forschung auf dem Gebeite des Ingenieurwesen, 27, no. 2, 46-51 (1961). 0462

In various detonation tubes research on H_2/O_2, hydrocarbon/O_2 mixtures, and in a shock tube research on hydrocarbon/air mixtures was carried out. In the detonation tube, in addition to the velocities of detonations, induction times reaction times and length of the reaction zone were determined. In the shock tube induction times were measured. The article describes apparatus and reports some experimental measurements.

Kaechele, W. H. (Reaction Motors Division, Thiokol), **INVESTIGATION OF SPECIAL RELATIONSHIPS IN THE HEAT TRANSFER PROPERTIES OF ANHYDROUS AMMONIA FLOWING IN STAINLESS STEEL TUBES.** U.S. Air Force, Report RMD-124-S1-A, Contract AF 33(600)-32248, n.d., 15 pp. (AD 219300). 0463

Ammonia-time Dependence: Tests, to see if the limiting flux for heat transfer fell substantially in periods under one hour, failed to reveal the strikingly evident decreases which had been observed when hydrogen peroxide was tested in this apparatus. Water tests: These tests were made to obtain a limited amount of data on water, and no peculiarities of the apparatus were observed. Twirler tests: This phase was undertaken to determine whether twirler inserts offered a practical means for operating rocket chambers at substantially greater heat flux values than are possible with conventional designs. It is known that tangential-entry designs produce a striking benefit, but twisted metal ribbons were found to offer little advantage for designs which are pressure-drop limited. Ultrasonic investigation: These tests were made to see if the increased values of limiting flux obtained by ultrasonic radiation in pot boiling could be obtained in forced flow systems. The tests were limited by inherent signal-noise generation to the detection of large increases in heat flux and/or large decreases in wall temperatures. Within this capability, the data showed no substantial benefit from ultrasonic energy.

Kambarov, Yu. G., and Mekhtiev, S. D., **HIGH-SPEED PYROLYSIS OF A GASOLINE FRACTION ON SEMICOMMERCIAL SCALE.** Khimicheskaya Promyshlennost, 1963, no. 5, 26-8. 0464

At 840°C and 0.041 sec contact time, low octane gasoline containing 5.3% aromatics and 0.02% sulfur yielded 76.8% gas, including 34.2% by volume of ethylene and a total of 46.2% unsaturated hydrocarbons. The liquid products contained 20-25% aromatic hydrocarbons. Only about 0.12% carbon, calculated on the feed material, was formed. Because of high linear gas velocities, most of the carbon was entrained from the reactor and collected in the trap. It may be expected that at 0.03-0.09 sec contact time and an average gas velocity of 11-33 m/sec practically all of the carbon will be entrained from the reactor in the form of finely divided particles. The experiments were conducted in an electrically-heated stainless steel reactor of 20 cm diameter and 100 cm height. A total of 22 runs were made at various steam injection and feed rates.

Kamenetskaya, S. A., Pshezhetskii, S. Ya., and Slavinskaya, N. A., **THE EFFECTS OF OZONE ON HYDROCARBON IGNITION. III. AUTOIGNITION OF CYCLOHEXANE WITH OXYGEN.** Zhurnal Fizicheskoy Khimii, 33, 271-5 (1959). (CA, 53, 11959e). 0465

The critical conditions for ignition of cyclohexane with O_2 alone or mixed with 4.4-13.2% O_3 were studied. O_3 lowered the autoignition temperature and pressure near the lower ignition limit and eliminated the autoignition induction period, in agreement with the Semenov heat ignition theory. O_3 reduced the activation energy from 43 kcal. to 9.2 kcal. for mixtures containing 13.3% O_3.

Kamiya, Y. and Ingold, K.U. (National Research Council of Canada), THE METAL-CATALYZED AUTOXIDATION OF TETRALIN. III. CATALYSIS BY MAGANESE, COPPER, NICKEL, AND IRON. Canadian Journal of Chemistry, 42, 1027-43, (1964). 0466

The catalysis of the autoxidation of tetralin by the decanoates of maganese, copper, nickel, and iron has been examined over a large concentration range at 50 C. With all four metals the oxidation rate approaches a limit at high catalyst concentrations but in each case this limit is smaller than the theoretical maximum rate of oxidation of pure tetralin. However, upon dilution with an inert solvent, such as chlorobenzene, or with the metal acetates, acetic acid, the theoretical maximum rate is attained. The low limiting rates in pure tetralin are apparently due to the low solubilities of the catalysts and are not due to chain termination by the catalysts.

Karpov, V. P. and Sokolik, A. S., RELATION BETWEEN SPONTANEOUS IGNITION AND LAMINAR AND TURBULENT BURNING VELOCITIES OF PARAFFIN HYDROCARBONS. Academy of Sciences (U.S.S.R.). Proceedings, Physical Chemistry Section, 138, 457-9 (1961). 0467

The authors compare the change of the laminar and turbulent burning rate of a mixture of methane, propane, or butane with air, with the delay of self-ignition as a function of mixture composition. For this purpose, they use a bomb of constant volume. In the case of methane, the delay decreases at 700-750°C in mixtures poor in methane, in the case of propane and butane, however, in mixtures rich in alkane. The authors state that for mixtures rich in alkane the rate of turbulent burning is much lower in methane than in propane and butane, although the burning temperature of methane is higher than that of the higher alkanes. For these reasons, it is assumed that there are certain kinetic differences between methane and the higher alkanes which effect the above discrepancies. These kinetic differences are neither related to the stage of chain generation nor to the stage of chain branching. Therefore. it is assumed that the differing characteristics of self-ignition of methane and C_3- and C_4 alkanes as a function of mixture composition are due to differences between these two alkane types in the stage of chain propagation.

Kazanskii, B. A., Dorogochinskiy, A. Z., Rozengart, M. I., Lyuter, A. V., and Mitrofanov, M. G., THE EFFECT OF SPACE VELOCITY ON THE PROCESS OF AROMATIZATION OF n-HEXANE OVER AN ALUMINA-CHROMIA CATALYST. Kinetics and Catalysis (U.S.S.R.), 2, 241-5 (1961). 0468

The aromatization of n-hexane over potassium-promoted chromia on alumina catalyst was studied at 510-550° and at different space velocities. The effects of experimental conditions on the yields of benzene, unsaturated hydrocarbons, and coke, and on catalyst productivity were determined. The reason for the different character of the relation between unsaturated hydrocarbon yield and contact time at different temperatures is discussed.

Kamiya, Y. and Ingold, K.U. (National Research Council of Canada), **THE METAL-CATALYZED AUTOXIDATION OF TETRALIN. III. CATALYSIS BY MAGANESE, COPPER, NICKEL, AND IRON.** Canadian Journal of Chemistry, 42, 1027-43, (1964). 0466

The catalysis of the autoxidation of tetralin by the decanoates of maganese, copper, nickel, and iron has been examined over a large concentration range at 50 C. With all four metals the oxidation rate approaches a limit at high catalyst concentrations but in each case this limit is smaller than the theoretical maximum rate of oxidation of pure tetralin. However, upon dilution with an inert solvent, such as chlorobenzene, or with the metal acetates, acetic acid, the theoretical maximum rate is attained. The low limiting rates in pure tetralin are apparently due to the low solubilities of the catalysts and are not due to chain termination by the catalysts.

Karpov, V. P. and Sokolik, A. S., **RELATION BETWEEN SPONTANEOUS IGNITION AND LAMINAR AND TURBULENT BURNING VELOCITIES OF PARAFFIN HYDROCARBONS.** Academy of Sciences (U.S.S.R.). Proceedings, Physical Chemistry Section, 138, 457-9 (1961). 0467

The authors compare the change of the laminar and turbulent burning rate of a mixture of methane, propane, or butane with air, with the delay of self-ignition as a function of mixture composition. For this purpose, they use a bomb of constant volume. In the case of methane, the delay decreases at 700-750°C in mixtures poor in methane, in the case of propane and butane, however, in mixtures rich in alkane. The authors state that for mixtures rich in alkane the rate of turbulent burning is much lower in methane than in propane and butane, although the burning temperature of methane is higher than that of the higher alkanes. For these reasons, it is assumed that there are certain kinetic differences between methane and the higher alkanes which effect the above discrepancies. These kinetic differences are neither related to the stage of chain generation nor to the stage of chain branching. Therefore. it is assumed that the differing characteristics of self-ignition of methane and C_3- and C_4 alkanes as a function of mixture composition are due to differences between these two alkane types in the stage of chain propagation.

Kazanskii, B. A., Dorogochinskiy, A. Z., Rozengart, M. I., Lyuter, A. V., and Mitrofanov. M. G., **THE EFFECT OF SPACE VELOCITY ON THE PROCESS OF AROMATIZATION OF n-HEXANE OVER AN ALUMINA-CHROMIA CATALYST.** Kinetics and Catalysis (U.S.S.R.), 2, 241-5 (1961). 0468

The aromatization of n-hexane over potassium-promoted chromia on alumina catalyst was studied at 510-550° and at different space velocities. The effects of experimental conditions on the yields of benzene, unsaturated hydrocarbons, and coke, and on catalyst productivity were determined. The reason for the different character of the relation between unsaturated hydrocarbon yield and contact time at different temperatures is discussed.

Kazanskii, B. A., Dorogochinskiy, A. Z., Rozengart, M. I., Tyunkina, N. I., Kuznetsova, I. M., Lyuter, A. V., and Mitrofanov, M. G., THE AROMATIZATION OF MIXTURES OF N-HEXANE WITH 2-METHYLPENTANE, WITH 3-METHYLPENTANE OR WITH METHYLCYCLOPENTANE. Academy of Sciences (U.S.S.R.). Bulletin. Division of Chemical Sciences, 1962, 1228-9. 0469

When mixtures of n-hexane with 2-methylpentane, 3-methylpentane and methylcyclopentane were passed over chromia on alumina catalyst at 550°C, four to five times the yield of benzene was obtained with the methylpentanes compared to methylcyclopentane.

Kazanskii, B. A. and Liberman, A. L., CATALYTIC DEHYDROGENATION OF PARAFFINIC HYDROCARBONS. World Petroleum Congress (Fifth). Proceedings, (IV), 29-36 (1959). 0470

Paraffins were converted to hydrocarbons containing a five-membered ring over a platinized charcoal catalyst at 310°C. Branched-chain hydrocarbons were converted more readily than straight chain isomers. Alkyl benzenes were further cyclized to indane and methylindanes.

Kazanskii, B. A., Rozengart, M. I., and Freiberg, L. A., EFFECT OF ADDED POTASH AND PHOSPHORIC ACID ON THE AROMATIZING ACTIVITY OF CHROMIUM OXIDE. Academy of Sciences, (U.S.S.R.). Proceedings. Chemistry Section, 134, 1183-5 (1960). 0471

Additions of potassium or phosphoric acid to a pure chromium oxide catalyst suppressed the dehydrocyclization of n-heptane to toluene but did not affect the rate of dehydrocyclization of n-heptene to toluene (450° and 535°C; space velocity = 0.8 hr^{-1}; 0.25%w K_2O, 0.14%w H_3PO_4).

Kazanskii, B. A., Rozengart, M. I. and Kuznetsova, Z. F., THE EFFECT OF THE ADDITION OF ALKALI ELEMENTS ON THE CATALYTIC PROPERTIES OF CHROMIA-ALUMINA CATALYSTS. Academy of Sciences (U. S. S. R.). Proceedings. Chemistry Section, 126, 405-8 (1959). 0472

The effect of the addition of lithium, sodium, potassium, rubidium, and cesium on the activity of chromia-alumina catalysts with respect to the dehydrocyclization of n-heptane and the dehydrogenation of cyclohexane was studied at 520°C. The addition of lithium had practically no effect on the yield of aromatics from heptane. The introduction of sodium increased the yield of aromatics by 8%. The promoting effect of the alkali elements was increased further with potassium and reached a maximum with rubidium.

Kazanskii, B. A., Rozengart, M. I., and Kuznetsova, Z. F., THE EFFECT OF THE ADDITION OF ELEMENTS OF THE SECOND GROUP OF THE PERIODIC SYSTEM ON THE ACTIVITY OF CHROMIA-ALUMINA AROMATIZATION CATALYSTS. Academy of Sciences (U. S. S. R.). Proceedings, Chemistry Section, 127, 669-71 (1959). 0473

The elements of the second group of the periodic system were found to have a promoting effect on the aromatization of cyclohexane. This effect increased with an increase in atomic weight from beryllium to barium; the yield of benzene in the presence of the catalyst containing barium was about 88% calculated on the original cyclohexane (95% of that theoretically possible), which exceeds by approximately 18% the yield of benzene in the presence of the unpromoted catalyst. The promoting effect of the elements of the second group on the dehydrocyclization of n-heptane was less than on the aromatization of cyclohexane, and was observed only for the alkaline earth elements. The addition of beryllium, magnesium, and zinc had practically no effect on the activity of the catalyst, and the addition of cadmium even decreased it somewhat. Mercury was not tested.

Kearby, K. K., CATALYTIC DEHYDROGENATION. pp. 453-91 in: Emmett, P. H., ed., "Catalysis, vol. III", New York, Reinhold, 1955. 0474

The dehydrogenation of paraffins (C_3, C_4), olefins (C_4) and alkyl aromatics (ethyl benzenes) over various catalysts is discussed. Known active catalysts with references to the original work are given. Effect of additives on performance of metal oxide catalysts is shown. Equilibrium curves of conversion as a function of temperature are given. 127 references are cited.

Keenan, J. G. (Rolls-Royce), SOME PROBLEMS ASSOCIATED WITH HIGH MACH NUMBER AIR BREATHING POWERPLANTS. Interavia, 18, 345-47 (1963). 0475

The article discusses probable military and civilian requirements for high speed aircraft during the 1960's and 1970's, and some of the problems anticipated in meeting these requirements. Civilian requirements will be limited to Mach 3 during this period while military aircraft capable of Mach 4 or higher dash, coupled with good transonic flexibility will be developed. The need for a military bomber or reconnaissance aircraft capable of sustained speeds of Mach 4 or higher is not so certain. Because of the transonic requirements, engine development will be restricted to afterburning (augmented) turbojets even up to Mach 4.5.

Kennerly, G. W. and Patterson, W. L., Jr. (American Cyanamid), KINETIC STUDIES OF PETROLEUM ANTIOXIDANTS. Industrial and Engineering Chemistry, 48, no. 10, 1917-24 (1956). 0476

This article is concerned with some problems encountered in the use of antioxidants in petroleum systems and discusses the classes of antioxidants and the mechanism of inhibitor action. Experiments evaluating the effectiveness of inhibitors were carried out using white mineral oil saturated with air. Induction periods were estimated from the oxygen absorbtion data obtained from tests in which a thermostated and constantly aerated sample was sampled and analyzed at intervals for peroxide content, and analysis of inlet and outlet air streams analyzed for O_2 content. The effects of initial peroxide content on inhibition by 2,2'-methylenebis (4-methyl-6-tert-butylphenol), and, of peroxide decomposition additives were also explored.

Keusch, R. B. (Power Plant Laboratory, WADC), EFFECT OF SUPERSONIC FLIGHT ON POWER-PLANT INSTALLATION SYSTEMS. American Society of Mechanical Engineers. Transactions, 77, 721-6 (1955). 0477

This paper treats power-plant installation-system problems either brought on or aggravated by supersonic flight. These problems are in addition to those of the basic engine; their magnitude and possible effect on the aircraft mission are treated. Among the power-plant installation-system areas considered are fuel systems, lubrication systems, power transmission, engine placement, air-induction systems, and cooling systems. Particular emphasis is placed on aerodynamic heating as it affects materials problems and the fuel system. Supersonic speed adds heat to the fuel system in such quantity that the fuel system design is particularly critical. Another report - Keusch, R B., SOME EFFECTS OF AERODYNAMIC HEATING ON AIRCRAFT FUEL SYSTEMS. U.S. Air Force, WADC TN WCLP-53-227, July 1953. 8 pp. (AD 17721). - has much the same information.

Keusch, R.B. **SOME EFFECTS OF AERODYNAMIC HEATING ON AIRCRAFT FUEL SYSTEMS.** U.S. Air Force WADC TN WCLP-53-227, July <u>1953</u>. 8 pp. (AD 17721) 0478

This report presents the analysis of some of the factors occasioned by aerodynamic heating on fuel systems. The speed range considered goes as high as Mach 6. The analysis includes the influence of thermal insulation as protection for the fuel system.

Khitrin, L. N., **PHYSICS OF COMBUSTION AND EXPLOSION.** Jerusalem, Israel Program for Scientific Translations, <u>1962</u>. (OTS 61-31205). 0479

The book is in the form of a text or reference book in two parts. The first part (of greater interest) treats the theoretical aspects of chemical kinetics as applicable to combustion processes, and ignition, flame propagation, detonation and some practical aspects. The theoretical sections are by far the most impressive. The second part treats heterogeneous combustion of liquids and solids.

Khromov, S. I., Balenkova, E. S., and Treshchova, E. G., **CONTACT-CATALYTIC CHANGES OF 1, 1-DIETHYLCYCLOHEXANE AND 1-ETHYL-1-PROPYLCYCLOHEXANE IN PRESENCE OF PLATINIZED CARBON.** Moskovskii Universitet. Vestnik, 12, Seriya Matematiki, Mekhanki, Astronomii, Fiziki i Khimii, no. 3, 191-8 (<u>1957</u>). (CA, <u>52</u>, 6209d). 0480

The reactions of 1,1-diethylcyclohexane (I) and 1-ethyl-1-propylcyclohexane (II) in the presence of platinized carbon at 320° were studied. I yields PhEt, $C_{10}H_8$, o-$C_6H_4Et_2$, and PhMe: II yields PhPr, PhEt, o-MeC_6H_4Et, α-$C_{10}H_7Me$, PhMe, and o-$C_6H_4Me_2$.

0481

Kim, G., ACTIVITY OF CHROMIA-SILICA AS A DEHYDRO-AROMATIZATION CATALYST. Ph. D. Dissertation, University of Pennsylvania, 1960. 97 pp. (Dissertation Abstracts, 21, 775, 1960).

The effect of small amounts of silica in chromia catalysts for the conversion of n-heptane into toluene has been studied by the use of a flow system. Maximum catalytic activity was observed at about 4.7%w silica. The amount of hydrate in the catalyst also showed a flat maximum at about 4.7% silica, and there is some evidence that the hydrate contributes to the activity. The maximum in the observed catalytic activity is considered to be due to the dual function of silica which, in part, suppressed crystallization of chromia, and, in part, increased the hydrate content.

0482

Kim, G. and Krieger, K. A., CATALYTIC ACTIVITY OF CHROMIA-SILICA FOR THE DEHYDRO-AROMATIZATION OF n-HEPTANE. pp. 687-709 in: "International Congress of Catalysis (2nd), July 1960, Paris. Proceedings, vol. 1", Paris, Editions Technip, 1961.

The effect of small amounts of silica in chromia catalysts on the conversion of n-heptane to toluene was studied. Maximum activity was observed with 4.7%w silica. The results suggested that small amounts of silica stabilized the catalyst, possibly by reducing the crystallinity of the chromia.

0483

Kirtley, J. G. and Lewis, A. (Shell Petroleum, Thornton Research Centre), FLAME STABILITY STUDIES OF DIFFERENT VAPORIZED FUELS UNDER NON-HOMOGENEOUS MIXING CONDITIONS IN A SMALL SCALE COMBUSTION TUBE. Fuel, 33, no. 1, pp. 5-19 (1954).

The flame stability limits of a number of fuels in a vapour form have been determined using a small scale quartz combustion chamber, with heterogeneous air-fuel mixing conditions. Quantitative comparisons of the limits for different fuels were restricted by the necessity for maintaining uniform fuel distribution in the combustion chamber so as to attain comparable mixing, and such comparisons are limited to isomeric fuels. With these it was shown that limit differences became appreciable only at extreme air flows, where the limits appeared to be dependent upon the ease of oxidation of the fuel - the straight-chain paraffins possessing wider limits than their branched-chain counterparts.

0484

Kirtley, J.G. and Lewis, A., **GAS TURBINE COMBUSTION STUDIES--FLAME STABILITY UNDER NON-HOMOGENEOUS COMBUSTION CONDITIONS IN A SMALL-SCALE VAPORIZED-FUEL BURNER.** Shell Thornton Research Centre, Report No. M.47/49, U.K. Ministry of Supply Contract No. 6/Gen/653/FC14(b), February 1950. 64 pp.

The effects of chemical properties of the fuel on flame stability were investigated under non-homogeneous combustion conditions, namely those discouraging complete premixing of fuel and air. The fuels tested covered a wide range of chemical structure and oxidation characteristics, and the effect of the addition of combustion promoters and inhibitors was also investigated.

0485

Kitson, F. G.. POTENTIOMETRIC DETERMINATION OF MERCAPTAN-SULPHUR IN AVIATION TURBINE FUELS. Canada. National Aeronautical Establishment. LR-113, September 1954. 10 pp. (AD 49526).

A potentiometric method is described for the estimation of mercaptan-sulphur in aviation turbine fuels. The fuel sample is dissolved in a quantity of isopropanol to which an excess of silver nitrate solution has been added. The mercaptans are precipitated immediately as the silver mercaptides thus eliminating the possibility of oxidizing the mercaptans during the titration. The excess silver nitrate is then titrated potentiometrically with alcoholic potassium chloride using a suitable reference electrode and a silver indicating electrode for the detection of the end point. Determinations were carried out on a number of fuel samples as well as on synthetic samples of n-butyl mercaptan and thiophenol. The repeatability of the method was found to be 0.0001% (w/w) on determinations of mercaptan-sulphur in aviation fuels. The accuracy of the method was compared with A.S.T.M. Method D1219-52T using synthetic samples of mercaptan-sulphur. The proposed method was found to be more accurate than the A.S.T.M. method and within 2% of the amount of mercaptan-sulphur added.

0486

Kittredge, G. D. (Phillips Petroleum), THERMAL STABILITY OF HYDROCARBON FUELS. U. S. Air Force, ASD TR 61-238, Part II, Contract AF 33(616)-7241, July 1962. 125 pp. (AD 285 636).

JP-6 type fuels were shown to deteriorate seriously in thermal stability performance following storage for 52 weeks or more at ambient temperatures. Storage under a sealed nitrogen atmosphere in the absence of solids or water contamination showed little ability to offset such deterioration. There was evidence that large concentrations of certain phenol type antioxidants might retard fuel deterioration in this respect as might tighter fuel composition limits on aromatic (and aromatic-olefin) hydrocarbons and possibly sulfur content. Potential deleterious effects were shown by trace copper contamination in JP-6 fuels. Fuel sulfur contamination appeared to contribute to fuel thermal instability performance, but showed up adversely in storage performance only in the presence of an aromatic-olefin fuel constituent. Test fuels which deteriorated in performance during storage usually showed decreased ability to transmit UV light as well, though the converse was not always true. A small scale thermal stability test procedure based on losses in UV light transmission following heating showed promising ability to differentiate thermal performance of JP-6 and poorer grades of jet fuel. Test results with special high-temperature fuels blended for 500F-plus stability performance were less promising.

Kittredge, G. D. (Phillips Petroleum), THERMAL STABILITY OF HYDROCARBON FUELS. U. S. Air Force, ASD TR 61-238, Part III, Contract AF 33(616)-7241. July 1963. 148 pp. 0487

Storage of JP-6 type fuels for 26 weeks at 110°F resulted in deterioration in their thermal stability quality. This was not alleviated by storage in coated containers. Phenol antioxidants have been beneficial when used at relatively high concentrations. Certain aromatics are indicated to be detrimental to storage stability. Two attempts to develop an accelerated aging test were mildly successful in duplicating effects of long term storage. Fuels shown to be grossly different by Fuel Coker data can be ranked in proper order by both tests. Evaluation of the small scale (5-ml bomb) thermal stability test method showed it responding to the same types of fuel components which influence the Fuel Coker, however, certain additives were not always recognized.

Kittredge, G. D., Gwinn, S. H. and Streets, W. L., GAS TURBINE AND JET ENGINE FUELS. Phillips Petroleum Co., Research Division, Summary Report, U. S. Navy Contract NO as 58-310-d, 1959. 0488

This report has to do with the storage stability of three JP-5 fuels, and blends of two additives for special fuels of varying hydrocarbon type. The final data reported are on only one dispersant type additive and one special isoparaffinic fuel in addition to the JP-5 fuels. It was observed that the special isoparaffinic base fuel showed no measurable deterioration under any of the storage conditions. All the other fuels showed increases in existant gum during storage. The dispersant additive increased the amount of gum. A fair correlation existed between gum at 12 weeks, 110°F and 96 weeks at ambient temperature. The water reaction test appeared to worsen during storage. Coker test filter ratings were generally unaffected or improved by 110°F storage, preheater ratings worsened. In ambient storage there was a tendency for the poorer JP-5 fuels to improve and for the better JP-5 fuel to degrade. The dispersant additive improved filter plugging performance of the initial blends. This was maintained during the 96 week ambient storage; preheater ratings tended to depreciate.

Kittredge, G. D. and Streets, W. L., GAS TURBINE AND JET ENGINE FUELS. Phillips Petroleum Company - Research Division, Report 2760-60 R, U. S. Navy Contract NOas 60-6009-c, December 1960. 72 pp. (AD 252 096). 0489

This report summarizes the results of combustion performance and storage stability tests carried out on JP-5 fuels and a variety of petroleum fractions. The relationship between flame radiant heat emission and combustor liner temperature, and the influence of polycyclic vs monocyclic aromatic fuel components on combustor heating are given. The influence of sulfur contaminants on flame tube durability was studied as well as the effect of sulfur on fuel thermal stability. Thermal stability for the hydrocarbons with and without additives was evaluated using gum content data, water reaction tests, the CFR Fuel Coker and a modified CRC Thermal Stability Bomb.

Kittredge, G.D. and Streets, W.L. (Phillips Petroleum Co.), STORAGE LIFE OF JP-6 GRADE JET FUELS. Society of Automotive Engineers, SAE Preprint 773B, October 1963. (National Fuels and Lubricants Meeting, Tulsa, Oklahoma). 0490

The problem of JP-6 jet fuel deterioration during ambient storage, which gives rise to serious thermal instability, has been studied. Four of five JP-6 fuels stored 78 weeks at ambient temperature degraded in thermal stability. Sealing samples under an inert nitrogen atmosphere showed no advantage, but phenol-type anti-oxidants were moderately effective when used in relatively large concentrations. Adverse effects of various aromatic fuel components and metal contaminants were observed. Changes in fuel light transmission were found to correlate qualitatively with coker test results. The work was done under U.S. Air Force Contract AF 33(616)7241.

Kittredge, G. D., Streets, W. L., and Ratchford, R. (Phillips Petroleum), THERMAL STABILITY OF HYDROCARBON FUELS. U.S. Air Force, ASD TR 61-238, Contract AF 33(616)-7241, July 1961. 107 pp. (AD 262338). 0491

One year of development work on small scale thermal stability test methods for jet fuels has produced three potentially useful techniques, (1) a recirculating-flow dynamic method measuring deposit insulating effects around a heated surface requiring 1000 ml fuel samples, (2) a static method measuring deposit insulating effects around a heated nickel wire requiring 150 ml fuel samples and (3) a static method based on changes in fuel light transmission characteristics after heating requiring 5 ml fuel sample. A JP-6 jet fuel storage stability investigation showed three out of five fuels significantly poorer after 26 weeks at 110F in terms of CFR Fuel Coker rating, while a fourth fuel showed evidence of deterioration in one container only which is attributed to solids contamination. Vented versus sealed-under-nitrogen storage had no influence on the changes. The only chemical or physical changes in the test fuel after storage which matched the thermal stability changes were the UV light transmission characteristics. The two fuels least affected by storage were low in both sulfur and polycyclic aromatics content.

Kleinstein, G. (Polytechnic Institute of Brooklyn), ON THE MIXING OF LAMINAR AND TURBULENT AXIALLY SYMMETRIC COMPRESSIBLE FLOWS, U. S. Air Force Office of Aerospace Research, ARL 63-108, Contract AF 33(616)-7661, June 1963. 75 pp. (AD 416 031). 0492

A unified analysis to solve mxing problems involving momentum, energy, and mass transfer in both laminar and turbulent axially symmetric compressible flow is presented. The method is based on the linearization of the conservation equations in the plane of the von Mises variables.

The application of this method to a laminar flow problem is shown to be in good agreement with a numerical solution of the boundary layer equations obtained by Pai. The application of this method to turbulent flow requires an expression for the eddy viscosity. To allow for compressibility effects, a possible modification of Prandtl's formulation, suggested by Ferri, is investigated. When this expression for eddy viscosity is introduced, the application of the present method to compressible turbulent flow yields analytical results which are in good agreement with available experimental data.

Klunker, E. B. and Ivey, H. R., AN ANALYSIS OF SUPERSONIC AERODYNAMIC HEATING WITH CONTINUOUS FLUID INJECTION. U. S. National Advisory Committee for Aeronautics, Report 990, 1950, 10 pp. 0493

An analysis of the steady-state aerodynamic heating problem at high, supersonic speeds is made for two-dimensional flows with laminar boundary layers. The aerodynamic heating is shown to be reduced substantially by injecting a small amount of coolant through a porous surface into the boundary layer.

Knight, H. S., Skei, T., Nixon, A. C., and Groennings, S. (Shell Development), CHROMATOGRAPHIC DETERMINATION OF GUM IN FUELS. U.S. Air Force, WADC TR 54-328, Pt. II, Contract AF 18(600)-37, March 1955. 14 pp. (AD 75819; PB 111861). 0494

Additional data are discussed concerning the chromatogum method for the determination of gum in fuels on the basis of the relation between gum content and length of a brown zone observed when the fuel is displaced over silica gel with α-methyl naphthalene as solvent and acetone as eluent. Data indicated that α-methyl naphthalene of the specified purity contains appreciable amounts of gum and that it deteriorates on storage. When more carefully purified MN was used, the zone length observed with high gum samples was shortened disproportionately. In addition, in order to avoid diffuse gum zones, it was necessary to reduce the pressure from 5 to 3 psi; this resulted in further shortening of the zone length. For these reasons, a narrower column was designed which gives improved precision with smaller samples. The method also appears applicable to determining insoluble gum. The correlation between the steam jet and chromatogum methods was poor for both soluble gum from gas oils aged at 100°C and insoluble gums from gas oils boiling above approximately 275°C.

Koch, S. D., Kliss, R. M., and Smith, J. O. (Monsanto Chemical), EVALUATION OF HIGH TEMPERATURE HYDROCARBON FUELS. PART I. LITERATURE SEARCH AND LIST OF RECOMMENDED HYDROCARBONS. U.S. Air Force, WADC TR 59-327, Part I, Contract AF 33(616)-5799, May 1959. 4 v. (AD 232479-82). 0495

This work was initiated in order carefully to examine existing hydrocarbons and their analogs to find and recommend pure hydrocarbons which would have improved thermal stability without sacrifice of heat of combustion or of other desirable characteristics. The literature search uncovered about six thousand hydrocarbons of interest. They are saturated polycyclics and the olefins and aromatic precursors from which they might be prepared. Boiling point, specific gravity, melting point, heat of combustion and viscosity vs temperature are tabulated where available for these hydrocarbons, and the availability and source of data on thermal stability, heat transfer properties, and critical constants is given. The list of fifty candidate fuels was chosen as a result of a careful examination of the literature search. The candidate fuels are divided into three groups: thirty compounds which are commercially feasible and which have highest heat of combustion per pound, five commercially feasible compounds of high heat of combustion per gallon, and fifteen compounds of unique or extraordinary structure which might warrant investigation.

0496 Koch, S.D. and Smith, J.O., SELECTION, PREPARATION AND EVALUATION OF PURE HYDROCARBON FUELS. Monsanto Chemical Co., Research and Engineering Division, Special Projects Dept., c. 1960. 21 pp.

A list of candidate fuels was drawn up, applying two different criteria to their selection. One group of compounds, of generally conventional structure and commercially synthesizeable, was chosen after careful examination of an extensive literature search on hydrocarbons. The other list of more exotic compounds was chosen either because of expected increase in heat of combustion and/or thermal stability from theoretical considerations, or because the compound represented a structural type which had been inadequately studied in the past. The work was done under Air Force Contracts AF33(616) 5799, AF 33(600)38448 and AF 33(600)39634.

0497 Koch, S. D., Wineman, R. J., et al (Monsanto Research), SYNTHESIS OF THIRTY-FIVE HYDROCARBON FUELS. U. S. Air Force, ASD TDR 62-408, Contracts AF 33(616)-7190, AF 33(600)-38448, AF 33(616)-5799, AF 33(600)-39634, May 1962. 414 pp. (AD 278441).

Thirty-five hydrocarbons were prepared for evaluation as high-temperature jet fuels. Thirty-two of them were prepared in two-liter quantity or more. Synthesis of 59 other polycyclic hydrocarbons for the same purpose under three earlier contracts is also described. Forty-one of the 94 compounds described had never been previously prepared. Methods of synthesis, product yield and purity, boiling point, refractive index, and density are given for the 35 compounds.

0498 Kogarko, S. M. and Borisov, A. A., MEASUREMENT OF IGNITION LAGS AT HIGH TEMPERATURES. Academy of Sciences (U. S. S. R.). Bulletin.Division of Chemical Sciences, 1960, 1255-60.

A shock tube (with the wave initiated by an explosive gas mixture in the driver-section) was used to study ignition delays of hydrocarbon and air. Equipment and technique used are described and preliminary results are presented. The primary objective of the study was to determine the temperature dependence of ignition delay.

Kogarko, S. N., Devishev, N. I., and Basevich, V. Ya., IGNITION OF GASES IN THE REACTION PRODUCTS OF A FLAME. Russian Journal of Physical Chemistry, 33, no. 10, 419-22 (1959).

It has been shown that, under conditions of ignition of hydrocarbon-air mixtures by the reaction products of a flame in the temperature range 550°-1150°C at 1 atm, the ignition delays amount to 2-200 msec and depend to a large extent on the initial concentration of active particles, varying ten-fold and more for a given temperature. The ignition delays under conditions similar to combustion in a turbulent flow are greater than the time the gas remains in the flame of hydrocarbon-air mixtures right up to a temperature of 1000°K. 0499

Kordes, E.E., Reed, R.D. and Dawdy, A.L., "STRUCTURAL HEATING EXPERIENCES ON THE X-15 AIRPLANE". U.S. National Aeronautics and Space Administration, TM X-711, March 1962. 18 pp. (AD 328 494). REPORT CLASSIFIED CONFIDENTIAL.

No Abstract. 0500

Kostoch, F. R. (North American Aviation), SST MATERIALS PROBLEMS. Materials Research and Standards, 3, no. 10, 806-9 (1963).

A general survey covers the thermal and stress conditions encountered by a Mach 3 supersonic transport; problems and requirements in the selection of materials for skins and heavy load-carrying sections; and a brief discussion of requirements for non-structural and subsystems materials, including lubricants, coatings, hydraulic fluids, plastics, etc. 0501

0502

Kotanchik, J. N. (NACA Langley Aeronautical Laboratory), EXPERIMENTAL RESEARCH ON AIRCRAFT STRUCTURES AT ELEVATED TEMPERATURES. Society for Experimental Stress Analysis. Proceedings, 14, no. 2, 67-80 (1957).

The equipment and methods used at the Langley Laboratory of the NACA in experimental research on aircraft structures at elevated temperatures are reviewed. The equipment ranges from conventional steady-state furnaces for stress-strain tests to transient radiant-heating apparatus and aerodynamic heating and loading in a supersonic air jet.

0503

Kozina, M. P., Skuratov, S. M., Shtekher, S. M., Sosnina, I. E. and Turova-Polyak, M. B., HEATS OF COMBUSTION OF SOME BICYCLANES. Russian Journal of Physical Chemistry, 35, 1144-6 (1961).

The heats of combustion of dicyclopentyl, bis(cyclopentyl) methane, cyclopentylcyclohexane, cyclopentylcycloheptane, dicycloheptyl, and trans-β-methyldecalin have been determined at 25°. A method has been proposed for the calculation of the heats of combustion of various bicyclanes from the heats of combustion of the monocyclanes and the heat of formation of the bicyclanes from the monocyclanes. A relation has been given for the calculation of the heats of combustion of decalins alkyl-substituted in the β-position. The heats of isomerisation of bicyclanes to trans-decalin or trans-β-methyldecalin have been calculated.

0504

Kozlov, G. I. and Knorre, V. G., AN INVESTIGATION OF THE KINETICS OF THE THERMAL DECOMPOSITION OF ETHYLENE BY THE SINGLE IMPULSE IMPACT TUBE METHOD. Kinetics and Catalysis (U.S.S.R.), 4, 164-7 (1963).

The single impulse impact tube method has been used for the investigation of the thermal decomposition of ethylene within the temperature range 1250 to 1850°K at an overall pressure of the reacting gas of 4 atm and with a reaction time of the order of 0.8 milliseconds. Two ethylene-argon mixtures have been used in the experiments, containing 1% and 5% of ethylene, respectively. A total kinetic equation of first order has been obtained for the consumption of the ethylene, which describes with sufficient accuracy the data obtained within this temperature range.

0505

Kozlov, G. I. and Knorre, V. G., **KINETICS OF THERMAL DECOMPOSITION OF METHANE BY THE SINGLE-PULSE SHOCK TUBE METHOD.** Russian Journal of Physical Chemistry, 37, 1128-30 (1963).

The kinetics of the thermal decomposition of methane were investigated by means of the single-pulse shock tube. The experiments were carried out in the range of Mach numbers of the incident shock wave corresponding to reaction temperatures of 1670 to 2090°K. A first order reaction rate expression is given which correlates the results.

0506

Kozlov, G. I., and Knorre, V. G. (Institute of Energetics, U.S.S.R.), **SINGLE-PULSE SHOCK TUBE STUDIES ON THE KINETICS OF THE THERMAL DECOMPOSITION OF METHANE.** Combustion and Flame, 6, 253-63 (1962).

An attempt has been made to investigate the thermal decomposition of methane by treatment of a series of successive stages during which breaking down, eventually to separate elements, occurs. The overall kinetics of acetylene decomposition first receives attention and there follow sections dealing with ethylene, ethane, and methane. A discussion of conditions for the formation of stable intermediate products of methane pyrolysis is included and it is stated that the kinetic equations obtained can be used for other products of thermal decomposition of methane. The paper contains a brief description of equipment and experimental techniques.

0507

Kozlowski, R. H., Mason, H. F., and Scott, J. W. (California Research Corporation), PREPARATION OF LOW FREEZING JET FUELS BY ISOCRACKING. Industrial and Engineering Chemistry Process Design and Development, 1, no. 4, 276-80 (1962).

Gas oils boiling in the range of 550° to 850°F were isocracked in the laboratory to evaluate the products as jet fuel components. Processing at 60% per pass conversion and 500° to 525°F recycle cut point gave about a 20 to 40% yield of kerosine-type jet fuel with freezing points below -60°F. Produced in addition to the jet fuel were butanes, high octane light gasoline, and naphthenic reformed feed giving a total C_4^+ liquid yield of about 117%. Neither the yields nor the low freezing points of the synthetic jet fuels produced appear to be significantly affected by feed properties. The very low freezing points are attributed to very low normal paraffin content. Low freezing kerosine-type jet fuel components of high quality can be produced from heavy, lower value distillates by isocracking.

0508 Krasnow, M.E., Reynolds, O.P. and Wolford, O.C., (Cook Electric Co.) THE BEHAVIOR OF FUELS AND LUBRICANTS IN DYNAMIC TEST EQUIPMENT OPERATING IN THE PRESENCE OF GAMMA RADIATION. U.S. Air Force, WADC TR 58-264, Part II, Contract AF 33(616)-3865, March 1959. 167 pp.

This report summarizes work conducted on a program designed to evaluate fuels, lubricants, and hydraulic fluids for use in a nuclear-powered aircraft. During the performance period, 52 fuels, 44 lubricating oils, 4 greases, 4 dry film lubricants, and 1 hydraulic fluid were investigated. The most promising materials are listed. These materials were selected on the basis of performance in dynamic test machinery operated in a radiation environment and predict useful performance characteristics of lubricants up to doses of 10^{10} ergs/gmC and of fuels up to 10^{9} ergs/gmC.

0509 Krause, A., METAL OXIDE CATALYSTS ON γ-Al_2O_3 FOR DEHYDROGENATING REACTIONS. (in German). Polska Akademia Nauk. Wydzial III. Nauk Matematyczno-ficznych, Chemicznych i Geologo-geograficznych. Bulletin. Serie des Sciences Chimiques, 8, no. 4, 201-2 (1960). (CA, 59, 3343f).

Radical formulas $Al_2O_3 \rightarrow$ O:Al· (I) + ·OAl:O (II) allow a symbolic differentiation between γ-Al_2O_3 and inactive α O:AlO-Al:O. During dehydration I and II accept one H_2O mol. For dehydrogenation only radicals II are active. They are electron acceptors, potential anions, and accept one H from the previously adsorbed hydrocarbon. Acid metal oxides (e.g. V_2O_5, MoO_3, CrO_3) when added convert γ-Al_2O_3 to a pronounced acceptor-type dehydrogenation catalyst. They exert an electronic effect on the cationic donor radicals R:Al· and convert these to acceptors. During dehydrogenation the acceptor radicals are converted to hydroxides. At the elevated processing temp. these hydroxides are dehydrated again and regenerated to form oxide radicals. 2R:AlO· + $PhC_2H_5 \rightarrow$ PhCH:CH_2 + 2R:AlOH, 2R:AlOH $\rightarrow H_2O$ + R:Al· + ·O-Al:R.

0510 Krieve, W. F. and Mason, D. M. (Jet Propulsion Laboratory), HEAT TRANSFER IN REACTING SYSTEMS: HEAT TRANSFER TO NITROGEN DIOXIDE GAS UNDER TURBULENT PIPE FLOW CONDITIONS. A. I. Ch. E. Journal, 7, no. 2, 277-81 (1961).

Heat transfer rates of both heating and cooling for dissociating nitrogen dioxide gas were experimentally measured under turbulent pipe-flow conditions. The range of the average Reynolds numbers for which these measurements were made was from 6,700 to 22,000. Thermal flux at the inside surfaces of the tubes ranged from 300 to 8,400 Btu/hr sq. ft. for heating and cooling. Wall temperatures of the heater section were varied from 100° to 400° F. and those of the cooler section were varied from 70° to 140°F. Mixed mean bulk gas temperatures for both heating and cooling were in the range 72° to 190°F. Radial velocity and temperature profiles were measured at various longitudinal positions in the heater section. For this equilibrium gas mixture heat transfer coefficients as high as 14 times those for the gas under frozen equilibrium conditions were obtained. Correlations which should be generally applicable to equilibrium reacting systems have been determined from the experimental data.

0511 Krieve, W.F. and Mason, D.M., HEAT TRANSFER IN REACTING SYSTEMS: 1. HEAT TRANSFER TO N_2O_4 GAS UNDER TURBULENT PIPE FLOW CONDITIONS. California Institute of Technology, Jet Propulsion Lab, Progress Report 20-366, U.S. Army, Ordnance Department Contract DA 04-495-ORD-18, ORDCIT Proj., November 1958. 13 pp. (AD 210121).

Heat transfer rates of both heating and cooling for dissociating N_2O_4 gas were experimentally measured under turbulent pipe-flow conditions. The range of the average Reynolds numbers for which these measurements were made was from 6700 to 22,000. Thermal flux at the inside surfaces of the tubes ranged from 300 to 8400 Btu/hr-ft^2 for heating and cooling. Wall temperatures for both heating and cooling were in the range 72 to 190°F. Radial velocity and temperature profiles were measured at various longitudinal positions in the heater section. For this equilibrium gas mixture heat-transfer coefficients as high as 12 times those for the gas under frozen equilibrium conditions were obtained.

0512 Krynitsky, J. A., PROBLEM OF JET FUEL CONTAMINATION. U. S. Office of Naval Research. Report of NRL Progress, December 1963, 1-7.

Serious cases of aircraft wing tank corrosion, fuel gage malfunctions, and other fuel system difficulties have been experienced in both military and commercial aircraft; these troubles have been caused by fuel contaminants such as water, particulate matter, microorganisms, and surfactants; paper discusses nature of these contaminants, interrelationship of these substances in causing aircraft fuel system damage, and practical methods for effecting control over problems; most promising current approaches are development of topcoating materials and of biocides for use in fuels and fuel systems.

0513 Krynitsky, J. A. and Garrett, W. D., THE SEPARATION OF WATER FROM FUELS. PART I. DEVELOPMENT OF LABORATORY EVALUATION METHOD. U.S. Naval Research Laboratory, NRL Report 5685, August 1961. 15 pp. (AD 263769).

A laboratory method and apparatus were developed for the evaluation of the water separation properties of fuels and fuel-additive combinations. The instrument, known as the Water Separometer, produces a water-in-oil emulsion mechanically, meters this emulsion through a cell containing standardized fiberglass coalescer disks, and analyzes the effluent for entrained water by light transmission. The relative ease of water removal from a given fuel is rated by averaging light transmission values obtained during a series of scheduled flow rates. This rating is known as the Water Separation Index (WSI). Variables affecting the performance of the method which have been studied include: coalescer media, water-to-fuel ratio, operating pressure, temperature, and cleanup procedure. Cooperative studies with other laboratories have shown the method to be satisfactory with respect to both repeatability and reproducibility. Comparison of data indicated that a good correlation exists between the developed laboratory method and the larger systems.

Krynitsky, J. A. and McLaren, G. W., Jr. (U. S. Naval Research Laboratory), SOME EFFECTS OF MICROBIAL GROWTHS ON SURFACTANT PROPERTIES OF FUELS. Biotechnology and Bioengineering, 4, no. 4, 357-67 (1962). 0514

Fungi and bacteria taken from fuel systems were allowed to grow in jet fuel (or hydrocarbon)--salt solution mixtures and the layers were analyzed for surfactant properties. The fuels included both JP-4 and JP-5 types and an alkylate bottom fraction. Controlled surface activity was imparted to some samples by adding minute quantities of either petroleum sulfonates or petroleum naphthenates. Analyses after growth periods of 2 to 14 weeks failed to show any significant increases in the surface active properties of any fuel or hydrocarbon sample. In all cases, there was either little change or else the surfactant effect was reduced slightly. Opposed to these findings, examination of the aqueous bottoms revealed that microbial growths did effect increases in their surface active properties.

Kuchta, J. M., Bartkowiak, A., Cato, R. J. and Zabetakis, M. G. (U. S. Bureau of Mines), IGNITION CHARACTERISTICS OF FUELS AND LUBRICANTS. U. S. Air Force, APL-TDR 64-25, Contract DO 33(657)-63-376, December 1963. 33 pp. 0515

Ignition temperatures of n-hexane, n-octane, n-decane, JP-6 jet fuel and aircraft engine oil MIL-L-7808 (0-60-18) were determined in air using heated Pyrex cylinders of 0.314-inch to 1.38-inch diameter and Nichrome wires, rods, or tubes of 0.016-inch to 0.75-inch diameter. The ignition temperature varied little with fuel-air ratio but increased as the size of the heat source was decreased. Expressions are given which define the variation of the hot surface ignition temperatures of these combustibles with the radius and the surface ignition temperatures of these combustibles with the radius and the surface area of the heat source. The expressions are applicable to stagnant or low velocity flow conditions (<0.2 in/sec). In addition, the hot gas ignition temperatures of the combustible vapor-air mixtures were determined with 1/4, 3/8 and 1/2-inch diameter jet of hot air. These ignition temperatures also varied little with fuel-air ratio and increased as the diameter of the heat source was decreased.

Kuchta, J. M. Bartkowiak, A., Spolon, I., and Zabetakis, M. G. (U.S. Bureau of Mines), FLAMMABILITY CHARACTERISTICS OF HIGH TEMPERATURE HYDROCARBON FUELS. U.S. Air Force WADD TR 61-89, Contract DO 33(616)-60-5, May 1961. 29 pp. (AD 268575). 0516

Data are presented on the flammability and autoignition temperature characteristics of JP-6, JP-150, and HTF-59-24 fuels. Flammability limits of the vapors of these fuels were determined in air at elevated temperatures and at atmospheric pressure. Auto-ignition temperatures and corresponding ignition delay times were obtained under static and dynamic conditions as a function of the pressure and the oxygen concentration of the ambient medium; the effect of fuel volume on auto-ignition was also determined in static tests. The auto-ignition of JP-6 fuel vapor-oxygen-nitrogen mixtures was studied in various vessels which were heated uniformly and non-uniformly; critical heat flow requirements for auto-ignition were found for spherical and cylindrical Cu vessels and a spherical stainless steel vessel.

0517

Kuchta, J.M., Bartkowiak, A., Spolan, I. and Zabetakis, M.G. (U.S. Bureau of Mines), FLAMMABILITY CHARACTERISTICS OF HIGH TEMPERATURE HYDROCARBON FUELS. U.S. Air Force, ASD TDR 62-328, Contract DO 33(616)-60-5, April 1962. 40 pp.

Experimental data are presented on the auto ignition temperature characteristics of JP-6 jet fuel and of aircraft engine oils 0-60-7, 0-60-18 and 5P4E. Minimum autoignition temperatures are given for these materials in various quiescent oxygen-nitrogen atmospheres. The effects of initial environmental pressure, fuel injection pressure, fuel concentration, and test vessel size are described. The variations of autoignition temperatures caused by different ignition criteria are discussed. Quantitative relationships are given which define the variation of ignition delays with autoignition temperatures in air under static and dynamic conditions. In addition, autoignition temperature data are reported for various JP-6 fuel-oxygen-nitrogen mixtures which were heated in large steel cylinders at low heating rates. Included in these data are gaseous product analyses which indicated the extent of oxidation at various temperatures under critical heating conditions.

0518

Kuchta, J.M., Bartkowiak, A., Spolan, I., and Zabetakis, M.G. (U.S. Bureau of Mines), FLAMMABILITY CHARACTERISTICS OF HIGH TEMPERATURE HYDROCARBON FUELS. U.S. Air Force, ASD TDR 62-328, Part II, Contract DO 33(616)-60-5, December 1962. 24 pp.

The autoignition temperature characteristics of JP-6 vapor-air mixtures containing small concentrations of ozone were investigated at pressures below 1 atm. Ignition delays were markedly influenced by the addition of ozone, and their variation with ozone concentration was determined at temperatures between 464 and 500°F. at atmospheric pressure. Temperature and pressure rises observed in these experiments are shown to be independent of the ozone concentration used. The hot-wire-ignition temperatures of JP-6 fuel vapor-air mixtures were also determined in air at atmospheric pressure. The relationship between wire diameter and ignition temperature appeared to be consistent with that predicted by the thermal theory of ignition. Minimum autoignition temperature data were also presented for two used aircraft engine oils in air at pressures between 1/8 and 1 atm.

0519

Kuchta, J. M., Bartkowiak, A., and Zabetakis, M. G. (U. S. Bureau of Mines), AUTOIGNITION CHARACTERISTICS OF JP-6 JET FUEL. U. S. Air Force, ASD TDR 62-615, Contract DO 33(616)-60-5, June 1962. 35 pp. (AD 284 354).

At reduced pressures (<1 atm.) or oxygen concentrations (<21 percent), the minimum autoignition temperatures of JP-6 were lower when ignition was evidenced by a sudden pressure or temperature rise than when it was evidenced by the appearance of a luminous flame. The significance of autoignition temperature data obtained using various ignition criteria is discussed.

Kuchta, J. M., Cato, R. J., and Zabetakis, M. G., IGNITION CHARACTERISTICS OF FUELS AND LUBRICANTS. U.S. Bureau of Mines, Quarterly Progress Report, U.S. Air Force, Contract DO 33(657)-63-376, 1 January to 31 March 1964, 7 pp. 0520

Ignition date for n-hexane, n-octane, n-decane, JP-6, and MIL-L-7808 engine oil are presented. Autoignition, hot surface ignition, and hot gas ignition experiments were performed, and the effects of test apparatus size, flow velocity, and mixture ratio were evaluated.

Kuchta, J. M., Cato, R. J. and Zabetakis, M. G., IGNITION CHARACTERISTICS OF FUELS AND LUBRICANTS. U. S. Bureau of Mines, Quarterly Progress Report, U. S. Air Force, Contract 33(657)-63-376, 1 April to 30 June 1964, 10 pp. 0521

This report describes progress in a study of the ignition temperature characteristics of aircraft fuels and lubricants. Hot surface ignition, hot gas ignition and reaction rates are considered. In hot surface ignition work autoignition temperature experiments were conducted with n-hexane, n-octane, n-decane, JP-6, and MIL-L-7808 engine oil in order to determine the effects of the nature and position of the heated surface, the oxygen concentration of the atmosphere, the nature of the diluent gas, initial mixture temperature, and flow velocity of the mixture. In hot gas ignition work temperature profiles were obtained with a hot air jet flowing into preheated air and into various combustible mixtures in order to determine the heat flux required to produce "cool" flame and "hot" flame ignitions. Preliminary experiments on reaction rate are described.

Kuchta, J.M., Cato, R.J. and Zabetakis, M.G., IGNITION CHARACTERISTICS OF FUELS AND LUBRICANTS. U.S. Bureau of Mines, Quarterly Progress Report, U.S. Air Force Contract DO 33(657) -63-376, 1 July to 30 September 1964. 17 pp. 0522

The work conducted is divided into three parts: (1) hot surface ignition, (2) hot gas ignition and (3) reaction rate studies. In the hot surface ignition work, autoignition temperature experiments were conducted with n-hexane, n-octane, n-decane, and JP-6 to determine the minimum diameter at which ignition may be obtained in a cylindrical Pyrex vessel containing air at atmospheric pressure. Similar determinations were made with benzene, toluene, cyclohexane and xylene. In the second part of the work, temperature, velocity and concentration profiles were obtained for a 1/2 inch diameter hot air jet flowing into preheated air and into preheated combustible vapor-air mixtures. Data from such measurements are being used to calculate the heat flux requirements for the hot gas ignition of hydrocarbon type combustibles. In the rate studies, experiments were run with 5 percent n-octane vapor air mixtures in special Pyrex vessels under various temperature and pressure conditions.

0523

Kuchta, J. M., Lambiris, S., Perlee, H. E., Halagan, D. R., and Zabetakis, M. G., (U.S. Bureau of Mines), FLAMMABILITY CHARACTERISTICS OF HIGH TEMPERATURE HYDROCARBON FUELS. U.S. Air Force, WADC TR 59-663, Contract DO 33(616)-57-4, July 1959. 33 pp. (AD 236661).

Data are presented on the flammability and spontaneous ignition characteristics of various aircraft fuels. Limits of flammability were determined in air at atmospheric pressure and elevated temperatures under essentially static conditions. Spontaneous ignition temperatures and corresponding ignition delay times were determined under static and dynamic flow conditions. In the static tests, an oxidizing atmosphere of air was used at both reduced and elevated pressures. The dynamic tests were conducted at elevated pressures employing various nitrogen-air concentrations. Other physical properties of these fuels are also presented. In addition, data are reported on the spontaneous ignition of fuel vapor-air mixtures contained in cylindrical and spherical vessels which were heated either uniformly or nonuniformly. (Similar to U.S. Bureau of Mines Report of Investigations 5992, 1962.)

0524

Kuchta, J.M., Lambiris, S., and Zabetakis, M.G., FLAMMABILITY AND AUTOIGNITION OF HYDROCARBON FUELS UNDER STATIC AND DYNAMIC CONDITIONS. U.S. Bureau of Mines, Report of Investigations 5992, 1962.

Data are presented on the flammability and spontaneous ignition characteristics of various aircraft fuels. Limits of flammability were determined in air at atmospheric pressure and elevated temperatures under essentially static conditions. Spontaneous ignition temperatures and corresponding ignition delay times were determined under static and dynamic flow conditions. In the static tests, an oxidizing atmosphere of air was used at both reduced and elevated pressures. The dynamic tests were conducted at elevated pressures employing various nitrogen-air concentrations. Other physical properties of these fuels are also presented. (Similar to (AD 236 661) WADC TR 59-663, 1960.)

0525

Kuliev, A. M., Mardanov, M. A., and Alekperov, G. Z., NEW APPARATUS FOR THE DETERMINATION OF THERMAL STABILITY OF MOTOR FUELS. Azerbaidzhanskiy Khimicheskiy Zhurnal, 1959, no. 6, 27-32. (CA, 58, abstr. 10016f).

Thermal stability of liquid fuels is determined by the amount of insoluble residue formed on heating for 4 hours in a bomb at 150°. Various types of apparatus were evaluated, and the effect of the air: sample volume ratio and of shaking the sample during its heating on residue formation were investigated. An improved apparatus for the determination was designed. It consisted of a thermostatic, electrically heated chamber containing 4 bombs rotated at 25 rpm on a horizontal shaft. In the new apparatus, determinations over 30 minutes at 175° with 50-ml samples gave sufficiently accurate results. For aviation fuels, low concentrations of oxygen at altitudes above 10 km are taken into account.

Kuo, H-H., MECHANISM OF AROMATIZATION OF ALKANES. I. OLEFIN FORMATION. Scientia Sinica (Peking), 11, 1075-84, 1962. (CA, 58, 1325a, 1963). 0526

A review of the role of olefin formation in the aromatization of alkanes. 14 references.

Kuo, H. H., RELATIVE RATES OF AROMATIZATION OF PARAFFIN AND DISTRIBUTION OF RESULTING AROMATIC HYDROCARBON ISOMERS. Jan Liao Hsueh Pao, 5, 43-52 (1960). (CA, 54, 19545c). 0527

A reaction mechanism for cyclization of paraffin, which was incompatible with that of Herington and Rideal (CA, 40, 1796^7), was suggested. Both mechanisms were compared as to aromatization of 5 and 6 carbon saturated hydrocarbons. It was concluded that results calculated with the mechanism proposed were closer to the experimental data than those from the Herington and Rideal theory.

Kurtovich, D. D. and Hays, G. E. (Boeing), SPONTANEOUS IGNITION AND SUPERSONIC FLIGHT. Society of Automotive Engineers. SAE Paper 431C, October 1961. 0528

An experimental investigation was made of spontaneous ignition of various aviation fluids: JP-4, JP-5, JP-6, 110/130 Avgas, turbine oil, Versilube F-50, hydraulic fluids, liquid hydrogen, and some high energy fuels. Emphasis was placed on the hazards involved in spontaneous ignition of the JP-type fuels under temperature and pressure conditions which might be encountered in supersonic flight. Experiments were carried out in three facilities: 350 ml., 0.23 cu. ft. and 7.5 cu. ft. Both cool flame and conventional hot flame ignitions were observed depending upon conditions. The influence of inerts and some combustion inhibitors was studied.

0529

Kutateladze, S. S., BOILING HEAT TRANSFER. U. S. Air Force, Foreign Technology Division, FTD-TT-62-52/1 + 2 + 4, January 1962. 31 pp. (AD 270076).

This report is devoted to the problems of heat transfer in nucleate boiling. The purpose is to discuss some of the main questions of boiling heat-transfer theory and to generalize the results of experimental work. The origin and growth of bubbles are discussed, critical heat flux relations are given and theoretical formulas are derived for the first critical heat-flux density in a large volume of free-convection liquid. The effect of forced convection on heat transfer with nucleate boiling in tubes is discussed, and similitude conditions are derived. An extensive bibliography is included.

0530

Kutzko, G.G. (General Electric), EFFECT OF HYDROCARBON FUELS ON THE OPERATION OF VAPOR PHASE FUEL SYSTEMS. U. S. Air Force, ASD TDR 62-920, Contract AF 33(616)-8224, October 1962. 120 pp. (AD 296 441).

Six hydrocarbon fuels were evaluated in a vapor-phase heat exchanger to fuel exit temperatures up to 1300°F in order to determine the effect of fuel flow rate, pressure, and temperature on the heat sink afforded by the fuel, the heat transfer from the tube to the fuel, and operation in a simulated fuel injection system. Vaporized decalin, a C9 to C11 normal paraffin mixture, Soltrol 170, and a Special JP-6 were found to yield significant heat sinks at temperatures up to 1300°F. Isopropylbicyclohexyl and diethylcyclohexane are not suitable as vapor phase fuels due to the formation of solids or other thermal decomposition products. A residence time concept correlates the effect of fuel flow rate, pressure, and temperature on the heat absorbed by the Special JP-6. Average tube-to-fuel heat transfer coefficients are correlated. Fuel impurities at the levels allowed by current fuel specifications have no significant effect on performance in a vapor phase heat exchanger. Combustion tests show no significant difference between the fuels.

0531

Kutzko, G. G. (General Electric), EFFECT OF HYDROCARBON FUELS ON THE OPERATION OF VAPOR PHASE FUEL SYSTEMS. U. S. Air Force, ASD TDR 62-920, Part II, Contract AF 33(616)-8224, January 1964. 198 pp.

Ten fuels covering a wide range of hydrocarbon types were evaluated in a hot fuel calorimeter to determine the feasibility of their use in a vaporizing fuel system. Fuel heat sink capacities, local rates of heat transfer, and the amount and type of fuel decomposition products were measured. Coke-forming tendency of the fuels was studied by passing the hot vapors through a simulated fuel injector and observing plugging of the passages. Combustion tests showed no significant difference between the fuels.

Kydd, P. H. and Mullaney, G. J. (General Electric Research), SUPERSONIC COMBUSTION. Combustion and Flame, 5, 315-18 (1961). 0532

A device is described in which diffusion flames of acetylene, hydrogen and preheated propane have been stabilized in a free jet at Mach 2·7. It consists of a hollow truncated cone through which flows a small part of the high velocity air stream in which it is submerged. The internal flow, which has been decelerated by a normal shock wave, is mixed with hydrogen and ignited. The high temperature combustion products, expanding through a nozzle in the downstream part of the cone, are used to ignite the main fuel jets surrounding this hot core. Experiments with acetylene have demonstrated that the combustion is extremely rapid and takes place at constant static pressure. The combustion efficiency 9 in. downstream from the fuel injector is 91 percent, and the heat release rate $2{\cdot}7 \times 10^8$ B.t.u./h-ft^3-atm^2.

Laidler, K. J., Sagert, N. H., and Wojciechowski, B. W. (University of Ottawa), KINETICS AND MECHANISMS OF THE THERMAL DECOMPOSITION OF PROPANE. I. THE UNINHIBITED REACTION. Royal Society (London). Proceedings, A270, 242-53 (1962). 0533

The uninhibited pyrolysis of propane was investigated from 530 to 670°C and at pressures up to 600 mm. In an unpacked vessel the reaction was of the first order at lower temperatures and higher presures. A transition to 3/2 order at higher temperatures and lower pressures was observed. The rates were somewhat reduced in a packed vessel, and an apparent order of 1.25 was obtained. The activation energy of the reaction in its first-order region was 67.1 kcal and that of 3/2-order reaction was 54.5 kcal. Added carbon dioxide had no effect on the rates either in the first-order or 3/2-order region. On the basis of this evidence, and of theoretical arguments, it is concluded that the reaction is largely homogeneous and occurs by a free-radical mechanism. The initiation reaction is considered to be the dissociation of propane into a methyl radical and an ethyl radical, this reaction being in its second-order low-pressure region under the conditions of the experiments. The termination reaction when the overall order is unity is concluded to be the recombination of a methyl and a propyl radical in the presence of a third body. In the 3/2-order region the termination reaction is believed to be the recombination of two methyl radicals, also in the third-order region.

Laidler, K. J., Sagert, N. H., and Wojciechowski, B. W. (University of Ottawa), KINETICS AND MECHANISMS OF THE THERMAL DECOMPOSITION OF PROPANE. II. THE REACTION INHIBITED BY NITRIC OXIDE. Royal Society (London). Proceedings, A270, 254-66 (1962). 0534

The kinetics of the pyrolysis of propane inhibited by nitric oxide were investigated from 640 to 560°C and at partial pressures of propane from 25 to 550 mm Hg. The pressure time curves were found S-shaped, and the induction period was lengthened considerably as the propane pressure was lowered. Complete inhibition by nitric oxide was obtained with 10 to 12% nitric oxide. The initial rates were found to be proportional to the 3/2 power of the pressure over most of the temperature range, and to a slightly lower power at the highest temperatures. The orders of reaction corresponding to the inflexion point are close to unity at the highest temperatures, and increase steadily as the temperature is lowered. The activation energy calculated from the inflexion rates in the first-order region was 69.4 kcal/mole. The rates decreased with an increase in the surface to volume ratio. The addition of a large excess of carbon dioxide had no effect on the fully inhibited rates. The results are shown to be consistent with a mechanism in which the initiation reaction involves the abstraction of a hydrogen atom from propane by nitric oxide, and in which the termination reaction is between HNO and a propyl radical.

Langdon, W. M., Fochtman, E. G., Stark, L. L. and Grant, M. G. (IIT Research Institute), EMULSIFIED WATER IN JET FUELS STUDIED. Petroleum Management, 35, no. 12, 184-90 (November 1963).

0535 Filter/separator tests for removal of free water from jet fuels are described. Two types of filter/separator element - one having a paper barrier and the other fiber glass barriers-were evaluated using several types of fuel and various additives. It was concluded that filter/separator performance characteristics are determined mainly by wetting properties of the coalescing medium; variations in chemical characteristics of the fuel had little systematic effect on performance. Development of an improved element will probably require use of media with well defined and stable wetting characteristics obtained by using a coalescing bed composed of two materials, one essentially hydrophobic and the other essentially hydrophilic.

Langenbeck, W. and Alm, J., UNTERSUCHUNGEN ÜBER DIE SELEKTIVITÄT VON NICKEL-ZINKOXID-KONTAKTEN BEI DER UMWANDLUNG VON CYCLOPENTANEN UND CYCLOHEXANEN. Zeitschrift für Anorganische und Algemeine Chemie, 324, 69-77 (1963).

0536 The gaschromatographic microreactor technique was used to determine the selectivity of Ni-ZnO catalysts which were prepared by decomposition of the mixed oxalates. While monoalkylcyclopentanes were cracked to a high degree even at 280°-440°, the cyclohexanes were converted to aromatics in good yields at 360. Increasing the Ni content of the catalysts or further raising the temperature stimulated the ring cleavage in this case too.

Latynin, Ye. V., ed., THERMOPHYSICAL PROPERTIES OF CERTAIN AVIATION FUELS IN THE LIQUID AND GASEOUS STATE. Moscow, Gosudarstvennoye Nauchno-Tekhnicheskoye Izdatel'stvo Oborongiz, 132, 1-161, 1961 (Trans. FTD TT-61-81/1+2; AD 274118).

0537 The collection gives the results of investigations of heat capacity, thermal conductivity, density, viscosity, surface tension and vapor pressure, and latent heat of vaporization of aviation fuels in the liquid and gaseous phases over a wide range of temperatures. Results are also given for investigations of diffusion in mixtures of vapors of vertain fuels and air at high temperatures.

Leary, W. A., Taylor, E. S., Taylor, C. F. and Jovellanos, J. U., **THE EFFECT OF FUEL COMPOSITION, COMPRESSION PRESSURE, AND FUEL-AIR RATIO ON THE COMPRESSION-IGNITION CHARACTERISTICS OF SEVERAL FUELS.** U. S. National Advisory Committee for Aeronautics, TN 1470, March <u>1948</u>. 107 pp. 0538

Contains a determination of variation in ignition delay and rate of pressure rise after compression for isooctane, 100-octane gasoline, triptane, and benzene. The tests were made with the M. I. T. rapid compression machine with fuel-air ratio and compression ratio as the only variables. Results suggest an explanation of the failure of benzene and triptane to detonate under engine conditions which caused isooctane severely.

Leas, A.M. (Ashland Oil and Refining Co.), RECLAMATION OF JP-6 TYPE JET FUELS WHICH BECAME THERMALLY UNSTABLE DURING STORAGE. U. S. Air Force, APL TDR 64-74, Contract AF 33 (657)-11097, June <u>1964</u>. 123 pp. (AD 601984). 0539

The thermal stability of nineteen degraded JP-6 type jet fuels was improved to a level in excess of the present MIL-J-25656B specification requirement by a filtration treatment. The improved thermal stability of these reclaimed fuels was retained for more than six months of ambient temperature storage. The ASTM-CRC Coker was used to measure thermal stability. The coker ratings could not be correlated quantitatively with the chemical and physical analyses because of the minute quantity of the contaminants. However, with the use of filter media these contaminants were concentrated sufficiently to show some degree of correlation with the coker ratings. Many of the additives present in these military fuels as well as those considered as possible future additives were removed in varying degrees by reclamation filtration. The generation of static electricity, filter media life, process economics, and design variables were other parameters which were investigated.

Lee, E. H. and Oliver, G. D. (Monsanto Chemical Co.), **CALCULATING HOMOGENEOUS REACTION RATES AND ORDERS IN A FLOWING GAS REACTOR. THERMAL DECOMPOSITION OF ETHYLBENZENE.** Industrial and Engineering Chemistry, <u>51</u>, no. 11, 1351-2 (<u>1959</u>). 0540

A method is described for analysis of data from tubular reactors operated with "differential conversion. The method is applied to data for thermal cracking of ethylbenzene to styrene, toluene, and benzene.

Leitz, F.B., Jr., Slott, R.S., Wurster, C.F., Jr., Smith, J.O. and Satterfield, C.N., EVALUATION OF PURE HYDROCARBONS AS ENDOTHERMIC AVIATION FUELS. Monsanto Chemical Co., Research and Engineering Division, Special Projects Dept., c. 1960. 20 pp. 0541

At multi-Mach speeds the only practical heat sink is the fuel; but the extent to which its heat capacity is available is limited by the temperature level at which thermal degradation reactions such as insoluble gum formation become intolerable. Another approach is to absorb heat by means of an endothermic reaction of the fuel. This paper reviews several possible heat-absorbing reactions with their promise and limitations, and describes a reactor system, under construction, with which the potentialities of endothermic fuels can be evaluated. This work was supported under contract AF 33(616)-6608, United States Air Force.

Leonard, J. M. and Klemme, D. E., FUNGI IN FUEL. pp. 1-8 in. U. S. Naval Research Laboratory, Report of NRL Progress, September 1962. (PB 181076). 0542

The problem of fuel contamination has been one of long standing for Navy chemists. Recent evidence suggests that some of the contamination may be caused by microscpoic organisms. Work at the U. S. Naval Research Laboratory has proved that this is true and that the main culprits are bacteria and fungi. The best immediate solution to the problem seems to be recognizing the source of the contamination and employing good housekeeping techniques to control it.

Letort, M., HIGH-ENERGY FUELS FROM COAL FOR SUPERSONIC PLANES. Société Royale Belge des Ingenieurs et des Industriels. Revue, 1962, 638-46. (CA, 58, 1619 h). 0543

A review of factors for applying coal-tar products to the fuel problem is presented. The calorific value, thermal stability, low temperature qualities, vapor pressure, and flame luminosity requirements of hydrocarbon fuels are discussed. The polynaphthenic hydrocarbons fit the general requirements best. Methods of catalytic hydrogenation of aromatics are also discussed.

Levy, S.,(General Electric), GENERALIZED CORRELATION OF BOILING HEAT TRANSFER. American Society of Mechanical Engineers. Transactions. Series C. Journal of Heat Transfer, 81, 37-42 (1959). 0544

A generalized equation to describe surface boiling of liquids is derived. The expression correlates all fluids independently of pressure and heating surface-fluid combination. The form of the relation was obtained from a simplified model of heat transfer to the bubbles close to the heated surface. Good agreement between test results and the derived equation was obtained for pool boiling and nucleate boiling heat transfer of subcooled and vapor-containing liquids.

Lewis, B. and vonElbe, G. (Combustion and Explosives Research, Inc.), COMBUSTION, FLAMES AND EXPLOSIONS OF GASES. 2nd Ed. New York, Academic, 1961. 731 pp. 0545

This source book contains both theoretical and experimental results summarizing the state of knowledge in the fields of flames, detonations and combustion processes of gaseous reactants up to the date of the edition (1961).

Lezberg, E. A. and Buchele, D. R., SOME OPTICAL TECHNIQUES FOR TEMPERATURE AND CONCENTRATION MEASUREMENTS OF COMBUSTION IN SUPERSONIC STREAMS. U. S. National Aeronautics and Space Administration, TN D-2441, August 1964. 0546

Three optical techniques are discussed for determining temperature and species concentration in supersonic streams of combustion products. The three techniques are line-reversal pyrometry, determination of the hydroxyl concentration by spectral line absorption and determination of carbon dioxide and water concentration by infrared spectral absorption. The line-reversal technique that uses a locally injected emitter and the hydroxyl radical absorption technique are illustrated by measurements in a supersonic nozzle. The determination of the infrared emitting species has had some limited demonstration in a shock tube. The limitations of these techniques for measurements in exhause nozzles and supersonic combustion experiments are examined with reference to temperature, optical depth, and response time.

Libby, P.A., (General Applied Science Labs., Inc.), THEORETICAL ANALYSIS OF TURBULENT MIXING OF REACTIVE GASES WITH APPLICATION TO SUPERSONIC COMBUSTION OF HYDROGEN. ARS Journal, 32, 388-96 (1962). 0547

The turbulent mixing of an axisymmetric jet of a reactive gas is considered. By assuming a convenient model for the compressible eddy viscosity, the momentum equation is reduced to a form amenable to approximate solution. The resulting velocity distribution in both incompressible and compressible flows is in reasonable agreement with experiment. The theoretical results for chemical equilibrium are shown to be in reasonable agreement with experimental data from low speed hydrogen flames. A numerical example of interest in connection with a hypersonic, air breathing vehicle is carried out in detail.

Liebman, I., Spolan, I., Kuchta, J. M. and Zabetakis, M. G., IGNITION OF TANK ATMOSPHERES DURING FUEL LOADING OPERATIONS. U. S. Bureau of Mines, Explosives Research Center, Final Report No. 3914, February 1964. (API Static Electricity Research Project S-3). 0548

During the loading of an air-filled tank, flammable zones can be expected to spread more rapidly with increasing fuel feed rate and temperature, depending on the vapor pressure of the liquid fuel and the diffusivity of its vapors. However, the flammable zone produced at elevated temperatures by fuels with high vapor pressures will tend to vanish more rapidly than the zones formed by less volatile fuels due to the more rapid formation of rich-limit mixtures by the highly volatile fuels. These effects of fuel temperature and feed rate were confirmed by fuel-loading experiments using JP-4, gasoline and kerosine.

Lienhard, J. H. (Washington State University), A SEMI-RATIONAL NUCLEATE BOILING HEAT FLUX CORRELATION. International Journal of Heat and Mass Transfer, 6, 215-19 (1963). 0549

Tien's model for nucleate boiling heat transfer is re-examined in the light of a recent experiment by Benjamin and Westwater. The study leads to a semi-rational modification of his prediction, which gives better correlation of available data.

Lin, T. Y. and Cheng, Y. C., **EFFECT OF NITROGEN OR SULFUR COMPOUNDS ON THE POISONING OF PLATINUM REFORMING CATALYST.** Wu-Han Ta Hsueh, Wuchang, China. Wu-Han Ta Hsueh Tzu Jan K'o Hsueh Hsueh Pao, 5, 32-56 (1959). (CA, 54, 5987e).

0550 The mechanism of cyclization and isomerization of alkanes is discussed. Platinum is considered to be the best reforming catalyst used. Platinum was found to lose its basic catalytic activity in the presence of 0.3% nitrogen or sulfur. The poisoned catalyst could be reactivated by fresh hydrocarbons. It was shown experimentally that the poisoning of platinum obeyed the mechanism of selective adsorption. Sulfur has higher selectivity to the dehydrogenation center and nitrogen compounds have higher selectivity to the isomerization center. All the variables had effects on the poisoning of platinum.

Lindley, C.A. (Aerospace Corp.), **PERFORMANCE OF AIR-BREATHING AND ROCKET ENGINES FOR HYPERVELOCITY AIRCRAFT.** International Council of the Aeronautical Sciences, Fourth Congress, Paris, Paper 64-557, August 24-28, 1964.

0551 The performance of a propellant augmented air-breather is shown to be superior to that of the unaugmented air-breather with a separate rocket. Tentative conclusions are drawn regarding the relative merits of various air-breathing and rocket propulsion schemes for several classes of hypervelocity flight missions.

Little, A. D., Inc., **INVESTIGATION OF PARAMETERS AFFECTING AIRCRAFT AND MISSILE FUEL FILTRATION.** U.S. Air Force, WADD TR 60-263, Contract AF 33(616)-6386, March 1, 1960. 55 pp. (AD 243251).

0552 A study was made of parameters which affect filter/separators. Information was obtained on the effect of qualified fuel additives on water separation, variables affecting coalescence of dispersed water, and variables affecting solids removal. Standard test methods and procedures are proposed for various aspects of filter/separator evaluation including: (1) a standard three-component particulate contaminant having both hydrophilic and hydrophobic fractions, (2) a method of dispersing contaminant to its ultimate particle size, (3) a method of injecting contaminant into the test facility, (4) a method of sampling fuel streams and analyzing for concentration of particulate matter by passing the sample stream directly through a Millipore Filter so that liquid samples need not be taken, (5) a method of sampling fuel streams, and analyzing for small amounts of water, (6) a highly refined kerosene as a standard fuel, and (7) a procedure for evaluation of filter/separation equipment incorporating separate runs for removal of water and solids singly and in combination for both high and low interfacial tension fuels.

Little, Arthur D., Inc., METHODS OF REMOVING WATER FROM AVIATION FUELS. Arthur D. Little, Inc., Report C-60347, U. S. Navy, Contract NOas 56-986-d, December, 1958. 85 pp. (AD 234986). 0553

Methods for removing free and dissolved H_2O from JP-5 aviation fuels were critically evaluated. Coalescence and membrane separation was suitable for installation in main fuel-supply liner. This method was demonstrated to effect essentially complete separation of free water from fuel with interfacial tensions well below 20 dy/cm. The most serious problem associated with phase separation is accidental passage of H_2O as a result of equipment failure or upset conditions. The techniques considered for dissolved H_2O removal include: (1) dry-gas stripping, (2) vacuum-stripping, (3) direct-contact desiccation, (4) distillation, and (5) refrigeration and filtration. Method 3 has the advantage of being able to handle gross amounts of free H_2O. Method 1 is believed to be one of the best methods since it is simple to control and involves a minimum of additional shipboard equipment. On a small scale, the dry-gas requirement for batch stripping closely approximates the theoretical minimum amount. Basic engineering-design relationships were established for packed towers for stripping water from JP-5. Substantial H_2O can be picked up again unless dried fuel is protected from humid air.

London, S. A., AIR FORCE PROGRAMS IN FUEL MICROBIOLOGY. U. S. Air Force, Aerospace Medical Research Laboratories, AMRL Memorandum M-24, January 1963. 13 pp. (AD 296873). 0554

A summary is presented of research programs connected with the 11 Air Force contracts awarded during 1962 for work connected with inhibition of micro-organism contamination of aviation fuels and lubricants.

Longwell, J. P. and Weiss, M. A. (Esso), HIGH-TEMPERATURE REACTION RATES IN HYDROCARBON COMBUSTION. Johns Hopkins University. Applied Physics Laboratory. Bumblebee report 221, U. S. Navy Contract NOrd 9233, October 1954. 28 pp. (AD 50821). 0555

In the design of high-output combustion chambers, maximum possible space heat release rates are desired. In order to minimize the volume and optimize design, it is of considerable important to known the kinetics-limited rates of reaction of hydrocarbons in air at usual combustion temperatures. This study is an attempt to determine those rates experimentally. Combustion was carried out inside three-inch and six-inch (inside diameter) insulated spherical reactors. The reaction space was vigorously stirred by incoming jets of homogeneous composition and temperature throughout the reactor. Blowout data were obtained for equivalence ratios from 0.4 to 2.0, pressures from one to one-eighth atmosphere absolute, and mass loadings from 0.6 to 10 gram-moles of air per second per liter of reaction volume. Average residence times varied from about 0.015 to 0.00035 second. Fitting the blowout data to the rate equations yielded an overall reaction order of 1.8 and an activation energy of 42,000 calories per mole. The maximum observed space heat release rate (near stoichiometric) was 3.0×10^8 Btu/hr-ft^3-atm$^{1.8}$. Solvent naphtha and isooctane were used as fuels.

0556 Los Angeles Aircraft Industries Association, and U.S. Office of Naval Research, SYMPOSIUM PROCEEDINGS. STRUCTURAL DYNAMICS OF HIGH SPEED FLIGHT. ACR-62, Vol. 2, April 24-26, 1961. (AD 325712). REPORT CLASSIFIED CONFIDENTIAL.

Titles of Papers presented were:
Hypersonic flutter model results and comparison with piston theory predictions.
Unusual flutter coupling in a high-speed missile.
Recent studies of several inputs to missile dynamic problems.
Analytical methods for the determination of aircraft response to nuclear blasts.
The effects of aerodynamic heating on panel flutter.

0557 Losikov, B. V., Puchkov, N. G., and Englin, B. A., MAIN ASPECTS OF PETROLEUM PRODUCT UTILIZATION; 2nd ed., Moscow, Gostoptekhizdat, 1959. 566 pp.

In the first part of this work, which is a revision of the first edition, the authors discuss the various kinds of fuels used to run internal combustion engines with spark plug ignition, diesel engines, and jet engines. The chemical composition of these fuels, their properties, stability, ignition, combustion and behavior during various phases of operation are analyzed. The problem of reducing carbon deposition, scaling and gumming, as well as of the corrosion of various engine parts and mechanisms are also discussed at length. The second part of this work is devoted to the use of lubricants, their properties, viscosity, oxidation resistance, etc. The authors discuss problems connected with the lubrication of interal combustion engines, transmission systems, jet engines, turbojet engines, turboprop engines and compressors of different types. Additives which improve the lubricating properties of oils, their oxidation resistance, and wear resistance are also discussed.

0558 Losikov, B. V., Rubinshteyn, I. A., and Sobolev, Ye. P., A METHOD OF STUDYING THE OXIDATION KINETICS AND THERMAL-OXIDATION STABILITY OF PETROLEUM PRODUCTS. Khimiya i Tekhnologiya Topliv i Masel, 1960, no. 7, 47-52.

An oxygen absorption test is described in which there is provision for replacing O_2 consumed during experiments. Pressure in the apparatus may be maintained constant irrespective of changes in atmospheric pressure.

Lowdermilk, W. H., Lanzo, C. D. and Siegel, B. L., INVESTIGATION OF BOILING BURNOUT AND FLOW STABILITY FOR WATER FLOWING IN TUBES. U. S. National Advisory Committee for Aeronautics, TN 4382, September 1958. 51 pp.

0559 The effects of flow restriction and compressible volume, located ahead of the test section, on flow stability and burnout heat flux were surveyed experimentally with water flowing in tubes. The minimum restriction pressure drop required to stabilize the flow and result in maximum burnout heat fluxes varied nearly linearly from 5 to 100 lb/sq. in. with an increase in velocity from 0.5 to 40 ft/sec. A compressible volume located between the restriction and the test section resulted in flow instability and lowered the burnout flux by as much as 80 percent. Correlations of the data are presented for low- and high-quality burnout regimes.

Lowdermilk, W. H. and Weiland, W. F., SOME MEASUREMENTS OF BOILING BURN-OUT. U. S. National Advisory Committee for Aeronautics, RM E 54K10, February, 1955, 18 pp.

0560 Measurements of boiling burnout heat flux for water flowing upward through an electrically heated tube were obtained for ranges of velocity from 0.1 to 19 feet per second; pressure from atmosphere to 2000 pounds per square inch; length-diameter ratios of 25, 37.5 and 50; and inlet subcooling from zero to 400°F. Unsteady flow was obtained for burnout conditions with a restriction located downstream of the point of burnout. A compressible fluid plenum chamber located between the restriction and the exit of the test section resulted in steady-flow burnout with a tenfold increase in the burnout heat flux.

Lucas, J. G. and Golladay, R. L., AN EXPERIMENTAL INVESTIGATION OF GASEOUS-FILM COOLING OF A ROCKET MOTOR. U. S. National Advisory Committee for Aeronautics, TN D-1988, October 1963. 30 pp.

0561 Data indicate that the Hatch-Papell gaseous-film-cooling correlation may be used in rocket combustion chambers with purely convective heating and nonreactive, nondecomposable coolants and in convergent and throat regions of the nozzle, if an increased heat-transfer coefficient is used. Reactive coolants may be used at the possible expense of a required flow somewhat higher than would be predicted for a nonreacting coolant with equivalent transport properties. The data indicate a possible large wall-temperature effect due to flame radiation, and an approximate method is presented for inclusion of this effect in the correlation.

0562 Joseph Lucas Ltd.-Research Laboratories, Burnley, England, REVIEW OF SPRAY AND VAPOUR COMBUSTION SYSTEMS FOR AERO GAS TURBINE ENGINES. Report B. 41.944, January 1953. (AD 315 938). REPORT CLASSIFIED CONFIDENTIAL.

Review of spray and vapour combustion systems for aero gas turbine engines. A potential advantage of the vapour system is that vapour can be piped in small quantities to a very large number of separate injection points in a single combustion chamber, in the fashion of the household gas burner. This is quite impracticable with liquid injection (unless possible by seepage through porous surfaces). Nevertheless the state of development of vaporising systems is such that this potential advantage has not as yet been fully obtained. Due to this limitation which appears to have been observed hitherto on the number of vapour admission points there is a tendency for final temperature traverses to be inferior to those from spray systems, but this effect should rapidly be reversed when wider distributions of vapour are used and improved knowledge of the mixing process is obtained. The vapour system has the further advantage at weak mixture conditions that is is less sensitive to enclosure temperature since there is no possibility of loss of efficiency through the impingement of droplets on the wall.

0563 Luidens, R. W. and Flaherty, R. J., ANALYSIS AND EVALUATION OF SUPERSONIC UNDERWING HEAT ADDITION. U. S. National Aeronautics and Space Administration, Memorandum 3-17-59E, April 1959. 55 pp. (AD 214914).

The linearized theory for heat addition under a wing has been developed to optimize wing geometry, heat addition, and angle of attack. The optimum wing has all of the thickness on the underside of the air-foil, with maximu thickness point well downstream, has a moderate thickness ratio, and operates at an optimum angle of attack. The heat addition is confined between the fore Mach waves from under the trailing surface of the wing. By linearized theory, a wing at optimum angle of attack may have a range efficiency about twice that of a wing at zero angle of attack.

A comparison of the conventional ramjet plus wing with underwing heat addition when the heat addition is concentrated near the wing shows the ramjet to be superior on a range basis up to Mach number of about 8. The heat distribution under the wing and the assumed ramjet and airframe performance may have a marked effect on this conclusion. Underwing heat addition can be useful in providing high-altitude maneuver capability at high flight Mach numbers for an airplane powered by conventional ramjets during cruise.

0564 Luikov, A. V. (Academy of Sciences of B. S. S. R.), HEAT TRANSFER BIBLIOGRAPHY - RUSSIAN WORKS. International Journal of Heat and Mass Transfer, 5, 571-82 (1962).

This extensive list of recent Russian publications on heat transfer is divided into sections on: books; analytical methods for solving heat and mass transfer problems; general heat transfer problems; heat and mass transfer with phase conversions; heat and mass transfer in chemical nuclear conversions; heat and mass transfer in drying processes; heat and mass transfer in the production of building materials and constructions; and thermophysical properties of various materials, heat agents and the methods of their determination, thermodynamics.

Luikov, A. V. (Institute of Energetics of the Academy of Sciences of B. S. S. R.), HEAT TRANSFER BIBILIOGRAPHY-RUSSIAN WORKS. International Journal of Heat and Mass Transfer, 6, 309-23 (1963). 0565

This extensive list of recent publications on heat transfer is divided into sections on: books, analytical methods for solving heat and mass transfer problems, general heat transfer problems, heat and mass transfer with phase conversions, heat and mass transfer with chemical conversions and combustion, heat and mass transfer in drying processes, heat and mass transfer in the production of building materials and constructions, thermophysical properties of various materials, heat agents and the methods of their determination, physics of high temperature processes and magnetic hydrodynamics, and heat and mass transfer in nuclear reactors.

Lundberg, R.E., Reynolds, W.C. and Kays, W.M. (Stanford University), HEAT TRANSFER WITH LAMINAR FLOW IN CONCENTRIC ANNULI WITH CONSTANT AND VARIABLE WALL TEMPERATURE AND HEAT FLUX. U. S. National Aeronautics and Space Administration, TN D-1972, August 1963. 194 pp. 0566

Consideration is given to the general problem of heat transfer in a concentric annulus with hydrodynamically fully established laminar flow. The differential equation for the temperature field is solved for special or fundamental boundary conditions, under the assumptions that the fluid in the annulus is incompressible, has constant properties, and that internal viscous generation is negligible. An apparatus for the experimental study of heat transfer to air with constant heat flux at either or both of the boundary walls is described. A comparison of the experimentally determined values with those predicted by the theory is presented and exhibits good agreement between them.

Lusebrink, T. R. (Shell Development), THERMAL STABILITY OF EXPERIMENTAL HIGH TEMPERATURE FUELS. U.S. Air Force, ASD TR 61-687, Contract AF 33(616)-7667, April 1962. 17 pp. (AD 276942). 0567

The high temperature stability of seven pure hydrocarbon fuels supplied by Wright Air Development Division were tested in the Shell Development Fuel Coker at 600, 700, and 800°F under recycle conditions. These fuels were: hexahydroindane, methyl hexahydroindane, pinane, bicyclohexyl, 9-methylperhydrofluorene, 2-ethylperhydrophenanthane, and 1,1-bis(4-methylcyclohexyl) ethane. On the basis of very limited data two trends regarding the effect of structure on high temperature stability were noted. One, condensed polycyclic naphthenes form slightly more deposit than non-condensed structures. Two, the presence of a five-membered ring appears to have a detrimetnal effect on stability as measured by deposit formation.

Lusebrink, T. R., Minor, H. B., Nixon, A. C., and Thorpe, R. E., NUCLEAR IRRADIATION OF JET FUELS: EFFECT OF DOSE ON THERMAL STABILITY AND OTHER PROPERTIES. American Chemical Society. Division of Petroleum Chemistry. Preprints, 3, no. 3, 165-83 (August 1958). 0568

The effect of radiation dose (gamma-ray and electron), high solubility iron, and peroxide contents on jet fuel stability were investigated. The level at which changes induced by radiation are first appreciable in the usual chemical and physical properties is about 3 x 10^7 r. In the dose range of 10^7 to 10^9 r many of the properties of jet fuels are exponential functions of the logarithm of the dosage. Thermal stability was measured in the Shell High-Temperature Stability Rig. In a mixed neutron-gamma flux more than half of the loss in thermal stability suffered by a group of three fuels may be attributed to dosage effects. In the range of 10^9 to 10^{11} rads/hr thermal stability, chemical and physical properties were comparatively independent of this variable.

Lusebrink, T. R. and Sorem. S. S. (Shell Development Co.), A TEST FOR EVALUATION OF JET FUEL STABILITY TO 950°F. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, C93-100 (September 1960). 0569

The high temperature stability of fuels for aviation gas turbines and rockets is currently evaluated in the CFR fuel coker, which is limited in temperature to a maximum of 500°F. A new heat exchanger design and other modifications of the CFR fuel coker, which makes it possible to operate the test at fuel and filter temperatures up to 950°F. are described. Only 125 ml of test fuel are required if a recycle procedure is used instead of the usual once through procedure requiring 5 gallons of fuel. Stability test results obtained with this revised equipment, which is designated the SD fuel coker, are compared with standard CFR fuel coker and EPPI research coker once-through tests for several reference and experimental fuels. The SD fuel coker is particularly useful for determination of the intrinsic stability of small quantities of pure hydrocarbons.

Lyubarskii, G. D., CATALYTIC DEHYDROGENATION OF LOWER PARAFFINIC HYDROCARBONS. Uspekhi Khimii, 27, 315-52 (1958). (CA, 52, 10862h). 0570

A review with 118 references, covering the period through part of 1958.

MacDonald, J. A., SPONTANEOUS IGNITION WITHIN A HEATED FUEL TANK WHEN PRESSURISED WITH AIR UNDER SIMULATED DIVING FLIGHT CONDITIONS. Gt. Brit. Royal Aircraft Establishment, RAE-TN-Mech. Eng.-341, September 1961. 12 pp. (AD 269937). 0571

Laboratory tests using a 4-inch stainless steel cylinder 12 inches long were made to explore the risk of spontaneous ignition in uniformly heated fuel tanks containing fuel vapor. The case investigated was that of a simulated dive from high altitude to ground level; the pressure within the tank being increased by 1.0 psi/sec. With Avtur fuel, spontaneous ignition occurred at wall temperatures above 230°C over a wide range of fuel vapor pressures. The value of the minimum wall temperature was not greatly affected by the temperature of the air inspired during a dive. Ignition did not occur immediately on air admission, but after a delay period which was mainly dependent on the wall temperature and fuel vapor pressure and the mean total pressure within the tank. The delay period agreed fairly well with other work in which well mixed streams of vapor and air were employed. Both the range of fuel vapor pressure giving ignition and the resulting pressure rise attained a maximum at a well temperature of 280°C. Ignitions were obtained at pressures corresponding to tank altitudes up to about 40,000 ft but the pressure rise on ignition did not exceed 2 psi at simulated altitudes above 23,000 ft.

Macfarlane, J. J. and Holderness, F. H., SOOT FORMATION IN HYDROCARBON/AIR FLAMES. I. PREMIXED FLAMES OF C_5 AND C_6 HYDROCARBONS AT PRESSURES UP TO 20 ATMOSPHERES. Gt. Brit. National Gas Turbine Establishment, Report R 253, February, 1963. 24 pp. (AD 411328). 0572

Quantitative measurements of soot formation are presented for premixed hydrocarbon/air flames. Various types of C_5 and C_6 hydrocarbons were turned in a laboratory scale steady flame at constant velocity over a range of pressures up to 20 atmospheres. Increases in soot formed per unit quantity of fuel burned, produced by increases in flame temperature suggest that the soot (a mixture of tar and carbonaceous solid) is produced by thermal degradation of a portion of the fuel under non-equilibrium reaction conditions. The applicability of the results to spray type gas turbine combustion systems is discussed.

MacKenzie, K. J. and Boddy, J. H., FUEL TESTING IN GAS-TURBINES: SOME EFFECTS OF ATMOSPHERIC HUMIDITY ON THE OPERATION OF COMBUSTION CHAMBERS USED FOR FUEL TESTING. Aircraft Engineering, 23, no. 264, 40-2, (1951). 0573

Calculations have been made to determine the effects of atmospheric humidity on the estimations of air mass flow and combustion efficiencies of gas turbine combustion chambers. Considerable errors may occur if no account is taken of humidity changes. Correction factors are provided to cover the expected range of variation in the British Isles. The influence of water vapour on combustion reactions is discussed and attempts have been made to predict the resultant effect on combustion chamber performance. Of the following performance characteristics it is shown that weak stable burning limits are likely to be affected to the greatest degree: The degree of heat release at the combustion outlet, the stable burning limits, outlet temperature distribution.

MacNevin, W., WATER DETECTION IN FUELS. Ohio State University. Research Foundation, Report no. 24 (Final report), U.S. Air Force, Contract W33-038-ac-16679 (17471), June 1949. 69 pp. (AD 39591). 0574

The study was directed toward the development of a system of detecting presence of water in aircraft fueling lines. The method selected was based on the turbidity of the water-in-fuel emulsion just downstream from the fueling pump. Various other methods were considered both for the actual field application and as calibration methods for field instruments.

Magaril, R. Z., A MECHANISM OF CARBON FORMATION IN THERMAL PROCESSES FOR THE CONVERSION OF HYDROCARBONS. Khimiya i Tekhnologiya Topliv i Masel, 8, no.8, 1-5 (1963). 0575

A mechanism of carbon formation in thermal processes for the conversion of hydrocarbons is tentatively formulated on the basis of a literature survey. At relatively low temperatures, such as in thermal cracking or reforming, the mechanism is stated to be different from that at high temperatures where an initially formed planar graphite nucleus having a high-energy unsaturation appears to be the main factor. 33 references. (in Russian)

Makowski, J. (AiResearch), PLANE'S SKIN'S HOT ... BUT CABIN AIR IS NOT. SAE Journal, 70, no. 7, 86, (1962). 0576

The paper describes three systems for maintaining comfortable cabin air temperatures in a supersonic aircraft. One of the systems described involves direct heat exchange with cold fuel. The necessity for redundant cooling systems is stressed.

0577

Makowski, J. and Linnett, K. (AiResearch Manufacturing), **PRECOOLED FUEL ACTS AS HEAT SINK FOR SUPERSONIC TRANSPORT AIR CONDITIONING SYSTEMS.** SAE Journal, 70, Nov., 66-7, (1962).

Mach 3 Supersonic Transports preclude the use of atmospheric air as a heat sink for air conditioning systems; any air taken aboard will be too hot to be useful as a sink. Fuel on its way to the engine, however, may act as a perfectly acceptable heat sink. The precooled fuel system as a direct heat sink for supersonic transports exhibits three main advantages: 1. The fuel is at a temperature low enough to be used as a direct heat sink. (A direct heat sink requires only heat transfer or transport systems between the cooled compartment and the sink ... no refrigeration cycle is needed. 2. The fuel is conveniently available aboard the aircraft. The sink imposes minimum weight and volume penalties on the aircraft because it serves purposes other than just heat absorption.

0578

Malik, J. G., Graber, F. W. and Keller, E. E., **MATERIAL - FUELS AND LUBRICANTS - RP-1 FUEL - PHYSICAL PROPERTIES.** General Dynamics/Convair, Report 8926-065, U. S. Air Force Contract AF 33(657)-8926, December 1958. 7 pp. (AD 290 659).

The density and viscosity of RP-1 fuel were determined by use of a modified Sprengel type pycnometer and a standard Ostwald viscometer, respectively. The thermal conductivity of liquid and solid RP-1 and the linear coefficient of thermal expansion of the solid RP-1 were determined with special apparatus. The specific heat and cubical coefficient of thermal expansion of liquid and solid RP-1, respectively, were calculated from appropriate physical data. The data obtained were as follows: (a) density of liquid, 0.7967 ± 0.0005 gm/ml at 25°C, 0.7987 - 0.0036 (t°C - 25.0) gm/ml, -45 to + 25°C; viscosity, 1.96 cp or 2.45 X 10^{-2} stoke at 20°C; thermal conductivity of liquid (332 ± 5) X 10^{-6} cal cm/cm^2 sec deg at 28°C; thermal conductivity of solid (6.4 ± 1.0) X 10^{-4} cal cm/cm^2 sec deg at 78°C, 10.0 X 10^{-4} cal cm/cm^2 sec deg at -196°C (estimated); specific heat of liquid, +0.53 cal/gm deg at 28°C; cubical coefficient of expansion of liquid, (8.7 ± 0.1) X 10^{-4} cc/cc deg from -40 to 25°C (calculated); linear coefficient of expansion, (61 ± 4) X 10^{-6} cm/cm deg -190 to +50°C. The report consists of this abstract only plus an attached reference report giving details of test procedure.

0579

Malmberg, E. W. (Sun Oil), **SHOCK TUBE STUDIES OF IGNITION CHARACTERISTICS OF SOME LIQUID HYDROCARBONS.** American Chemical Society, Division of Fuel Chemistry. Preprints of Papers Presented at St. Louis, Missouri, March 21-30, 1961, pp. 18-25.

Ignition delays were measured for mixtures with oxygen of benzene, toluene, i-octane, and pentane and for some pentane-air mixtures. A shock tube was used and delays were measured behind the reflected wave. No diluent was used in the mixture but maximum pressures in the reaction section were about 100 mm. The experimental program was limited and data showed considerable scatter.

Mamedaliev, G. M., Topchiev, A. V., Vlasova, N. D., and Anikina, G. N., DEMETHYLATION AND ISOMERIZATION OF PSEUDOCUMENE ON ALUMINOSILICATES. Academy of Sciences (U.S.S.R.). Bulletin. Division of Chemical Sciences, 1961, 588-95. 0580

A study of the demethylation and isomerization of pseudocumene was carried out in the presence of benzene and toluene over silica-alumina catalysts. At 1-10 atm pressure and 450°-480°C both toluene and xylene were found when benzene was added to the feed; with toluene in the feed, xylene was the only reaction product. Yields of 30% and lower were obtained.

Markels, M., Jr. (Atlantic Research Corp.), SOLUTION AND EVOLUTION OF GASES AND VAPORS IN AIRCRAFT FUELS. U. S. Air Force, WADC TR 59-193, Contract AF 33(616)-3735, April 1959. 152 pp. (AD 233936, PB 161900). 0581

A program was undertaken to study solution and evolution rates of gases and vapor in aircraft fuels. The purpose was to establish parameters and develop theories to predict the operation of the fuel tanks of high-powered, high-altitude aircraft. Aircraft fuels were pressurized under various gases in shaking tanks for various fuel levels, temperatures, pressures, contaminants, shaking frequency, and shaking direction. Shaking frequency proved to be the most important variable in controlling the rate constants of solution and evolution. Not only did the rates tend to increase with increased frequency, but when the shaking frequency was in phase with the natural oscillation of the fuel, the rates increased one hundred to a thousand times. Contaminants such as fine dust which held and disbursed minute air bubbles did not affect solution but markedly increased the evolution rate. However, this effect occurred during the first evolution cycle only, corresponding to the first initial climb to high altitude. Fuel level affected the rates by affecting wave action in the tank. The rates increased with increasing amplitude and generally decreased with increase in tank size.

Markels, M., Jr., Brandreth, D., DeZubay, E., Durfee, R., Macek, A., Schmitt, E. and Sargent, W., SLURRY FUELS (U). Atlantic Research Corporation, Report 61-5048-Q3, Third Progress Report, U.S. Air Force Contract AF 33(616)-7432, July 1961. (AD 327 307). REPORT CLASSIFIED CONFIDENTIAL. 0582

An effort is being made to obtain high volumetric heating value slurries, including formulating slurries of metals and borides in cryogenic fluids such as liquid H and He. High volumetric heating value slurries are applicable to low altitude, high velocity airframes of large body-to-wing drag ratios. The cryogenic slurries are most applicable to reaction engines having fuel and oxidizer streams composed of three or four components.

0583 Markels, M., Jr., DeZubay, E.A., Durfee, R., Schmitt, E., Sargent, W. and West, W., SLURRY FUELS (U). Atlantic Research Corporation, Report 61-5048-Q 4, Fourth Progress Report, U.S. Air Force Contract AF 33(616)-7432, November 1961. (AD 328 144). REPORT CLASSIFIED CONFIDENTIAL.

The development of high volumetric heating value slurries was substantially completed during this report period; several classes of slurries were formulated.

0584 Markels, M., Jr., Friedman, R., DeZubay, E., Brandreth, D., et. al. (Atlantic Research Corporation), HIGH VOLUMETRIC HEATING VALUE FUELS (U) - VOL. II - PREPARATIONS AND PROPERTIES OF SLURRY FUELS. U.S. Air Force, ASD TDR 62-489, Vol. II, Contract AF 33(616)-7432, September 1962. (AD 336 879). REPORT CLASSIFIED CONFIDENTIAL.

A detailed presentation of the preparation, characterization, and combustion behavior of heavy-metal slurries with high volumetric heating values is presented. With processing equipment now available, those slurries could be processed in quantities necessary for testing prototype engines.

0585 Marsh, B.W. and Bajek, J.J., EVALUATION OF METHODS FOR SELF-ACCELERATION OF RAMJET ENGINES. Marquardt Aircraft Co., Report 5340 A, U.S. Air Force Contract AF 33(616)-51, December 1953 - Revised August 1954. (AD 80350). REPORT CLASSIFIED CONFIDENTIAL.

This report presents the results of a study made to evaluate and apply methods for self-acceleration of ramjet engines. The basic objectives of the study summarized in this report are (1) to evaluate the potentialities of several advanced-type ramjet engines with respect to improving the range and/or gross weight characteristics of supersonic missiles (2) to evaluate the relative abilities of the same engines to minimize or eliminate ramjet-powered missile booster requirements in order to reduce the complexity of the two-phase power plant system. A broad approach to the solution of the problem of ramjet self-acceleration is presented, including an evaluation of such methods as variable geometry devices, ramjet afterburners, high energy fuels, and rocket ramjet configurations. Performance studies were conducted for each of the engine types using values of combustion efficiency that may be expected after a reasonable development period. The study was limited to consideration of nacelle type engine installations.

Martin, E.C., A RESEARCH AND DEVELOPMENT STUDY OF FUEL AND OIL CONTAMINANTS. Southwest Research Institute, Final Report, U.S. Army Contract, DA 23-072-AMC-128A, June 1964, 129 pp. (AD 350 861). REPORT CLASSIFIED CONFIDENTIAL. 0586

No abstract.

Martin, H. F. and Gudzinowicz, B. J. (Monsanto Research Corp.), THE THERMAL STABILITY OF POLYNUCLEAR AROMATIC HYDROCARBONS AND THE POLAROGRAPHIC HALF-WAVE REDUCTION POTENTIAL. Nature, 200, no. 4901, 67-70 (1963). 0587

When a newly observed relationship between $E_{1/2}$ with other molecular properties was compared with published correlations of $E_{1/2}$ with other molecular properties for 14 polynuclear aromatic hydrocarbons, it became apparent that thermal stability is a function of the energy required to promote electrons to the lowest unoccupied orbitals, and the higher the energy, the higher the stability and the "p" ultraviolet band frequencies, and the more negative the values of $E_{1/2}$.

Martin, L. J., Mell, C. W., and Milek, J. T. (Hughes Aircraft), ADVANCED HEAT TRANSFER FLUIDS. U. S Air Force, WADD TR 61-186, Contract AF 33(616)-7109, July 1961. 365 pp. (AD 268374). 0588

A materials research and development project was undertaken to find fluids for use over the temperature range of -80°F to 400°F. Five fluids (silicone-type) were found to meet the requirements. Test procedures and apparatus were modified in order to test fluid samples of small volume. A stainless steel dynamic loop apparatus was built and operated at 400°F. An extensive literature survey covering organic and metal-organic compounds, heat transfer, thermal apparatus, and measurement techniques, electronic equipment cooling, liquid metals and fused salts is included.

Martin, R., Niclause, M., and Dzierzynski, M., **INFLUENCE COMPLEXE DE TRACES D'OXYGENE ET EFFETS DE PAROIS DANS LA PYROLYSE DU PROPANE.** Comptes Rendus des Seances de l'Academie des Sciences (Paris), <u>254</u>, 1786-8 <u>(1962)</u>. 0589

When propane was pyrolyzed in a pyrex glass vessel, small traces of oxygen accelerated the reaction rate. Oxygen was consumed during the pyrolysis and the accelerated rate declined accordingly. The effect of oxygen on the reaction rate varied with the surface-volume ratio of the reactor and for high surface-volume ratios oxygen acted as an inhibitor.

Martinengo, A., Wagner, H. Gg. and Zunst, D. **"UNTERSUCHUNGEN UBER SELBSTZUNDUNGS-REAKTIONIEN VON KOHLENWASSERSTOFF-LUFTMISCHUNGEN DURCH ADIABATISCHE VERDICHTUNG. II TEIL. VERSUCHSERGIBNISSE"**, Zeitschrift for Physicalische Chemie Neue Folge, <u>22</u>, 292-304 (1959). 0590

A rapid compression machine was used to study ignition delays of various hydrocarbons and hydrocarbon mixtures with air. Data are presented for n-C_6, n-C_7, n-C_8 and n-C_{10} paraffins. Data are interpreted in terms of a two step ignition process with ignition times for each step determined from pressure records. Light emission was also recorded.

Maslianskii, G. N. and Bursian, N. R., **DEHYDROGENATION KINETICS OF CYCLOHEXANE AND ITS HOMOLOGS ON A CHROMIUM CATALYST AT ATMOSPHERIC PRESSURE.** Journal of General Chemistry (U. S. S. R.), <u>28</u>, 2684-9 (<u>1958</u>). 0591

The kinetics of cyclohexane dehydrogenation were studied over a chromia on alumina catalyst at 410-475° and atmospheric pressure. It was established that the rate of the dehydrogenation reaction was described by the kinetic equation for a monomolecular reaction and inhibited by hydrogen but not benzene. The rate of dehydrogenation of six-membered naphthenes increased regularly with an increase in the hydrocarbon's molecular weight.

0592 Masson, D. J. and Gazley, C., Jr. (Rand Corporation), **SURFACE PROTECTION AND COOLING SYSTEMS FOR HIGH SPEED FLIGHT.** Aeronautical Engineering Review, 15, no. 11, 46-55 (1956).

A general survey of problems involved in high speed flight of either missiles or airplanes as related to temperature and materials is presented. Various surface protection systems - thick skin, insulation, internal cooling, and transpiration and mass-transfer cooling - are considered. Expendable coolants (e.g., water) are favored over fuel as a coolant so long as only the sensible heat of the liquid fuel is available (i.e., engines are designed for liquid fuel).

0593 Mathauser, E. E. (NASA, Langley Research Center), **REFRACTORY METALS FOR THERMAL-PROTECTION SYSTEMS.** Astronautics and Aeronautics, 2, no. 7, 66-9 (1964).

Within the past decade, considerable effort has been directed at studies of refractory metals with the objective of utilizing them in high-temperature environments. Substantial progress has been made in understanding the behavior and use of the refractories; but many problems still remain, and to date relatively little use of these metals has been made in other than specialized applications, e. g. rocket-motor nozzles, furnace structures, and lamp filaments. This discussion concerns the status of refractory-metal sheet for thermal-protection systems, and draws attention to factors that have a major influence on utilization of refractories, such as availability, material properties, fabrication, and protective coatings.

0594 Matveev, I. G., Gelperin, N. I., Vilshau, K. V. and Globus, R. L., **HYDROCARBONS OF THE DIPHENYLMETHANE SERIES AS HIGH-TEMPERATURE HEAT-TRANSFER MEDIA, AND THEIR PHYSICOCHEMICAL PROPERTIES.** Journal of Applied Chemistry (U. S. S. R.), 31, 856-61 (1958). (CA, 52, 17936 b).

The physicochemical properties of ditolyl-dixylyl-, dicumyl-, and tetraisopropyldiphenylmethane were determined. The properties given include: density to 200°C, viscosity to 150°C, vapor pressure to 160°C, boiling point to 5-atmospheres, freezing point, flash point, surface tension at room temperature, and thermal conductivity to 100°C. Changes in properties resulting from prolonged boiling were also evaluated. The compounds are not toxic, do not corrode iron, and can be used as heat-transfer media in the liquid or gas state. The most stable is ditolylmethane and the least stable is tetraisopropyldiphenylmethane.

Maurer, G.W., BIBLIOGRAPHY OF TWO-PHASE FLOW HEAT TRANSFER. Westinghouse Atomic Power Division, TM-249, U.S. Atomic Energy Commission Contract AT-11-1-Gen-14, August 1960. 0595

This bibliography was prepared to provide a relatively comprehensive listing of the literature on two-phase heat transfer and related topics. The bibliography should be especially useful to those beginning research on problems related to boiling heat transfer. Many references on bubble dynamics are included since they have proved useful in the analysis of boiling phenomena.

In general, the bibliography does not include references on two-phase flow pertaining to type of flow, pressure drop and vapor fractions. Although it was recognized that these phenomena may influence the process of boiling heat transfer to a flowing fluid, they were not included because of the practical limit on the scope and size of the bibliography. Also, good bibliographies and literature surveys on two-phase flow and vapor formation are available and are listed under general references.

Mayer, E. and John, R. R. (Arde Associates, Combustion Dynamics Division), SURVEY OF THE ROLE OF CHEMISTRY IN PREMIXED COMBUSTION PHENOMENA. U. S. Air Force, AF OSR TR 57-79, Contract AF 18(600)-1560, October 1957. (AD 136 647). 0596

The role of chemistry in premixed gaseous combustion phenomena is discussed on the basis of a critical survey of the literature. The phenomena considered include laminar-flame propagation, space-homogeneous combustion, ignition, quenching and stability limits. The current literature dealing with these phenomena is critically reviewed.

Mayhew, W. E. (Republic Aviation Corp.), DESIGN AND DEVELOPMENT OF A 1000°F HYDRAULIC SYSTEM, PART I, INVESTIGATION. U. S. Air Force, WADC TR 59-430, Part I, Contract AF 33(616)-5117, July 1959. 208 pp. 0597

This report includes a state-of-the-art survey into the availability of fluids, materials and components to be used in a hydraulic system where a significant portion of the system will operate at 1000°F fluid temperature in an ambient of 1200°F. A fluid evaluation program is described which confirms the selection of bis(m-phenoxyphenyl)ether as the most promising fluid for this system. Physical properties and performance data for the phenoxyphenyl ether have been compiled and are included. A limited seal test program is also described in which various materials and seal configurations were tried for high temperature sealing. A high temeprature hydraulic system design is shown and components required for the system are discussed. Specifications for all components and the fluid were drawn up and are included in a separate volume.

Mazanski, T. and Taniewski, M., THERMAL DECOMPOSITION OF PROPANE-BUTANE MIXTURES. Przemysl Chemiczny, 39, no. 3, 170-5 (1960). (CA, 57, 13593d). 0598

The degree of reproducibility of the pyrolysis of propane-butane mixtures in laboratory tubular reactors (600-800°) is reported. The influence of temperature (650-800°) and contact time (0.6-127.5 sec.) on the course of the ethylene-propylene pyrolysis of propane-butane mixtures were observed. The log of contact time, in the range of temperatures examined, is a linear function of temperature.

Mazitova, F. N. and Paushkin, Ya. M., NEW OXIDATION INHIBITORS AND STABILIZERS FOR GASOLINE. Khimiya i Tekhnologiya Topliv i Masel, 3, no. 11, 10-12 (1958). (CA, 53, 3672e). 0599

In comparison with a B 95/130 stability of 60 min. for a leaded gasoline without additives, the following values are reported after addition of the amines listed: p-tert-butylphenol 60; di-tert-butylphenol 240; o-amino-p-tert-amylphenol 240; di-methylphenyl-m-amino-p-hydroxyphenylmethane 240; 2,6-diamino-4-tert-butylphenol 540; p-hydroxydiphenylamine 330; "Ionol" 330. The additives were used in concentrations of 1-5.5 mg./100 cc.

McCafferty, R. J., ANALYTICAL INVESTIGATION OF FUEL TEMPERATURES AND FUEL-EVAPORATION LOSSES ENCOUNTERED IN LONG-RANGE HIGH-ALTITUDE SUPERSONIC FLIGHT. U.S. National Advisory Committee for Aeronautics, RM E53E25, August 1953, 38 pp. 0600

Two types of fuel losses were considered, loss due to adiabatic evaporation during climb and loss due to aerodynamic-heating effects. Heat-balance relations were employed to estimate amount of heat transferred to fuel contained in a cylindrical fuselage. Influence of flight speed, flight altitude, fuel withdrawal rate, tank size, tank pressurization, insulation, and initial fuel temperature on evaporation of JP-4 fuel was predicted. Influence of fuel volatility was determined by comparing evaporation obtained with JP-4 fuel and that obtained with JP-5. Results of analysis predicted, for an uninsulated tank, JP-4 fuel-boiling losses of 38% of total fuel weight carried by aircraft at the maximum flight speed (Mach 4) and altitude considered. Fuel losses increased with increasing flight speed and flight time but decreased with increasing altitude. Fuel loss caused by adiabatic evaporation could be eliminated by ground refrigeration, tank pressurization, or use of low volatility fuel. Fuel loss due to aerodynamic heating could be eliminated by a combination of insulation of a practical thickness and use of a low volatility fuel; however, if tank pressurization were employed without insulation excessive pressures would be required.

McCarthy, J. R. and Wolf, H. (North American Aviation), FORCED CONVECTION HEAT TRANSFER TO GASEOUS HYDROGEN AT HIGH HEAT FLUX AND HIGH PRESSURE IN A SMOOTH, ROUND, ELECTRICALLY HEATED TUBE. ARS Journal, 30, 423-5 (1960). 0601

The results presented here summarize experiments conducted over a sufficiently wide range of pressure and heat flux to be of interest in the design of high performance rocket engines although the gas temperature at the inlet to the test section was greater than -160 F. Heat fluxes as high as 14.8 Btu/sec in.^{2} and pressures to 1250 psia were achieved. The data presented are the initial results of a program directed toward the determination of the heat transfer characteristics of gases under conditions of very high surface to fluid bulk temperature ratios. It is anticipated that values of this ratio as high as 10 can be achieved with the present apparatus, which consists of two electrically heated stainless steel test sections 13-in. long, having an ID of 0.194 and 0.305 in. (L/D = 67 and 42.6, respectively). The average heat transfer coefficients could be correlated well in terms of dimensionless parameters with physical properties evaluated either at average bulk temperature or wall temperature, and are in good agreement with other recent data.

McCarty, T. A. and Weingartner, A. C. (APL, Johns Hopkins University), INSULATION BURDENS MACH 7 RAMJET. SAE Journal, 69, no. 12, 48-49 (1961). 0602

The paper discusses the problems involved in using a combination of insulation and vaporizing water to maintain sufficiently low temperatures on surfaces of an external expansion ramjet for a Mach 7 aircraft. Several insulation materials and systems of application are considered and compared in weight of insulation plus water required.

McCaully, R. J., Olds, W. F., Reiman, P. A. (Arthur D. Little), INVESTIGATION OF WATER-REACTIVE CHEMICALS FOR ANTI-ICING ADDITIVES IN AVIATION FUELS. U.S. Air Force, WADD TR 61-40, Contract AF 33(616)-7006, March 1961. 52 pp. (AD 256758). 0603

Four compounds have been found effective in preventing filter icing when fuel temperatures are reduced to -65°F, including 2,2-dimethoxypropane, trimethyl orthoformate, trimethyl orthoacetate, and trimethyl orthovalerate. Additive concentrations as low as 0.1% are sufficient to prevent icing when 500 mg/l of water is present in the fuel. Each of the possible additives requires acid catalysis to initiate reaction with water. Several acid systems have been found effective including hydrogen chloride, phosphoric acid, and boron trifluoride. Acid concentrations in the range of 0.015 to 0.040 milliequivalents per ml of additive are sufficient. Acid concentrations in the fuel are so low that corrosion effects are minimized. If necessary, however, certain corrosion inhibitors approved for use in military aviation fuels may be incorporated in the additive-catalysts system. Compatibility of the additive system with the topcoating material used on integral fuel tanks of certain aircraft appears to be satisfactory. The reactive additive systems are soluble in the fuel and will react with any water or ice present to form soluble and combustible reaction products. Thus water in the fuel system is chemically destroyed and removed from the aircraft.

McClelland, C. C., EFFECTS OF JET FUEL CONSTITUENTS ON COMBUSTOR DURABILITY. U. S. Naval Air Engineering Center, Aeronautical Engine Laboratory, NAEC-AEL-1736, May 1963. 13 pp. (AD 404084) 0604

The possibility of reducing jet engine combustor liner temperatures by controlling the fuel properties which cause excessive flame radiation was investigated. A J79 combustion chamber was tested with twelve fuels at two inlet temperatures and three heat release rates. The results were similar to those for a J57 combustor except for the effects of design variables. The data showed a relationship of flame radiation and liner temperatures with fuel luminometer number and hydrogen content. Polycyclic aromatic hydrocarbons were found to be more severe than monocyclic. Liner temperatures can be improved by fuel selection but the effect of fuel properties is limited and further improvement must be sought in combustor design. Test fuels included JP-4, JP-5 (an ordinary JP-5, one that was aromatic free, and blends with mono and polycyclic aromatics), "JP-150", normal heptane, iso-octane, toluene, and tetralin.

McGough, C. B. and Houghton, G. (University of Pittsburgh), CATALYTIC ACTIVITY OF THE LANTHANIDE OXIDES FOR THE DEHYDROGENATION OF CYCLOHEXANE. Journal of Physical Chemistry, 65, 1887-91 (1961). 0605

A rising temperature flow reactor was used to determine the activation energies, frequency factors and kinetics for the heterogeneous dehydrogenation of cyclohexane over La_2O_3, CeO_2, Pr_2O_3, Nd_2O_3 and Sm_2O_3. The effect of crystal structure was evaluated by preparing the oxides in their different crystal forms (A, B or C structures) and the effect of a support was investigated by depositing the oxides on alumina. Within the error of experiment, no effect of the support, crystal structure, paramagnetism or valence state could be detected, indicating perhaps that the catalytic activity of the lanthanide oxides is associated with outer electronic states. Compared to Cr_2O_3, the lanthanide oxides were less active and showed higher activation energies.

McGregor, J. M. (Thermoline Company, Inc.), MICROORGANISMS FAIL TO GROW IN FURANE LINED JET FUEL STORAGE TANKS. Materials Protection, 2, no. 6, 24-6 (1963). 0606

The paper presents field data showing ability of a furane resin coating to prevent bacterial growth in jet fuels during storage. It gives results of laboratory tests conducted to correlate with 14 year field data on 60,000 Air Force tanks.

McKee, D. W. (General Electric Research Laboratory), CATALYTIC ACTIVITY AND SINTERING OF PLATINUM BLACK. I. KINETICS OF PROPANE CRACKING. Journal of Physical Chemistry, 67, 841-6 (1963). 0607

The activity of unsupported platinum black for the catalytic cracking of propane has been studied between 100 and 200° by a static volumetric technique. The results indicated that the specific activity of platinum (activity per unit area of catalyst surface) was considerably less than that of nickel for this reaction. However, the activity of platinum black was very dependent on the degree of sintering, a process which occurred readily with the reduced metal at temperatures above 100°. The specific activity of the metal decreased rapidly as sintering proceeded, indicating that the sintering process involved reduction in both surface area and density of surface sites (vacancies or point defects) which were responsible for the catalytic activity. The ratio of ethane:methane in the products of cracking of propane was generally greater for platinum than for nickel. The activation energy for the cracking reaction was found to be 24 kcal/mole but this value decreased with increasing density of active sites.

McKee, D. W. (General Electric Research), THE KINETICS OF PROPANE CRACKING ON NICKEL. American Chemical Society. Journal, 84, 4427-31 (1962). 0608

The catalytic cracking of propane on unsupported nickel has been studied over the temperature range 100-200°. Methane, small amounts of ethane and a carbonaceous surface residue of variable composition were the products of the reaction, which proceeded with an activation energy of 15 ± 1 kcal./mole. A zero-order dependence of the rate of reaction on the partial pressure of propane was generally found, although poisoning of the catalyst by strongly adsorbed residues became increasingly important at higher temperatures. Possible mechanisms of the cracking reaction are discussed.

McKeown, A. B. and Hibbard, R. R., EFFECT OF DISSOLVED OXYGEN ON THE FILTERABILITY OF JET FUELS FOR TEMPERATURES BETWEEN 300° and 400°F. U. S. National Advisory Committee for Aeronautics, RM E55I28, December 1955. 22 pp. 0609

The effect of dissolved oxygen on the filter-clogging characteristics of three JP-4 and two JP-5 fuels was studied at 300° to 400°F in a bench-scale rig, employing filter paper as the filter medium. The residence time of the fuel at the high temperature was approximately 6 seconds. For these conditions, the clogging characteristics of the fuels increased with both increasing temperature and increasing concentration of dissolved oxygen. The amount of insoluble material formed at high temperatures necessary to produce clogging of filters was very small, of the order of 1 milligram per gallon of fuel.

McLafferty, G H. (United Aircraft), RELATIVE THERMODYNAMIC EFFICIENCY OF SUPERSONIC COMBUSTION AND SUBSONEC COMBUSTION HYPERSONIC RAMJETS. ARS Journal, 30, 1019-21 (1960). 0610

An analytical model is set up to permit comparison of the relative thermodynamic efficiencies (fuel consumption or specific impulse) of supersonic combustion and subsonic combustion hypersonic ramjets for arbitrary inlet performance. The results indicate that the specific impulse of a supersonic combustion ramjet will be superior to that of a subsonic combustion ramjet at Mach numbers above approximately 7 for configurations having isentropic spike external compression inlets and above 10 for configurations having internal compression inlets.

McLean, C.D. and Goodrich, J.E., THERMAL STABILITY OF GAS TURBINE FUELS. California Research Corp., Summary Report, U.S. Air Force Contract AF 18 (600)-152, April 1955. 32+ pp. 0611

The purpose of this investigation was to isolate and identify the chemical nature of constituents responsible for thermal instability of jet fuels. A review of available literature and past experience indicated that the thermally unstable compounds in a jet fuel might be polar nitrogen and sulfur compounds. A hot plate test which involved recirculation of fuel over a heated surface and measurement of total deposits formed was used to evaluate the stability of several JP-4 fuels. Tests showed that the most unstable compounds were concentrated in the polar fractions of the fuels. However, the stability of these polar compounds was found to depend upon the nonpolar medium into which they were blended.

McManus, H. N., Jr., Ibele, W. E., and Murphy, T. E., THE EFFECT OF FUEL TYPES AND ADMISSION METHOD UPON COMBUSTION EFFICIENCY. American Society of Mechanical Engineers. Transactions. Series A. Journal of Engineering for Power, 81, no. 4, 423-6 (1959). 0612

A series of tests to determine the effect of combustion-chamber length for three different types of fuel admission (gaseous, spray, and vaporized) upon combustion efficiency was performed in identical combustor geometries and with similar air-flow patterns. The effects of fuel-air ratio and full-section velocity were examined for individual methods of admission. The effect of fuel volatility also was examined. It was found that the vaporized-fuel type of admission was superior in efficiency to the spray-fuel admission in all comparable cases. Increased fuel volatility improved performance in the case of the vaporizer but did not affect the performance of the spray nozzle. The performance of vaproizing tubes was found to vary inversely with size. An optimum size was exhibited.

Meguerian, G.H., Hillstron, W., Hirschberg, E.H., Rakowsky, F.W. and Zlets, A., FUNDAMENTAL INVESTIGATION OF THE CATALYTIC DEGRADATION OF HYDROCARBON FUELS. American Oil Co., Quarterly Report No. 1, U.S. Army Contract DA 18-108-AMC-198A, September 1963. 15 pp. (AD 422 003). 0613

Effects of Co, Mn, and Fe octanoates upon gum formation during oxidation (actual gum) and during storage at elevated temperatures (potential gum) were investigated. The fuel mixture consisted of 80 vol. % dodecane, 10 vol. % isooctane, 5 vol. % tetralin, and 5 vol. % dodecene-1. Azobisisobutyronitrile was used as initiator in all cases. Both actual and potential gum increased in the presence of the metal salts. This increase, however, resulted from the catalytic acceleration of oxidation rather than from catalysis of the gum forming step. Effects of 18 solid and 2 liquid compounds upon cool-flame and autoignition reactions of iso-octane were surveyed. Oxides of Pb, As, Bi, Ge, W, and Sb inhibited either cool-flames, autoignition, or both. Another group of oxides (Ag, Sn, Cu, Cr, and Co) gave very intense post cool-flame reactions although inhibited both cool-flame and autoignition reactions. The nature of this phenomenon will be further investigated by product analysis.

Melik, J. S. and Johnson, M. F. L. (Sinclair Research), DEALKYLATION OF tert-BUTYLBENZENE BY CRACKING CATALYSTS. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, B109-18 (September 1960). 0614

A differential reactor system was used to measure rates of dealkylation of tert-butylbenzene over a variety of catalysts, as a function of temperature and of added water vapor. With but one exception, activation energies were the same for all catalysts studied. Differences in activity between catalysts were believed to be due to differences in the number of sites capable of catalyzing this reaction. The addition of water vapor with the hydrocarbon had little effect, up to a point, upon the activity of silica-alumina, kaolinite-based catalyst, mixed base catalyst, or silica-alumina-zirconia. Water was harmful to boria-alumina or fluoride-alumina, by causing volatilization of the promoter. Water enhances the activity of silica-magnesia or montmorillonite based catalyst.

Metcalfe, H., SOME ASPECTS OF THE DESIGN OF HYPERSONIC VEHICLES. pp. 345-368 in: Collar, A. R. and Tinkler, J., eds. "Hypersonic Flow". New York, Academic, 1960. 0615

After the various flight regimes of hypersonic vehicles are presented, a discussion of airframe shape is developed. This is followed by an examination of forms of aerodynamic control. The discussion concludes by making suggestions for configurations for a range of tasks and by outlining areas in which design information is urgently required.

Methven, T. J. and Hartley, R. A., AN EXPERIMENTAL EVALUATION OF HEAT TRANSFER TO FUEL IN INTEGRAL WING TANKS OF HIGH SPEED AIRCRAFT. Gt. Brit. Royal Aircraft Establishment, RAE-TN-Mech. Eng.-349, August 1962. 27 pp. (AD 281 785). 0616

Heating tests were made on tanks containing either kerosene or water to determine heat transfer relationships for integral wing fuel tanks exposed to aerodynamic heating. A particular study was made of the tank base and included the effect of simple baffles immersed in the fuel near the base of the tanks to reduce the heat flow. The tank top surface was also studied with and without an airspace between fuel and surface, and for the surface at slopes up to 30 degrees from the horizontal. The results from the tests showed good agreement generally with established convective heat transfer information. They showed that a simple baffle can reduce heat transfer to the bulk fuel to 20 per cent of that for a plain base. The layer of fuel under the baffle serves as insulation, but can be burned at the end of the flight; it thus has the advantage of not reducing payload as an ordinary insulation would. The test conditions represented a supersonic transport aircraft cruising at M = 2.2 at 60,000 feet, but the results have wider applications.

Michel, R. and Duong-Vinh-Hung (O.N.E.R.A.), FLUX DE CHALEUR AU BORD D'ATTAQUE D'UNE AILE A FORTE FLECHE EN HYPERSONIQUE. International Council of the Aeronautical Sciences, Fourth Congress Paris, Paper 64-561, Aug. 24-28, 1964. 0617

The paper reports results of an experimental and theoretical study of the transfer of heat at the leading edge of a strongly swept wing at Mach numbers of 7 and 10.

Michigan University, HEAT TRANSFER; SYMPOSIUM. Held at the University of Michigan, Summer 1952. Ann Arbor, University of Michigan, 1953. 286 pp. 0618

Some of the papers which are particularly pertinent are HEAT TRANSFER WITH EVAPORATION by W. M. Rohsenow, RECENT DEVELOPMENTS IN CONVECTIVE HEAT TRANSFER WITH SPECIAL REFERENCE TO HIGH-TEMPERATURE COMBUSTION CHAMBERS by M. Summerfield, and two papers by E. R. G. Eckert, CONVECTIVE HEAT TRANSFER AT HIGH VELOCITIES and TRANSPIRATION AND FILM COOLING. Papers on thermal stress in structural materials are also included.

Mickle, E. A., Clauson, W. W., and Szego, G. C. (General Electric), FREE RADICALS AS HIGH ENERGY PROPELLANTS. U.S. Army, Ordnance Department, Contract DA 33-008-ORD-1956, n.d. 1060 pp. (AD 231222). 0619

Hydrogen is the only free radical system possessing sufficient energy storage capability to be useful as a rocket propellant. Metastable states of helium and neon have higher specific energy storage capabilities than the hydrogen free radical and may be more readily stabilized at high concentrations. Cations have high energy storage capability but will be difficult if not impossible to stabilize. Specific impulse of systems of high specific energy content can be maximized by the addition of such diluents as hydrogen and helium.

Mielnikova, B., Wislicki, B. and Klein, S., EVALUATION OF TURBOJET-ENGINE FUELS. Warsaw. Instytut Lotnictwa. Prace, no. 18, 19-33 (1963). (International Aerospace Abstracts, 4, 426, abstr. A64-13596). 0620

Comparative investigation of the efficiency of several methods for the evaluation of the properties of turbojet-engine fuels is discussed. The methods studied are: (1) a technique based on chromatographic analysis, (2) selective extraction by means of carbomide, (3) group analysis, (4) tests of oxidizability and smoke properties, and (5) a technique based on the use of basic physical-chemical constants. The experimental results obtained are used to assess the possibility of reducing the number of engine tests required in the evaluation of fuel properties. 34 references are given.

Miller, R.D., "JET ENGINE FUEL EVALUATION". Sun Oil Company Automotive Laboratory. Final Report, U.S. Air Force Contract AF 33(616)-2653, 2 August 1955. 8 pp. 0621

The report covers experimental work on deposit formation in jet engine nozzles. Tests were made in small scale apparatus and covered a JP-4 fuel and nine fuel blends. Results indicated that: 1) low molecular weight components reduced deposits; 2) oxygen in the fuel increases deposits; 3) high molecular weight materials or those capable of polymerization increase deposits; 4) no definite correlation was found between deposit formation and chemical composition of the fuel; 5) nozzle deposits from different fuels had substantially the same chemical composition (qualitatively).

Miller, D. R., Evers, R. L., and Skinner, G. B. (Monsanto Research), EFFECTS OF VARIOUS INHIBITORS ON HYDROGEN-AIR FLAME SPEEDS. Combustion and Flame, 7, 137-42 (1963). 0622

The effects of small amounts of eighty compounds (gases and vaporized liquids) on the flame speed of the fastest-burning hydrogen-air flame were measured. Those most effective in reducing the flame speed were hydrocarbons as a group, bromine-substituted hydrocarbons, several metallic chlorides, and iron carbonyl. Chlorine- and fluorine-substituted hydrocarbons were relatively ineffective. The effects of methane and ethylene on hydrogen-air flames were studied in detail as functions of hydrogen-air ratio, amount of additive up to four per cent, and preflame gas temperature. Both hydrocarbons reduced flame speeds more effectively in rich than in lean hydrogen-air mixtures. This work was sponsored by the U. S. Air Force under Contract AF 33(616)-7757.

Miller, T. L. and Johnson, M. J. (University of Wisconsin), GROWTH OF YEASTS ON PARAFFIN HYDROCARBONS. American Chemical Society, Abstracts of Papers, 145th Meeting, September 1963, pp. 16P-17P 0623

Yeasts were isolated from soil on mineral salts-hydrocarbon media. One isolate, resembling *Candida intermedia*, grew well on hexadecane-mineral salts medium. The optimum growth pH was 5.5, where 5.9 g ammonia nitrogen was converted to cellular nitrogen for every 100 g hexadecane used. When grown on octadecane, the organism produced 94.8 g cells, containing 6.5 g cell nitrogen per 100 g octadecane used. The generation time was 5 hr. Growth rate and cell yield increased with length of carbon chain in experiments with the C_{12}-C_{18} normal aliphatic hydrocarbons. One of the cultures isolated was a stable mixed culture containing both *Candida guilliermondii* and *Candida parapsilosis*. Neither organism grew well on hydrocarbons without the addition of growth factors, but the mixture grew well, giving a generation time of 5 hr and a cell yield of 71% of the hexadecane used. This mixed culture apparently produces products other than cells and carbon dioxide.

Minachev, Kh. M., Markov, M. A., and Shchukina, O. K., THE DEHYDROCYCLIZATION OF n-HEPTANE OVER OXIDES OF THE RARE-EARTH ELEMENTS. Petroleum Chemistry USSR, 1, no. 4, 514-16 (1962). 0624

The dehydrocyclization of n-heptane was studied over Nd_2O_3, Sm_2O_3, Gd_2O_3, Ho_2O_3, Er_2O_3, and Y_2O_3 at temperatures of 530-560°C. It was observed that the overall catalytic activity of the oxides investigated rises with an increase in the atomic weight of the metal.

Minor, H. B., Nixon, A. C., and Thorpe, R. E. (Shell Development), STABILITY OF JET TURBINE FUELS. U.S. Air Force, WADC TR 53-63, Part 3, Contract AF 33(616)-2707, February 1957, 141 pp. (AD 118084). 0625

Small amounts of chromatographic polar fractions reduced the high-temperature stability of a stable straight-run fraction; olefin and olefin-diolefin fractions were inert. Dispersants were effective in prolonging filter plugging time although the rate of deposit accumulation on the filter was not changed. Silica gel treatment had a beneficial effect on high-temperature performance, but Na treatment did not. The one successful storage inhibitor was again effective under mild conditions of aging. Metal deactivator is effective in preventing catalytic action by Cu-containing steels but is only partially effective against Cu surfaces. The final results of the 5-yr desert storage program are discussed briefly. Chromatographic separation of catalytically cracked, thermally cracked, and straight-run gas oils into type components showed that conjugated diolefins, aromatic, olefins, and resin fractions which consist largely of N bases and phenols, are responsible for instability and lack of antioxidant susceptibility under mild aging conditions. Objectionable olefinic constituents are not appreciable in straight-run gas oils; they are more prevalent in thermally cracked than in catalytically cracked gas oils.

Minor, H. B., Nixon, A. C., and Thorpe, R. E., (Shell Development), STABILITY OF JET TURBINE FUELS. PART IV. THERMAL AND OXIDATIVE STABILITY. U.S. Air Force, WADC TR 53-63 Part 4, Contract AF 33(616)-2707, February 1957, 86 pp. (AD 118085). 0626

Both thermally and catalytically cracked California gas oils differ from the straight run principally in unsaturated components. The differences are reflected in the greater instability of the cracked products. The thermally cracked gas oil contains greater proportions of reactive components than the catalytically cracked oil; olefins are 3-fold, alkyl thiophenes are about ten-fold, and aromatic olefins are markedly greater. The thermally cracked gas oil is much less stable than the catalytically cracked gas oil. The instability of total aromatics in cracked products can be inhibited when blended with saturates at 10 vol % but even the relatively stable higher-boiling catalytically cracked aromatics have poor susceptibility when they are undiluted. The poor additive response of jet fuels appeared to be a cumulative effect of aromatics, aromatic olefins, dienes, thiophenes, and polar hetero compounds. Phenols, N bases, pyrroles and aromatic olefins in combination with mono- and diaromatics have a pronounced adverse effect on the thermal stability of an aromatic-free straight-run solvent. Prior aging of jet fuels causes a large decrease in thermal stability.

Mitchell, J. J., (Texaco Research Center), MECHANISM OF THE DEHYDROCYCLIZATION OF n-HEPTANE. American Chemical Society. Journal, 80, 5848-51 (1958). 0627

The mechanisms in the literature for the dehycrocyclization of n-heptane to toluene all predict that the dehydrocyclization of n-heptane-1-C^{14} would produce toluene with 50% of the C^{14} in the methyl group. One run, at conditions which gave a product containing 56 mole per cent toluene, gave 27 ±1% of the C^{14} in the toluene methyl group; another at conditions yielding a product containing 74 mole per cent toluene, gave 29 ±1% of the C^{14} in the methyl group. Two possible mechanisms leading to this lower value of methyl C^{14} content and a test to distinguish between them are proposed.

Moissis, R. and Berenson, P. J., ON THE HYDRODYNAMIC TRANSITIONS IN NUCLEATE BOILING. American Society of Mechanical Engineers. Transactions. Series C. Journal of Heat Transfer, 85, 221-9 (1963). 0628

The two hydrodynamic transitions which take place in nucleate boiling off a horizontal surface are described. The first, which is governed by continuity considerations, results in a change in the vapor removal process from an intermittent to a continuous one. The second which is a result of a Taylor-Helmholtz instability, determines the maximum ("burnout") heat flux. Equations are presented which predict with good accuracy the two transitions heat fluxes.

Molony, O. W., NEW INHIBITORS FOR MOTOR FUEL. Benzole Producers Ltd. (London). Research Paper, 1957, no. 7. 12 pp. (CA, 54, 20173 i). 0629

Laboratory tests were made to assess the effectiveness of oxidation inhibitors (2,4-dimethyl-6-tert-butyl-phenol, p-butylaminophenol, N,N'-di-sec-butyl-p-phenylenediamine, 2,6-di-tert-butyl-p-cresol, and p-tert-butyl-catechol), and, for convenience, comparison with the effectiveness of catechol and cresol was also made. Their resistance to removal by H_2O or alkali was examined, and the results obtained were compared with those obtained by Jones (CA, 47, 1370f).

Momtchiloff, I. N., Taback, E. D., and Buswell, R. F., KINETICS IN HYDROGEN-AIR FLOW SYSTEMS. I. CALCULATION OF IGNITION DELAYS FOR HYPERSONIC RAMJETS. pp. 220-30 in: "Symposium (International) on Combustion, 9th, Cornell University, August 27 - September 1, 1962." New York, Academic, 1963. 0630

An analytical method of estimating auto-ignition delay time based on dissociation and recombination rates of gases had been developed. In this analytical method, the one-dimensional gas-dynamics equations are combined with reaction-kinetics equations to formulate a set of simultaneous differential equations. These equations describe the behavior of a mixture of reacting gases flowing supersonically down a duct. A computer program has been evolved and used to solve these equations for the particular case of hydrogen-air mixtures. The ignition delay periods obtained through this program are in good agreement with the limited amount of experimental data available.

Moretti, G. (General Applied Science Laboratories), ANALYSIS OF TWO-DIMENSIONAL PROBLEMS OF SUPERSONIC COMBUSTION CONTROLLED BY MIXING. American Institute of Aeronautics and Astronautics. Aerospace Sciences Meeting, Preprint 64-96, January 1964. 5 pp. 0631

An unconventional combustion configuration in which combustion takes place in a stream of gaseous reactants flowing at supersonic speed is under experimental study. Schematically, a nozzle injects fuel into the main air stream. Under proper conditions, the combustion may start by autoignition as soon as some fuel mixes with air. In this paper, a theoretical analysis of the aerothermochemical process was made for a better understanding of the phenomenon and as a guide to a better design. Equations describing the process are written and methods for numerical solution are described.

Morozov, V. G., AN EXPERIMENTAL STUDY OF CRITICAL HEAT LOADS AT BOILING OF ORGANIC LIQUIDS ON A SUBMERGED HEATING SURFACE. Internation Journal of Heat and Mass Transfer, 2, 252-8 (1961). 0632

Data of experiments for the determination of critical heat flows at boiling of methyl alcohol (P = 1-64·5 atm) and normal propyl alcohol (P = 1-46 atm) on a submerged heating surface are deduced in the present paper. The treatment of experiments is given in relative co-ordinates. The influence of different factors on the values of critical flows is shown.

Morris, B. T. (Marquardt Aircraft), RAMJETS, STATE OF THE ART, 1958. Astronautics, 3, no. 11, 60-1 (1958). 0633

Activity in development of applications for ramjet engines, including Navaho, Kingfisher, LeDuc and Griffon II is discussed. Work on non-hydrocarbon fuels is also mentioned.

Motte, E.I., FILM BOILING OF FLOWING SUBCOOLED LIQUIDS. U.S. Atomic Energy Commission, UCRL-2511, June 1954, 139 pp. 0634

Heat transfer coefficients across the vapor film were evaluated from the rates of heat transfer in upward flow forced convection from outside single horizontal tubes to four liquid systems: ethyl alcohol, benzene, hexane and carbon tetrachloride. These heat transfer coefficients were found to be markedly increased by subcooling the liquids. It has previously been shown that, since the vapor film is in laminar flow in forced convection film boiling, heat is transferred across the vapor film by conduction and radiation. In this study it has been further shown that, if the liquid is subcooled, heat is transferred from the vapor liquid interface into the liquid by eddy conduction and the effect of thermal conduction is negligible. Correlation of the data for the four liquid systems investigated was found possible by use of theoretical parameters.

Motte, E. I. and Bromley, L. A. (University of California), FILM BOILING OF FLOWING SUBCOOLED LIQUIDS. Industrial and Engineering Chemistry, 49, no. 11, 1921-8 (1957). 0635

The heat transfer coefficients across the vapor film in film-type boiling can be markedly increased by subcooling the liquid. Values of this heat transfer coefficient have been found to approach those of nucleate boiling. Experimental data are presented for benzene, carbon tetrachloride, ethyl alcohol, and hexane flowing across tubes of various sizes.

Moult, E. A. (de Havillard Engine Company, Limited), POWER PLANTS FOR SUPERSONIC FLIGHT. Institute of the Aeronautical Sciences. International Congress (5th), June 20-23, 1955, Los Angeles, Proceedings, pp. 520-57. 0636

This paper reviews possible types of power plant required to propel aircraft at speeds equivalent to Mach 2 or Mach 3 in the stratosphere. Thrust and drag relationships are considered at different speeds and altitudes for the liquid fuel rocket, the ram-jet, the turbojet and the turbojet with afterburner. The importance is stressed of a margin of thrust over drag for climb and acceleration and of the possibilities of mixed power units in this connection. After a brief consideration of weights, sizes, and fuel consumptions, the paper deals at some length with the effects of high-speed flight on the performance and design of the turbojet engine. Great importance is attached to the need for efficient intake design and on the influence of ram pressure and temperature on the main components. At high speeds of flight there are special attractions in high-temperature operation and in afterburning. Only a moderate pressure ratio is needed and a simple, light, and robust engine is possible.

Movsumzade, M. M. and Dedusenko, L. S., DEALKYLATION OF POLYETHYLBENZENE. Azerbaidzhanskii Khimicheskii Zhurnal, 1961, no. 4, 53-60. (CA, 57, [illegible]463e). 0637

Technical mixtures of polyethylbenzene that have a boiling range of 175-350° were dealkylated by using the reversibility principle of the Friedel-Crafts reaction. The objective was to study basic conditions for obtaining optimum yields of ethylbenzene.

Mowrer, W. and Schirmer, R. M., PHILLIPS' MICROBURNER EVALUATION OF WADC JET FUELS "A" AND "B": Phillips Petroleum Company Research Division. Report 1569-56R, September 1956. 6 pp. (AD 123868). 0638

Two high density hydrocarbon fractions, WADC Fuels "A" and "B", were evaluated in Phillips Microburner. Combustion cleanliness characteristics were established by measurements of fuel vaporizer deposit formation rate, combustion chamber deposit formation rate, and exhaust gas smoke density. The Microburner combustion cleanliness characteristics of the two special WADC fuels were generally comparable to "minimum quality" JP-4 or JP-5 type fuels. However, Fuel "A" was cleaner from the standpoint of deposit formation than Fuel "B", a characteristic which is ascribed to the low volatility and high existent gum content of Fuel "B".

Mueller, R.D., Killackey, J.J. and Tang, K.K. (AiResearch Mfg. Co.) "STUDY OF FUEL EVAPORATIVE ENGINE OIL COOLING SYSTEMS FOR HIGH PERFORMANCE AIRCRAFT". U.S. Air Force, WADD TR 60-47, Contract AF 33(600)-35411. September 1960. (AD 321719). REPORT CLASSIFIED SECRET. 0639

The report describes an investigation of the use of fuel vaporization in the engine oil cooler to provide adequate cooling, with application to the B-70 aircraft with J-93 engine, operated with JP-6 fuel. Several systems were examined, however, the most favorable consisted of a conventional liquid-liquid cooler augmented by a vaporizing cooler in times of high heat load. Design conditions call for a fuel flow of about 30 lb/min and a maximum heat rejection capability of 4-8 x10^3 Btu (less than 300 Btu/lb of fuel). The report includes an unclassified appendix on boiling heat transfer and a confidential appendix on combustion of prevaporized fuel.

0640

Mullins, B. P., BUBBLE-POINTS, FLAMMABILITY LIMITS AND FLASH POINTS OF PETROLEUM PRODUCTS. Gt. Brit. National Gas Turbine Establishment, Report R 200, November 1956, 22 pp. (AD 119939).

Relationships between the bubble-points, flammability limits and flash points of a fuel have been demonstrated numerically for four hydrocarbon fuels ranging from aviation spirit to gas oil. The mean molecular weights of the fuel vapours at the bubble-points have been computed and several nomographic methods of presenting corrected bubble-point data are outlined with examples. Weak and rich flammability limits in air of the four fuels were calculated over a range of static pressures. The weak limit curve represents the conditions of the closed flash point test and so by differentiation of this curve a flash point pressure correction factor was obtained for each fuel. Excellent agreement between theoretical and measured values was found in all cases and a simple general rule for estimating flash points is given. Fuels tested were a 100 octane gasoline, a wide range distillate, a reference kerosene and a reference gas oil.

0641

Mullins, B. P. (Gt. Brit. National Gas Turbine Establishment), IGNITION DELAY MEASUREMENTS ON GAS TURBINE FUELS BY THE N. G. T. E. METHOD. De Ingenieur, 66, no. 36, 57-61 (1954).

The N. G. T. E. method and apparatus are described. While most of the paper is devoted to the ignition delays of liquid droplets and sprays, some data and description are also given for fuel-air gaseous mixtures.

0642

Mullins, B. P., SPONTANEOUS IGNITION OF LIQUID FUELS. London, Butterworths, 1955. 117 pp. (North Atlantic Treaty Organization. AGARDograph No. 4).

The monograph reviews the status of knowledge in that area of combustion concerned with spontaneous combustion. It deals with spontaneous ignition of combustibles that are liquid at normal temperature and pressure. It contains a review of the theoretical work on thermal and chain theories of ignition, a description of methods used in studying ignition phenomena experimentally, a tabulation of available data on spontaneous ignition temperatures, and sections discussing effects of additives and the influence of various factors on ignition delay.

Mullins, B. P. and Penner, S. S., EXPLOSIONS, DETONATIONS, FLAMMABILITY AND IGNITION. New York, Pergamon, <u>1959</u>. (North Atlantic Treaty Organization. AGARDograph No. 31). 0643

The book treats, analytical, theoretical and experimental studies and results in the field of its title. Works through August 1957 are adequately reviewed. Of particular interest are the compilations of experimental results on flammability limits, and ignition delay in spontaneous ignition.

Mumm, J. F. (Babcock and Wilcox), HEAT TRANSFER TO BOILING WATER FORCED THROUGH AN ELECTRICALLY HEATED TUBE. pp. 103-9 in: U. S. Atomic Energy Commission, "Reactor Heat Transfer Information Meeting, 1954." U. S. AEC, BNL-2446, December <u>1955</u>. 0644

The rate of heat transfer to steam-water mixtures during forced flow through a uniformly heated channel was studied and the effects of quality, heat flux, flow rate and pressure on this rate were determined. The work was limited to flow of water through a horizontal round tube with the following approximate range of variables: mass velocity 70 to 280 lb/sec-ft^2, pressure 45 to 200 psia, heat flux 50,000 to 250,000 Btu/hr-ft^2, fraction of flow evaporated 60% maximum. A correlation is given which is applicable in the range of qualities from 0 to 40%. The heat transfer coefficient increases with increasing quality up to a quality near 50%. After that it decreases rapidly toward a gas film coefficient which was reached near a quality of 70% for these tests. The apparatus and procedure used in the tests are described but no detailed data are given.

Myers, D.D., SOME THERMAL ASPECTS OF HIGH-SPEED AIRCRAFT DESIGN. North American Aviation, Inc., Downey, Calif., Confidential Report. Report No. AL-1645, Revised. February <u>1953</u> - Revised April <u>1953</u>. (AD 6804). REPORT CLASSIFIED CONFIDENTIAL. 0645

The advent of turbojets, rockets, and ramjets has introduced to the aircraft designer new speed regimes which have forced a redirection of thinking in the design of high-speed aircraft. Aerodynamic heating at high speeds is requiring the use of new materials, new cooling concepts, and new methods of construction. In addition, certain design conditions which in the past have had a small part to play in aircraft design have become of primary importance in high-speed flight. This paper is intended to examine the fundamentals of aerodynamic heating and to suggest some of the problems being encountered in the design of high-speed aircraft. Examination of the problems is made at $M = 3.0$ in most cases to exaggerate the effects to be faced by aircraft designers in the near future.

Naboko, I. M., ONSET OF COMBUSTION WHEN A SUPERSONIC GAS FLOW IS RETARDED BY AN OBSTACLE. pp. 41-5 in: Predvoditelev, A. S., ed., "Physics of Heat Exchange and Gas Dynamics". New York, Consultants Bureau, 1963. 0646

The paper reports results of experiments in combustion of $4H_2 + O_2$ behind shock waves moving with M = 2.65 or less in a shock tube apparatus. Observations were made both with and without obstructions present. Ignition delay times in the range 4 to 80 μsec were observed at temperatures around 800°K. The experiments and calculations show that in establishing combustion behind the shock wave, the process of ignition is not only governed by the temperature created behind the shock wave but also by the velocity of motion of the gas in the region behind the wave. Thus, only when the gas heated by the shock wave remains in a state with a high temperature for a period of time no less than the induction period of the mixture at the given temperature does it ignite.

Nagamatsu, H. T, and Martin, E. D., (General Electric Research Lab.), COMBUSTION INVESTIGATION IN THE HYPERSONIC SHOCK TUNNEL DRIVER SECTION. Journal of Applied Physics, 30, 1018-21 (1959). 0647

An investigation was made of the combustion of stoichiometric mixtures of hydrogen and oxygen with a varying percent of helium in the constant volume driver section for a hypersonic shock tunnel. The pressure was measured as a function of time for a number of initial pressures, mixture ratios, and multiple sparks for ignition. The maximum pressures observed were close to that expected for smooth burning. When detonation was encountered, the ratio of the peak pressure to the initial pressure was about 50.

Nagiyev, M. F., pp 65-95 in: CHEMISTRY, TECHNOLOGY AND CALCULATION OF THE PROCESS OF MOTOR FUEL SYNTHESIS. Moscow, Izdatel'stvo Akademii Nauk SSSR, 1955. (U.S. Air Force Trans. MCL-578/III; AD 257143). 0648

This paper is a very general survey describing jet engines and their fuels. The characteristics of different hydrocarbon types present in fuels are considered, and ranges of property values are given. Some properties of oxidizers other than atmospheric air are tabulated, and the effect of different oxidizers on fuel performance is mentioned. Data are presented for the heat of combustion of beryllium-kerosene suspensions with nitric acid as oxidizer.

National Research Council, Prevention of Deterioration Center, BIBLIOGRAPHY ON MICRO-ORGANISMS AFFECTING PETROLEUM AND PETROLEUM PRODUCTS INCLUDING REPORTS ON SULFATE-REDUCING BACTERIA. August, 1961. 35 pp. (AD 265033). 0649

A list of references is presented on (1) the characteristic behavior of specific types of anaerobic, aerobic, pathogenic types of bacteria and fungi, (2) the effects of producing contaminant residue, deterioration, corrosion of pipelines, linings of fuel storage tanks, metals, and other container-type storage devices, and (3) the development of bacterial and fungal inhibitors such as bactericides, fungicides, and other types of countermeasures such as coatings and resistant additives. Many foreign reports of French, German, Italian and Russian origin are presented.

Nehring, D. and Dreyer, H., UMWANDLUNG VON CYCLOHEXAN AN NICKEL AUF DOTIERTEN TRÄGERN. Zeitschrift für Anorganische und Allgemeine Chemie, 315, 27-34 (1962). 0650

The dehydrogenation and destructive hydrogenation of cyclohexane occuring on doped Ni/Al_2O_3-catalysts have been investigated. The doping components added to the weakly n-conducting Al_2O_3 were ThO_2 (p-conductor) and TiO_2 (n-conductor). Measuring the electric conductivities and surface effects, the observed dependence of the relative dehydrogenation activity on the composition of the oxide carrier could be explained.

Nelson, F. L., Osterhout, D. P., Schwindeman, W. R. (Socony Mobil), EVALUATING ADDITIVES FOR DISTILLATE FUELS - STABILITY TESTS. Industrial and Engineering Chemistry, 48, no. 10, 1892-8 (1956). 0651

The proper evaluation of additives requires consideration of three major points: a full understanding of the phenomena occuring in the field; laboratory tests which truly reflect field performance (long term may be required to be realistic), and a full knowledge of the possible hazards involved, to avoid imparting undesirable characteristics to the fuel. Evaluations of this type are best made by careful simulation offield conditions. Storage stability, sediment inhibition, and dispersancy are discussed, together with the beneficial and harmful effects of additives.

Neugebauer, F. J. (General Electric Co.), COLLECTION OF HEAT-TRANSFER PROPERTIES OF GASES AT MODERATE PRESSURES AND RULES FOR RAPID ESTIMATION OF MISSING DATA. G. E. Report No. 62GL64, April 30, <u>1962</u>, U. S. Navy Contract Nonr-3804(00). 208 pp. (AD 281901). 0652

Heat capacities, thermal conductivities, viscosities, and Prandtl numbers are collected for many compounds. Correlations are given for these properties and for combined groups of properties.

Nicholls, J. A. (University of Michigan), STABILIZATION OF GASEOUS DETONATION WAVES WITH EMPHASIS ON THE IGNITION TIME DELAY ZONE. Ann Arbor, University of Michigan, <u>1960</u>. 154 pp. (PB 149305). 0653

The characteristics of gaseous detonation waves are considered insofar as they influence the dynamic conditions that must be met in order to generate a standing gaseous detonation wave. The method adopted for the experimental study consists of mixing unheated H with the heated air in the supersonic portion of an axisymmetric convergent-divergent nozzle. The nozzle is operated underexpanded so that acceleration of the mixture to the required high Mach no. is realized in the open jet. Combustion occurs downstream of the normal shock wave that exists in such underexpanded jets. Experiments are described wherein stationary shock wave-combustion configurations were realized. These experiments covered the mixture stagnation temperature range of about 1800° R-2430°R and a wide fuel-air range. In all cases of interest, the shock wave and flame were separated by a distance corresponding to the mixture ignition delay time. This delay time varied from 10 to 50 µsec., the shorter times occurring with higher temps.

Nicholls, J. A. (University of Michigan), STANDING DETONATION WAVES. pp. 488-98 in: "Symposium (International) on Combustion, 9th, Cornell University, August 27 - September 1, 1962." New York, Academic, <u>1963</u>. 0654

The paper examines the reported results on standing detonation waves as obtained in different facilities and compares them. Comparisons are also made with results obtained in shock tubes and a ballistic range. The ignition delay period, the effects of vibrational relaxation and the importance of two-dimensional effects are considered.

Nicholls, J. A., Dabora, E. K., and Gealer, R. L. (University of Michigan), STUDIES IN CONNECTION WITH STABILIZED GASEOUS DETONATION WAVES. pp. 766-72 in: "Symposium (International) on Combustion, 7th, London and Oxford, August 28 - September 3, 1958." London, Butterworth, 1959. 0655

A research program has been under way at the University of Michigan which is explicitly aimed at the achievement of a standing detonation wave. The purpose of this paper is to present the approach used, the experimental technique, and some of the preliminary results obtained. The authors observed experimentally a shock stabilized flame region in a supersonic flow field, using hydrogen air combustible mixtures. The authors themselves questioned whether the phenomenon should properly be termed a standing detonation wave, since the configuration used gave a stable standing shock wave whether this was accompanied by combustion or not.

Nicholls, J. A., Dabora, E. K., Morrison, R. B. et al (University of Michigan), AN EXPERIMENTAL AND THEORETICAL STUDY OF STATIONARY GASEOUS DETONATION WAVES. U. S. Air Force, AFOSR-1764, Contract AF 49(638)-562, October 1961. 80 pp. (AD 268927). 0656

The major portion of this report is devoted explicitly to the study of the standing detonation wave in a hydrogen-air mixture. The experimental arrangement and procedure employed are briefly described and the experimental results presented. A revised analysis of the ignition delay zone behind the shock is presented which handles the equations more rigorously than an earlier treatment. The prediction of the time rate of growth of concentrations of the radicals behind the shock is found to be slightly different from the earlier analysis, but the prediction of ignition delay is unchange. Vibrational relaxation is considered insofar as it affects the ignition time delay.

Nichols, M. R. (Langley Research Center, NASA), SUPERSONIC TRANSPORT PROPULSION REQUIREMENTS. Aerospace Engineering, 20, no. 9, 12-13 and 58-63, (1961). 0657

A typical supersonic transport mission is discussed from the standpoint of propulsion requirements. Possible engine configurations and their potential capabilities are described. The problem of fuel heating associated with the use of the fuel as a heat sink during deceleration or emergency descent is mentioned.

Nichols, O.D., Goodwin, T.C., Muccino, A.J. and Rice, R.G., **FLAMES AND FLAME PROPERTIES. A DDC REPORT BIBLIOGRAPHY.** U.S. Defense Documentation Center, AD 422 075, October 1963. 0658

This bibliography represents a comprehensive coverage on flames. All references are from the DDC unclassified, unlimited collection. Actual report dates span from December 1950 to May 1963. Approximately 700 references are cited. The broad areas of flame propagation and analysis, kinetics and thermodynamics, flame velocity, and several others are covered.

Nichols, O.D. and Rice, R.G., **COMBUSTION AND EXHAUST PRODUCTS. A DDC REPORT BIBLIOGRAPHY.** U.S. Defense Documentation Center, AD 423 550, December 1963. 0659

This is the second of a series of bibliographies covering two broad subjects - flames and combustion. Part I appears under two separate covers as AD-422 075 and AD-344 535, entitled "Flames and Flame Properties". The unclassified, unlimited AD-422 075 contains about 800 references. AD-344 535 is confidential and unclassified limited, and contains about 250 references. The present bibliography covers condensation trails, combustion chamber gases, combustion deposits, exhaust flames, and exhaust gases. Dates of reports referenced cover the time span April 1951 to May 1963. About 500 references are cited. These are restricted to the DDC unclassified, unlimited collection.

Nicolescu, I. V., **ACTIVITY AND SELECTIVITY OF CATALYSTS CAPABLE OF AROMATIZING AND DEHYDROGENATING HYDROCARBONS.** Academia de la Republique Populaire Roumaine. Revue de Chimie, 7, no. 1, 359-67 (1962). (CA, 59, 8507 e). 0660

The principal experimental results obtained in studies concerning the relation between the physical properties (electrical conductivity and crystal structure) and the activity of certain catalysts (MoO_3-Al_2O_3, Pt-Al_2O_3, ZnO + promoters) in the aromatization and dehydrogenation of hydrocarbons are summarized, the main conclusions being discussed. There are 29 references.

Nicolescu, I. V. and Popescu, A., THE MECHANISM OF HETEROGENEOUS CATALYSIS. I. Revista de Chimie (Bucharest), 8, 688-91 (1957). (CA, 52, 10699g). 0661

The cyclization of hexane and heptane to cyclohexane and methylcyclohexane, respectively, was studied over $Ni-Al_2O_3$ and $Ni-Al_2O_3$-Pt catalysts. A yield of 2% cyclohexane was obtained with a $Ni-Al_2O_3$ catalyst containing 36.6% Ni. The addition of 0.2% Pt increased the production to 14%, whereas a decrease in Ni to 5.44% with 0.2% Pt gave a yield of 4% (at 460°). Similar results were obtained with methylcyclohexane where a 90% yield was obtained with a $Ni-Al_2O_3$-Pt catalyst containing 5.44% Ni and 0.2% Pt (at 520°). Experiments made with heptane showed the following results: a yield of 52% was produced by a $Ni-Al_2O_3$-Pt catalyst containing 5.44% Ni and 0.2% Pt. When a $Ni-Al_2O_3$ mass was used with 36.6% Ni a cyclization of 33% was obtained. A decrease in Ni lowered the yield to 27% and a further decrease to 5.46% Ni resulted in a cyclization of 28%. The temperature in these experiments was 560°. The results are discussed in the light of modern structural and free valency theory of catalysis. 17 references.

Nix, P. S. and Weisz, P. B. (Socony Mobil Oil Co.), CATALYST MIXTURES AS A TOOL TO REACTION PATH STUDIES. American Chemical Society, Abstracts of Papers, 145th Meeting, September 1963, pp. 29 I-30 I. 0662

Numerous hydrocarbon transformations involve participation of two different catalytic centers of "dual function catalysts" by way of diffusing hydrocarbon intermediates; such reactions include paraffin isomerization, naphthene-aromatic transformations, etc. It is possible to duplicate such catalysis by using mixtures of separate and particular solid granules of two materials, each representing one of the two distinct catalytic functions ("acid" and "dehydrogenation"). In particular, a miniature fluidized particle bed of such mechanical mixtures is a rich and versatile tool for research and exploration. It allows independent variation and control of the effective rate constants of each of the two catalytic functions. It allows research and exploration for various hydrocarbon transformations into the reaction paths involved with respect to each catalyst function, into the nature and magnitude of the independent rate-constants, and into the aging or deactivation characteristics of each function, etc.

Nixon, A. C., AUTOXIDATION AND ANTIOXIDANTS OF PETROLEUM. Chapter 17, pp. 695-856 in: Lundberg, W. O., Ed., "Autoxidation and Antioxidants," Volume II. New York, Interscience, 1962. 0663

This chapter includes a section on jet fuels covering specifications, composition, autoxidation and gum formation. The effects of composition, metals and contaminants, treatments and additives on storage stability are discussed and the effect of instability on filterability is covered. High temperature thermal stability is discussed, including test methods, effects of fuel composition, contaminants, treatments and additives.

0664

Nixon, A. C., Bjorklund, I. S., Hawthorn, R. D., Henderson, H. T. and Ritchie, A. W. (Shell Development), VAPORIZING AND ENDOTHERMIC FUELS FOR ADVANCED ENGINE APPLICATION. PART I. U. S. Air Force, APL TDR 64-100, Part I, Contract AF 33(657)-11096, September 1964. 143 pp.

Studies leading toward the development of specifications for heat sink fuels for hypersonic aircraft are reported. Consideration of the effect of design parameters on the conditions under which endothermic reactions can be carried out has led to the conclusion that space velocities of 50 or higher would be necessary due to volume limitations in high-speed aircraft. Rate considerations favor catalytic reactions. Preliminary studies of the dehydrogenation of propane to propene and methylcyclohexane to toluene have been made, and dehydrocyclization of various paraffins attempted. Conditions include temperatures to 1300°F, pressures to 10 atmospheres and space velocities to 100. Using a platinum on alumina catalyst, almost complete conversion of MCH was achieved with a maximum heat sink of 2000 Btu/lb at 1300°F. Chromia on alumina was a less successful catalyst but with propane it yielded a total heat sink at 1200°F of 1600 Btu/lb. Thermal stability studies include the modification of two types of cokers to minimize contamination possibilities and improve reproducibility. Fuels may be tested at temperatures up to at least 1000°F. The thermal stabilities of samples of n-dodecane, toluene and methylcyclohexane decreased in the order named.

0665

Nixon, A.C., Cole, C.A., and Minor, H.B., (Shell Development Co.), THE EFFECT OF COMPOSITION AND STORAGE ON LABORATORY PROPERTIES OF JET FUELS. Society of Automotive Engineers. SAE Paper 524, June 1955. 7 pp.

Studies on the stability of jet fuels have revealed that it is a function of the conditions to which the fuel is exposed as well as of the property being examined. Storage stability is a function of the fuel type, minor constituents present, and degree of exposure to oxygen. It can be improved by treating and by exclusion of air. Low and ambient temperature filterability is a function of the type rather than the quantity of insolubles present. High temperature stability, as measured by pressure drop across filters is related neither to low temperature stability nor to the amount of deposit, but again to the character of the deposits formed. Dispersants may be of assistance in enabling the system to tolerate the deposits.

0666

Nixon, A. C., Cole, C. A., and Minor, H. B. (Shell Development), EFFECT OF COMPOSITION AND STORAGE ON THE PROPERTIES OF JET FUELS. Journal of Chemical and Engeering Data, 4, no. 2, 187-92 (1959).

A constant flow filterability test was used to measure relative storage stabilities of jet fuels. Steam jet gum vs years of desert storage, various refinery treatments, and oxygen availability were determined. Insolubles were examined by the electron microscope; more crystalline deposits gave less filter plugging. Effect of temperature and water on filterability was also inspected. Water alone gave no filtering difficulty, but with insolubles filtering difficulties were increased. Effects of dispersants and of hydrocarbon types on filterability were examined.

Nixon, A. C. and Lusebrink, T. R. (Shell Development), **RESEARCH ON THE EVALUATION OF NEUTRON AND GAMMA IRRADIATION EFFECTS OF SIX HYDROCARBON-TYPE FUELS.** U.S. Air Force, WADC TR 59-108, Contract AF 33(616)-6052, September 1959. 33 pp. (AD 229449). 0667

Previous work with three fuels indicated that neutrons in a mixed gamma-neutron field had a strikingly deleterious effect on thermal stability. Since the experimental conditions could have contributed to this result, additional experiments have been done in an effort to recheck the results obtained. Five hydrocarbon fuels (RAF-99 and Shell 1A (saturates), RAF-104, RAF-107, Decalin, and Shell 1A plus aromatic extract) were irradiated in the Convair reactor at various levels up to 10^8 rads. Examination of the irradiated fuels confirmed that neutrons were more deleterious to thermal stability than a pure gamma field although the neutron flux amounted to only 7% of the total and the change in the usual inspection properties was no greater than would be expected from an equal amount of gamma-radiation.

Nixon, A. C. and Minor, H. B. (Shell Development), **EFFECT OF ADDITIVES ON JET FUEL STABILITY AND FILTERABILITY.** Industrial and Engineering Chemistry, 48, no. 10, 1909-16 (1956). 0668

Although the specification inhibitors can prolong the induction periods of jet fuels, they have generally no favorable effect on the gum formation rate under even accelerated and, particularly, normal storage conditions. The nitrogen-containing inhibitors are often actually pro-oxidant, while the trialkyl phenol inhibitors tend to be inert. Increasing the concentration of 26 B4M and PDA inhibitors does not increase their effectiveness (PDA becomes more deleterions with increasing concentration). Neither of these additives improves high temperature stability of jet fuels, but 26 B4M reduces the ambient temperature filter-plugging tendency of jet fuels after aging, while nitrogen-containing inhibitors (PDA and AP) tend to increase it. Metal deactivator somewhat reduced the tendency for jet fuels to cause high temperature deposits.

Nixon, A. C., Minor, H. B., and Calhoun, G. M. (Shell Development), **EFFECT OF ALKYL PHENOLS ON STORAGE AND MANIFOLD STABILITY OF GASOLINES.** Industrial and Engineering Chemistry, 48, no. 10, 1874-80 (1956). 0669

A simple glass manifold test was shown to give substantially the same results as does the Socony heated manifold engine test. Manifold temperature has an important influence on deposit-forming tendencies. Comparison is shown of the relative effectiveness of 43 alkylphenols as antioxidants.

0670 Nixon, A. C., Skei, T. and Knight, H. S. (Shell Development), CHROMATOGRAPHIC DETERMINATION OF GUM IN FUELS. U. S. Air Force, WADC TR 54-328, Contract AF 18(600)-37, September 1954. 11 pp. (AD 49906).

A chromatographic method for determining gum in small samples was developed. A small glass absorption column is packed with fine activated silica gel, and 1/2 to 2 ml of sample is introduced. (Benzene-free samples are first diluted with benzene.) The sample is followed by a small quantitiy of α-methyl-naphthalene and acetone eluant. The length of a brown zone containing the gum is measured and empirically correlated with the steam-jet gum content. Jet fuels were evaluated which represented straight-run, thermally cracked, catalytically cracked, and blended samples from various sources. The gas oils were distillation fractions from a catalytically cracked stock with a 90% end point of 585°F. The brown zone lengths for the jet fuels and gas oils of known steam-jet (500°F) gum content were determined with 0.5-ml samples. Above about 30 mg/dl, the data obtained by chromatographic means deviated an average of about 10% from the steam-jet gum curve; at steam-jet gum values below about 30 mg/dl, the chromatographic data diverged farther from the curve, particularly for gas oils. Preliminary tests on 3 gasolines of moderate gum content, as determined by the steam-jet method at 500°F, showed a correlation between gum content and zone length.

0671 Nixon, A. C. and Thorpe, R. E. (Shell Development), THE EFFECTS OF COMPOSITION ON THE STABILITY AND INHIBITOR RESPONSE OF JET FUELS. American Chemical Society. Division of Petroleum Chemistry. Preprints, 1, no. 3, 265-79 (August 1956).

The compositions of jet fuels, particularly that of the light gas oil fractions of catalytically cracked and thermally cracked California gas oils, and of straight run fractions, were determined by silica gel and activated alumina chromatography separations. Identifications were made by ultraviolet and infrared spectroscopy, and in some cases by mass spectrometry. Separated fractions were compared for storage stability by aging at 100, 70, and 43.3°C. Soluble and insoluble gum contents were determined by ASTM D-381-54T (steam jet) or by the chromatogram procedure. High temperature (450°F) stability was measured by the Shell Development recycle filter test method.

0672 Nixon, A. C. and Thorpe, R. E. (Shell Development), STABILITY OF JET TURBINE FUELS. PT V. EFFECT OF NUCLEAR RADIATION. U.S. Air Force, WADC TR 53-63, Pt V, Contract AF 33 (616)-2707, April 1957. 71 pp. (AD 118230).

Differences are noted between the damage suffered by various jet fuels, both with regard to chemical changes and stability effects. On the basis of the infrared spectra of the irradiated fuels, three general radiation reactions occur in jet fuels: 1. Formation of carbonyl compounds (in air) 2. Formation of olefins (in both air and nitrogen) 3. Destruction of benzene and naphthalene (particularly in nitrogen). Irradiation of jet fuels to 1 x 10^8 roentgens increases soluble gum (as measured by chromatogum, with and without prior aging) to about the same level in either air or nitrogen. The insoluble gum level is not altered appreciably in either case. Of three typical jet fuels, two (a special kerosene and a JP-5 fuel - Los Angeles Basic crude) improved in thermal stability at 450°F as a result of irradiation in air to 10^8 roentgens. A JP-4 fuel - San Joaquin crude - on the other hand, was affected adversely, as judged by filter-plugging tendencies. The results of initial studies of "radiation protectors" indicate that the aromatic compounds investigated thus far do not generally extend sponge-type protection to jet fuels; instead they themselves react in substantial amounts on irradiating.

Nixon, A. C., Thorpe, R. E., and Minor, H. B. (Shell Development), THE EFFECT OF NUCLEAR RADIATION ON JET FUELS. Industrial and Engineering Chemistry, 52, 47-50 (1960). 0673

The effects of gamma and neutron irradiation on various hydrocarbons including 3 jet fuels were studied. Various tests, including the Shell high temperature thermal stability test, were performed before and after irradiation. It is not difficult to obtain fuels tolerant of 10^8 r of gamma radiation, but all of the fuels suffered damage at 3 to 4 x 10^{14} thermal neutrons/sq-cm, with total dosage less than in the gamma tests. Aromatics in fuel blends may contribute to radiation instability since they are highly reactive in dilute blends. This work was sponsored by the U.S. Air Force under Contract AF 33(616)-2707.

Nixon, A. C., Thorpe, R. E., Minor, M. B., and Lusebrink, T. R. (Shell Development), RESEARCH ON DETERMINATION OF THE STABILITY OF JET ENGINE FUELS. U.S. Air Force, WADC TR 53-63, Part VI, Contract AF 33(616)-3888, May 1958. 185 pp. (AD 151193). 0674

The investigation of the effects of environment and composition on the thermal and radiation stability of jet fuels was continued. Major effort was devoted to the study of radiation damage as a function of dosage and fuel composition. The relationship between most properties and log dosage followed an exponential curve in the range 10^7 to 10^9r, but the thermal stability underwent a sinusoidal type of change. The greatest degradation occurred at 10^7r or below, with an improvement over base at about 10^8r, followed again by degradation at higher dosages. Some anitoxidants and dispersants had a beneficial effect on thermal stability even after storage. Metal deactivators appeared to be unsatisfactory for the elimination of the adverse effect of metal on thermal stability. A completely saturated fuel seemed to be the best choice for a fuel to be used in a radiation environment, although there was some evidence that fuels containing a high proportion of C_5 rings should be avoided.

North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development. COMBUSTION RESEARCHES AND REVIEWS 1955. London, Butterworths, 1955. 187 pp. (North Atlantic Treaty Organization. AGARDograph No. 9). 0675

The book contains 14 invited papers from the 6th and 7th AGARD Combustion Panel Meetings held in 1954. Most of the papers deal with aspects of combustion of sprays of fuel droplets. However, a paper on flames in ramjet combustors by J. P. Longwell, two papers on carbon formation in combustors by G. Porter and by C. Fouré, and one on flame radiation by C. Codagove are of more direct interest to the subject of fuels for high output combustors.

North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, SELECTED COMBUSTION PROBLEMS. London, Butterworths, 1954. 534 pp. (Combustion Colloquium, 1st, Cambridge University, December 7-11, 1953). 0676

The bulk of the papers treat laminar and turbulent flame propagation. Two papers of particular interest in the section on Technical Combustion Problems are those by B. P. Mullins and P. Lloyd on THE PROBLEM OF COMBUSTION AT HIGH ALTITUDE and that by B. P. Mullins on COMBUSTION IN VITIATED AIR.

North Atlantic Treat Organization. Advisory Group for Aeronautical Research and Development, SELECTED COMBUSTION PROBLEMS, II. London, Butterworths, 1956. 495 pp. (Combustion Colloquium, 2d, Liege, December 5-9, 1955). 0677

Particularly pertinent are papers by R. R. Hibbard and H. C. Barnett, FUELS FOR TURBOJET POWERED AIRCRAFT; R. S. Brokaw, THERMAL IGNITION WITH PARTICULAR REFERENCE TO HIGH TEMPERATURES; and the papers on high altitude combustion problems.

Nowakowski, L. and Hetper, J., CATALYTIC DEHYDROGENATION OF PROPANE ON A STATIONARY BED. Przemysl Chemiczny, 40, 696-8 (1961). (CA, 57, 15860d). 0678

The dehydrogenation of C_3H_8 over Cr_2O_3-Al_2O_3 is described. The maximum conversions and yields of C_3H_6 were obtained at 620-60° with gas flow of 300 l./l. catalyst/hr. in laboratory quartz reactors and at 570-600° with gas flows of 400-700 l./l. catalyst/hr. in Cr-steel reactors. Under these conditions the catalyst activity did not change during 6 hrs. in the quartz reactor and during 4 hrs. in the Cr-steel reactor.

Oblad, A. G., Milliken, T. H. and Mills, G. A., THE EFFECTS OF THE VARIABLES IN CATALYTIC CRACKING. pp. 165-88 in: Brooks, B. T., Boord, C. E., Kurtz, S. S., Jr. and Schmerling, L., eds., "The Chemistry of Petroleum Hydrocarbons, vol. II", New York, Reinhold, 1955. 0679

The effect of temperature, pressure, space velocity and nature of the catalyst on the catalytic cracking reaction is discussed. Practical feed stocks were used and effect of the above variables on the product distribution was studied.

Olson, W. T. (NACA), COMBUSTION FOR AIRCRAFT ENGINES. Institute of the Aeronautical Sciences. International Aeronautical Conference, 5th, June 20-24, 1955, Preprint no. 561. 35 pp. 0680

The development of high-speed combustion systems for aircraft has been a major achievement in engineering. Designs for these combustion systems have had to mate what nature dictates that fuel, air, and flame must do on the one hand with demands imposed by flight and by the engine on the other hand. The main things that must be achieved in the design of combustors for turbojets, afterburners, and ram jets are efficient, high heat-release rates, suitable outlet temperature profile, low pressure losses, and reliability from light weight equipment. Reliability includes such items as durability, freedom from deposits, and easy ignition. Extensive information exists on subjects such as fuel atomization and vaporization, mixing, flammability limits, ignition energy, flame propagation, smoke formation, and flame quenching - basic processes that occur in combustors. This information, together with engineering experience, has provided design ideas and insights that assist in meeting the advancing needs of the art. Some of this information and experience is discussed herein. The relations of certain combustion principles to the applied problems are stressed.

Olson, W. T. (N. A. C. A.), POSSIBILITIES AND PROBLEMS OF SOME HIGH ENERGY FUELS FOR AIRCRAFT. SAE Transactions, 67, 82-94, 1959. 0681

Boron compounds offer a heat of combustion 40% greater than that of aircraft fuels in current use. Diborane and pentaborane have burned satisfactorily in turbojets, afterburners, and ramjets. But boron compounds leave troublesome deposits and they present supply, storage, and handling problems. This paper describes investigations into the use of boron hydrides as high-energy liquid fuel. Present results indicate that the ultimate fuel will be a boron-hydrogen-carbon compound. The author also discusses other high-energy fuels of magnesium, aluminum, berylium, and boron. Magnesium has been found to be a top fuel for short-time high-thrust applications, because of its high combustion temperature.

Olson, W. T., Childs, J. H., and Jonash, E. R. (Lewis Flight Propulsion Laboratory, NACA), THE COMBUSTION-EFFICIENCY PROBLEM OF THE TURBOJET AT HIGH ALTITUDE. American Society of Mechanical Engineers. Transaction, 77, 605-15, (1955). 0682

This paper discusses NACA research on combustion efficiency of turbojet engines at high altitudes. Representative results are presented to illustrate the trends obtained with the following categories of variables: (a) Combustor operating variables (b) combustor design variables, and (c) fuel variables. As the environment of the combustor becomes one of low pressure and low temperature at high altitude, low combustion efficiencies and limited values of obtainable temperature rise are encountered. Increased cross-sectional area of combustor for a given weight flow of air decreased velocities and facilitated high combustion efficiency at altitude. Increased volume in the flame zone and gradual admission of the air into the combustion space aid combustion by helping to provide that localized fuel-air mixtures of correct composition exist sufficiently long for ignition and combustion to occur. The combustor design, the fuel injection, and the fuel volatility must be matched if optimum combustion efficiency is to be achieved. Further, for a given combustor, fuel injector, and fuel volatility, fuels of higher flame speed and/or lower ignition temperatures gave higher combustion efficiency at high-altitude operating conditions.

Olvera, J. J., THE USE OF GAS-SOLID AND GAS-LIQUID CHROMATOGRAPHY IN COMBUSTION GAS ANALYSIS. University of Arizona, M. S. Thesis, 1964, 57 pp. (AD 60228). 0683

The primary purpose of the study was to improve gas sampling techniques and to refine the calibration data for the application of the principles of gas chromatography to the analysis of combustion products from the University of Arizona Combustion Tunnel. The secondary purpose was to extend the capability of the existing chromatography apparatus to the detection of selected hydrocarbons of the paraffin and olefin families.

O'Neal, Jr., C., EFFECT OF PRESSURE ON THE SPONTANEOUS IGNITION TEMPERATURE OF LIQUID FUELS. U. S. National Advisory Committee for Aeronautics, TN 3829, October 1956. 21 pp. 0684

Spontaneous ignition temperatures were measured in air for n-heptane, isooctane, benzene, and JP-4 and JP-5 aviation fuels in the pressure range of 1 to 9 atmospheres. A solid stream (no spray) of fuel was injected into a 125-cc Erlenmeyer flask enclosed in a bomb. Fuel charges were varied so that the lowest temperature at which spontaneous ignition occurs was obtained. The spontaneous ignition temperature of all the fuels decreased with increasing pressure. Most of the decrease occurred in the range of 1 to 3 or 4 atmospheres. Time lags before ignition were measured.

0685 Orr, C. R., COMBUSTION OF HYDROCARBONS BEHIND A SHOCK WAVE. pp. 1034-45 in: Symposium (International) on Combustion, 9th, Cornell University, August 27-September 1, 1962. New York, Academic, 1963.

The combustion of dilute fuel-oxygen mixtures in argon was studied by observing the infrared emissions of reactants, intermediates, and products. The combustion reactions were initiated by the incident shock wave in a simple two-section shock tube. The rates of formation of products (H_2O, CO, and CO_2) from combustion of ethylene, acetylene, isooctane, n-heptane, benzene, and a mixture of hydrogen and CO were compared at two temperatures that were well above their minimum ignition temperature. Complete spectra (in frequency and time) were also obtained for the preflame region for isooctane, n-heptane, and benzene and for the entire low temperature flame region for n-heptane and benzene. Isooctane and n-heptane showed extensive preflame activity. These fuels were completely degraded prior to the flame regardless of the length of the preflame region. Benzene was only 15-20 per cent degraded in the preflame region and produced much less intermediate material, aside from CO. Of the hydrocarbons tested, n-heptane had the highest rate of combustion as indicated by rate of formation of CO_2 whereas isooctane had the lowest. Production of CO from benzene is considerably slower than from any other fuel.

0686 Orr, C. R. and Sorem, S. S. (Shell Development), FLAME RADIATION OF TURBOJET FUELS. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, C59-68 (September 1960).

A small scale prevaporizing combustor was utilized to study the formation and consequences of carbonaceous particles produced during combustion. Flame radiation and liner temperature data were analyzed in terms of fuel luminometer number to evaluate the luminometer as an instrument for determining the burning quality of jet fuel. Combustor results indicate that preflame reactions in the fuel-air mixing region are the major factors leading to excessive flame radiation. Combustor liner temperature was affected by the size, shape, and location of the flame rather than by the intensity of its radiation. Minimum radiation can be achieved by insuring complete vaporization of the fuel and by giving the fuel-air mixture minimum opportunity for preflame reaction. The luminometer ranks fuels in the same order as the small scale combustor in respect to radiation; however, the rate of reduction of radiation with increasing luminometer number becomes very small for high numbers - i.e., greater than 90. A procedure for performing a modified luminometer test is proposed which would provide a quality factor that more clearly describes the carbon-forming tendency of a jet fuel.

0687 Osterhout, D. P., Jr. (Socony Mobil), AN INVESTIGATION OF THE FUEL REQUIREMENTS FOR SUPERSONIC TRANSPORTS. American Petroleum Institute. Proceedings, 43, Section III, 158-64 (1963).

Under the joint sponsorship of the Federal Aviation Agency, National Aeronautics and Space Administration, and the Department of Defense, the Coordinating Research Council, Inc., is conducting a comprehensive research program to establish the suitability of fuels for use in the supersonic transport, recognizing the interdependence of fuel availability or cost, aircraft performance, and airline economics. Considerable progress to date has been made in carrying out the CRC objective. A large-scale rig facility capable of simulating aircraft conditions is ready for testing; environmental conditions have been established for a typical supersonic transport mission profile; small-scale fuel coker test studies are underway; techniques for measuring critical properties of aircraft turbine fuels are being reviewed; and a bank of fuels has been established for the CRC program and other privately conducted studies utilizing components or test rigs operated under supersonic flight conditions.

0688 Oswatitsch, K., **EXTREME SPEEDS AND THERMODYNAMIC STATES IN SUPERSONIC FLIGHT.** U. S. National Advisory Committee for Aeronautics, TM 1434, April 1958. 39 pp.

Typical of all cases of high-speed flow is the conversion of high kinetic energy into extreme thermodynamic states with temperatures of several thousand degrees; frequently, the gas is dissociated and ionized. A small sensitivity to high speeds is characteristic of gases of low molecular weight. With a minimum of mathematical and physical complexity these matters are discussed in relation to meteors, shock tubes, ram jets, and rockets. The discussion is directed primarily to experts in neighboring fields and interested novices.

0689 Owen, J.M., **EFFECT OF AERODYNAMIC HEATING ON OVER-ALL AIRCRAFT SYSTEM DESIGN.** Northrop Aircraft, Inc., Report No. NAI-54-119, Interim Technical Report-Summary to 14 March 1954, U.S. Navy Contract Nonr-1165(00), May 1954. (AD 44 529). REPORT CLASSIFIED CONFIDENTIAL.

The purpose of the program discussed here is to determine the effects of aerodynamic heating on aircraft systems, and to investigate in a general fashion the problems associated with the conditioning of such systems against these effects. The present phase of the program is directed toward the determination of the weight increase and thrust loss necessitated by the cooling or conditioning systems required to counteract the aerodynamic heating effects for a typical fighter aircraft in the Mach number range M = 1.0 to 3.0 and for altitudes to 75,000 ft.

0690 Palmer, H. B. (Pennsylvania State University), **KINETICS AND MECHANISM OF CARBON DEPOSITION DURING GASEOUS PYROLYSIS.** Fuel Society Journal, University of Sheffield, 13, 7-18 (1962). (CA, 57, 12803a).

A review with 26 references.

Panchenkov, G. M. and Baranov, V. Ya, KINETICS OF THERMAL CRACKING OF HYDROCARBONS AND THEIR MIXTURES. Kinetics and Catalysis (U.S.S.R.), 1, no. 2, 172-9 (1960). 0690

An equation for the kinetics of thermal cracking is given that is based on a radical-chain mechanism for the cracking reaction. The derived equation is applicable to the calculation of the kinetics of continuous-flow thermal cracking of either individual hydrocarbons (n-hexadecane) or petroleum products, at various temperatures and pressures. The values of thermal cracking rate constant upon changing pressure from atmospheric to 50 atm pass through a maximum at about 10 atm.

Panchenkov, G. M. and Kazanskaya, A. S., THE KINETICS OF CATALYTIC CRACKING OF n-ALKANES. Zhurnal Fizicheskoi Khimii, 32, 1779-84 (1958). (CA, 53, 4876e). 0692

Cracking of n-C_6H_{14}, n-C_7H_{16}, and n-C_8H_{18} over synthetic 30% Al_2O_3-70% SiO_2 catalyst in a flow apparatus proceeded as a homogeneous unimolecular decomposition reaction. The kinetics were expressed by $n_0 x = -Ln_0 \ln (1 - x) - K$, where n_0 was the number of mols. of the feed, x the fraction of decomposed moles, K the apparent reaction constant, and L an adsorption coefficient. The activation energies of cracking were: 36,600 cal./mol. for C_6H_{14}, 29,400 cal./mol. for C_7H_{16}, and 24,900 cal./mol. for C_8H_{18}.

Panchenkov, G. M. and Yang, K. -H., KINETICS OF COKE FORMATION ON ALUMINOSILICATE CATALYSTS DURING CRACKING OF PETROLEUM FRACTIONS AND HYDROCARBONS. pp. 285-9 in: Ministerstvo Vysshego i Srednogo Spetsialnogo Obrazovniya SSSR. "Kataliz v Vysshei Shkole", Trudy Pervogo Mezhvuz. Soveshch. po Katalizu, 1958, Part 1. Moscow, Izd. Univ., 1962. (CA, 59, 2554b) 0693

During the cracking of a kerosine-gas oil fraction (bp 200-325°) (I), cetane (III), and Decalin (III), the kinetics of coke formation on the surface of the catalyst [Al_2O_3 14.0%, SiO_2 84.66%, Na_2O 0.36%, Fe_2O_3 0.13%, CaO 0.8% (surface d. 305 sq. m./g.)] were studied. Constants of coke formation and active surface areas of the catalyst were calculated at various cracking temperatures. These are (in sq. m./g.): I 29.2 (450°); II 20.6 (430°); 20.6 (450°), 24.9 (500°); and III 10.4 (430°), 12.5 (450°), 19.4 (500°).

Panchenkov, G. M., Yang, K. H., and Hsiao, J. C., THE KINETICS OF COKE FORMATION DURING THE CRACKING OF INDIVIDUAL HYDROCARBONS. Kinetica i Kataliz, Akademiya Nauk SSSR, Sbornik Statei, 1960, 255-63. (CA, 57, 8807d). 0694

The cracking of cetane and decalin on aluminosilicate catalyst was studied. A coke formation equation which is in accord with experimental work was formulated. This equation can be used to determine the actual cracking surface. The latter increases with increasing size of the hydrocarbon molecules. For cetane, it is 6.8-8.2% and for decalin, 3.4-6.4% of the total surface.

Pankey, G. L. (General Dynamics/Convair), THERMAL INSULATION PROTECTION SYSTEMS FOR MACH 3.0 TO 4.4 FLIGHT VEHICLES. PART II. ADVANCED SYSTEM STUDIES AND FINAL EVALUATION. U.S. Bureau of Naval Weapons, ZM-640, Contract NOas-59-6263-c, Final Report, December 1960. 261 pp. (AD 264985). 0695

Three insulation systems representative of the present state-of-the air in design and materials were given extensive tests and analytical studies to determine the feasibility of their application for the protection of aluminum aircraft and/or missiles in the Mach 3.0 to 4.4 (500°F to 800°F equilibrium surface temperature) regime. It was shown that it is presently feasible and practical to insulate aluminum aircraft for short time Mach 3.0 to 3.2 applications if external insulation systems of a composite elastic nature are utilized. The unit weight of aluminum airframes so insulated will be competitive with uninsulated steel or titanium structures, and the cost will be substantially less. The total useful life of elastic insulation systems is indicated to be in excess of 500 hours under Mach 3.12 (500°F conditions). For application in the 550°F to 600°F range (M = 3.2 to 3.5 conditions) the elastic insulation system outer surface coating materials are adversely time-temperature critical.

Papok, K. K., Anisimov, K. N., Zuseva, B. S., and Kolobova, N. E., EFFECT OF THIO DERIVATIVES OF UNSATURATED PHOSPHONIC ACIDS ON THE ANTIOXIDANT PROPERTIES OF MINERAL OIL. Journal of Applied Chemistry (U. S. S. R.), 32, 685-8 (1959). 0696

The effects of thioesters of unsaturated phosphonic and thiophosphonic acids, and of diesters of alkyl-thiovinylphosphonic acids on the antioxidant properties of mineral oil were studied. The thioesters of β-alkoxy(phenoxy)vinylphosphonic and β-alkoxy(phenoxy)-vinylthiophosphonic acids are effective antioxidants; the most powerful of these is the dithioethyl ester of β-ethoxyethoxyvinylphosphonic acid. The antioxidant properties of esters of unsaturated phosphonic acids are greatly improved by introduction of sulfur. Esters of alkyl thiovinylphosphonic acids do not increase thermooxidative stability or diminish lacquer formation.

0697 Papok, K. K. and Semenido, Ye, G., eds., MOTOR FUELS, OILS, AND LIQUIDS. Moscow, Gostoptekhizdat, 1957. 512 pp. (U. S. Air Force translations available as OTS 60-13131 and OTS 60-13132 cover pp. 10-314 and pp. 315-512, respectively.)

This book is a reference text on fuels and lubricants. A rather extensive section (pp. 315-512) on jet aviation fuels treats state of the art (1957) specifications and problems in manufacture, use and handling and storage of jet fuels for subsonic commercial aircraft and low Mach number supersonic military aircraft. Projections of future requirements are discussed, but this discussion deals primarily with such problems as improving thermal stability, increasing the volumetric heat of combustion and rate of combustion and improving existing standards with regard to corrosion, icing, and freezing point.

0698 Papok, K. K. and Semenido, Ye. G., Eds., MOTOR, JET, AND ROCKET FUELS; 4th ed., Moscow, Gostoptekhizdat, 1962. 741 pp. (English translation available as FTD-TT-62-1308/1 + 2, AD 406864).

This is the fourth edition, revised and enlarged, of the original book published in 1957. The large amount of new material included, the editors believe, justifies considering it an entirely new book. It deals with the physical, chemical, and service properties of propellants and fuels for aircraft piston engines, turbojets, ramjets, rockets, automobiles, diesels, stationary turbines, and boilers. In addition to combustion problems, discussions of corrosion, carbon deposits, and residue formation are included. References follow each chapter.

0699 Pappas, C. C. and Okuno, A. F., MEASUREMENT OF HEAT TRANSFER AND RECOVERY FACTOR OF A COMPRESSIBLE TURBULENT BOUNDARY LAYER ON A SHARP CONE WITH FOREIGN GAS INJECTION. U.S. National Aeronautics and Space Administration, TN D-2230, April 1964. 83 pp.

Local heat-transfer and recovery temperatures of the turbulent boundary layer with foreign-gas injection of helium, air, and Freon-12 (CCl_2F_2) were measured on a porous cone at cone Mach numbers 0.7, 3.67, and 4.35 and in a Reynolds number range of 1 to 5 millon. The heat-transfer coefficients generally show a substantial decrease of up to 80 percent from the zero-injection value for all injection gases and the relative effectiveness of the gases is in accord with theory. The recovery temperature (wall temperature for zero heat transfer to the wall) at $M = 0.7$, for helium injection, increases with injection to a value greater than the total stream temperature and then decreases with increased injection. At the two higher Mach numbers, for all the injection gases tested, the recovery temperature first decreases with injection then increases to values which can be greater than the total temperature of the stream. For the highest injection rates at Mach number 4.35 the heat transferred to the wall can increase with increased injection. The heat-transfer coefficient ratios are in general agreement with the Rubesin theory heat-transfer predictions for Mach numbers from 0 to 4.35.

Patient, J. E. and Ziebland, H. NEW VALUES OF THE VISCOSITY, THE DENSITY AND THE THERMAL CONDUCTIVITY FOR PREMIUM GRADE KEROSENE (ALADDIN PINK). Gt. Brit. Explosives Research and Development Establishment, Technical memorandum 13/M/59, July 1959. 6 pp. (AD 226575). 0700

A study has been made of the viscosity, density and thermal conductivity of premium grade kerosene (Aladdin Pink), in the first instance between 20° and 100°C and at atmospheric pressure. Simple equations for the temperature dependence of the above quantities were found, which correlated the experimental data well and which appear suitable for extrapolation to about 150°C without significant loss in accuracy.

Paushkin, Y.M., THE CHEMICAL COMPOSITION AND PROPERTIES OF FUELS FOR JET PROPULSION. New York, Macmillan, 1962. 0701

Section one, pp. 19-200, deals with "Fuels for Aero-Jet Engines" and covers the following subjects:

1. General Information on Aero-Jet Engines.
2. Hydrocarbon Composition and Physico-Chemical Properties of Crude Petroleum for Production of Jet Propulsion Fuels.
3. General Characteristics of Turbojet Fuels.
4. Hydrocarbon Composition and Calorific Value of Jet Propulsion Fuels.
5. Inorganic and Elemento-Organic Substances, and Their Possible Use as Fuels.
6. Completeness of Combustion of Fuels and Carbon Formation in Aerojet Engines.
7. Starting Properties of Jet Propulsion Fuels.
8. Flame Velocity and Combustion Stability of Jet Propulsion Fuels.

Paushkin, Ya. M., Mazitova, F. N., and Kurashev, M. V., CHEMICAL STRUCTURE AND EFFICIENCY OF ANTIOXIDANTS FOR MOTOR FUELS. Izvestiya Vysshikh Uchebnykh Zavedenii. Neft i Gaz, 1959, no. 3, 67-73. (CA, 54, abstr. 13619 h, 1960). 0702

Results of an intensive study of antioxidants based on their action on the test fuel T-1, with special reference to the substituted aminophenols, are plotted and tabulated. Lengthening of the alkyl side chain raised the effectiveness of the additive. The best antioxidant of those studied was 2-amino-4-tert-amylphenol which, in the presence of Cu, reduced the amount of sediment to <one-third that for the untreated fuel. In general, synthetic aminophenols possess high antioxidant efficiency for leaded and cracked gasolines and other reactive fuels, and their presence reduces significantly the formation of insoluble deposits.

0703

Paushkin, Ya. M., Sychev, R. V., Vishnyakova, T. P., and Shomov, A. K., THE EFFECT OF CHEMICAL COMPOSITION AND ADDITIVES ON THE COMBUSTION OF FUELS IN REACTION MOTORS. pp. 293-314 in: "Mezhvuzovskoe Soveshchaniye po Khimii Nefti, 1956. Sbornik Trudy". Moscow, Izdatelstvo Moskovskogo Universiteta, 1960. (CA, 55, abstr. 15903b).

The requirements for fuels for reaction motors are discussed, and a laboratory apparatus for studying the combustion of liquid fuels is described. The completeness of combustion decreased and the amount of carbon deposit increased with increasing aromatic content of liquid hydrocarbons burned in air. A laboratory apparatus for determining the time and temperature for spontaneous ignition of organic compounds with 98% HNO_3 is described, and results are given with hydrocarbons, furfuryl alcohol, and Et_3N. An English translation of this article is available as U.S. Air Force, FTD-TT-62-743/1 + 2 + 4. (AD 292214).

0704

Paushkin, Ya. M., Vishnyakova, T. P. and Chernukhina, V. G., CONVERSION OF NAPHTHENIC HYDROCARBONS TO AROMATIC HYDROCARBONS WITH A CATALYST CONTAINING 0.1-0.3% Ni. Izvestiya Vysshikh Uchebnykh Zavedenii, Neft i Gaz, 1961, no. 5, 69-73. (C. A., 55, 22791d, 1961).

A nickel on alumina catalyst was active for enhancing aromatic content of 70-140°C gasoline fraction (Russia) from 4-5% to 25-28%. The catalyst could be regenerated by burning in air.

0705

Pedersen, C. J. (du Pont), MECHANISM OF ANTIOXIDANT ACTION IN GASOLINE. Industrial and Engineering Chemistry, 48, no. 10, 1881-4 (1956).

A review is presented of the different hypotheses on the mechanism of antioxidant action in the light of experimental evidence obtained with antioxidants in cracked gasoline under a certain set of conditions, showing that antioxidants of different types must function in different ways. A mechanism of autoxidation of gasoline is also presented. The efficiencies of the antioxidants were determined in thermally cracked gasoline by the oxygen bomb induction period method (ASTM D-525-49), at 100°C and 7 atmospheres of oxygen pressure, and expressed as molar efficiencies relative to N,N'-di(sec-butyl)-p-phenylenediamine, which is arbitrarily classified as 100% efficient.

0706 Pellini, W. S. (U. S. Naval Research Laboratory), MATERIALS REQUIREMENTS OF HYPERSONIC FLIGHT VEHICLES. Journal of Metals, 12, 952-63 (1960).

The paper surveys the factors that determine the materials requirements for airframe and propulsion components of hypersonic flight vehicles. Temperature limits of structural materials are given, and various types of construction for protection against transient and steady-state aerodynamic heating are described and compared. Cooling of rocket motors is discussed.

0707 Penner, S. S. (California Institute of Technology), COMBUSTION AND PROPULSION RESEARCH. Chemical and Engineering News, 41, no. 2, 74-80 (1963).

The paper is a general review of current work in combustion research. A substantial section is devoted to the review of supersonic combustion for hypersonic ramjets.

0708 Penner, S. S. and Mullins, B. P., Eds., EXPLOSIONS, DETONATIONS, FLAMMABILITY AND IGNITION. New York, Pergamon, 1959. 287 pp. (North Atlantic Treaty Organization. AGARDograph No. 31).

The book provides a summary of recent advances relating to explosions, detonation, flammability and ignition. The major portions of the book deal with questions of flammability and ignition which the two authors have discussed from different viewpoints, the one analytical, the other semi-empirical and practical. Of particular interest is the section dealing with high temperature ignition delay-data.

Pennsylvania State University, Petroleum Refining Laboratory, EVALUATION OF METHODS FOR PREDICTING VAPOR DENSITIES OF PURE HYDROCARBONS. Pennsylvania State University, Department of Chemical Engineering, Report No. API-6-64, April 1964. 39 + XXXXII pp. 0709

This evaluation was undertaken to determine which of the many methods for estimating vapor densities is most suitable for the API Technical Data Book. Although accuracy in representing the available literature data for hydrocarbons is the primary criterion, the selected method should also be internally consistent with methods for predicting the effect of pressure on such properties as enthalpy and heat capacity. Two tabular compressibility factor methods and three equations of state were evaluated. The Pitzer method was more suitable for desk calculations than the other tabular method (Lydersen) that was evaluated. The Hirschfelder-Buehler-McGee-Sutton equation of state is of comparable accuracy in the homogeneous region, but very poor for saturated vapor densities. The generalized Martin-Hou equation is the best available method for saturated vapor densities, but is not accurate in the homogeneous region at moderate and high vapor densities. The Benedict-Webb-Rubin equation accurately represents literature data, but it is only applicable to a small number of hydrocarbons. Final recommendations will be made after these methods are evaluated for the derived thermal properties.

Perchonok, E., (Marquardt), PERFORMANCE EVALUATION OF RAMJET PROPELLANTS. pp. 363-393 in: Penner, S. S. and Ducarme, J., eds., "The Chemistry of Propellants; a meeting organised by the AGARD Combustion and Propulsion Panel, Paris, France. June 8-12, 1959", Oxford, Pergamon, 1960. 0710

The performance of solid and liquid ramjet propellants is surveyed. The fuels considered include hydrocarbons, metals, slurries, boron compounds, and cryogenic liquids. Combustion properties and some physical properties are tabulated, and the heat sink capacities of some potential fuels are given. Engine cooling requirement for steady-state flight at M = 6 is implied.

Perel, J.M., RESEARCH AND DEVELOPMENT ON THE COPPER CONTAMINATION OF JP-5 FUEL BY 90-10 AND 70-30 COPPER-NICKEL ALLOYS. U.S. Navy, New York Naval Shipyard, Material Laboratory, Final Report, Lab. Project 5319-29, November 1957. 20+ pp. (AD 156659). 0711

Single and two phase immersions, using JP-5 fuel and sea water, were conducted to evaluate the factors affecting the rate and extent of copper contamination of the fuel by 70-30 and 90-10 copper-nickel alloys. The 70-30 alloy exhibited the greater resistance to corrosion by fuel and/or sea water. Free naphthenic acid produced the greatest contamination of the fuel, and nullified the inhibiting effect of Santolone "C" in two phase systems. Copper was assayed spectrophotometrically with Neocuproine as color reagent.

Perelman, R. G., THE ATTACK ON THE THERMAL BARRIER, Nauka i Zhizn', 1959, no. 6, 59-64.

0712

This is a popular introduction to the problems connected with the attempt to overcome the so-called thermal barrier, i.e., the sharp increase in heating up of the aircraft during flight, and the increasing difficulties connected with building high speed aircraft.

Perlee, H.E., Litchfield, E.L. and Zabetakis, M.G. (U.S. Bureau of Mines), REVIEW OF FIRE AND EXPLOSION HAZARDS OF FLIGHT VEHICLE COMBUSTIBLES. U.S. Air Force, ASD TR 61-278, Supplement 3, Contract DO 33(616)-60-8, June 1964. 17 pp.

0713

This report presents experimental results pertinent to inhibition of gaseous detonation, ignition of solid oxygen-liquid hydrogen mixtures, and flammability characteristics of halogenated hydrocarbons. The halogenated hydrocarbons do not appear to be particularly effective inhibitors of gaseous hydrogen-oxygen detonation. Combustibles such as methane and hydrogen were found to be superior to the halogenated hydrocarbons on a weight basis. Cryogenic mixtures of solid oxygen and liquid hydrogen can be ignited by 0.5 ounce projectiles moving at speeds as low as 1310 ft/sec. Ignition appears to occur at shock strengths of 1.5 to 3.0 kilobars. Although the halogenated hydrocarbons considered here do not appear to be flammable in air at atmospheric pressure and ordinary temperatures, some are flammable in oxygen under these conditions.

Petrov, A. A., I. KINETICS OF THE DEHYDROGENATION OF HEXANES ON AN ALUMINIUM-CHROMIUM CATALYST. Petroleum Chemistry U.S.S.R., 1, 26-33 (1962).

0714

The kinetics of the dehydrogenation of hexanes on an aluminium-chromium catalyst was studied in the temperature range 450-510°. It was shown that the dehydrogenation belonged kinetically to the class of reactions strongly retarded by the decomposition products and was well described by A. V. Frost's equation for monomolecular reactions under conditions of continuous flow. The structure of the initial alkane (with the exception of 2,2-dimethylbutane) had little influence on the velocity of the dehydrogenation.

Petrov, A. A., KINETICS OF THE DEHYDROGENATION OF C_6 — C_8 ALKANES ON AN ALUMINUM-CHROMIUM CATALYST. Petroleum Chemistry USSR, 1, 506-13 (1962). 0715

The kinetic laws of the dehydrogenation of C_6—C_8 alkanes of various structures on a chromia on alumina catalyst at 490° were investigated. It was found that the kinetics of the dehydrogenation of the alkanes obeys the laws of reactions strongly hindered by the decomposition products and are well described by A. V. Frost's equation. For hydrocarbons having more than six carbon atoms in the main chain, the rate of the dehydrogenation reaction does not greatly depend on the molecular weight and structure of the initial hydrocarbon (with the exception of gem-disubstituted hydrocarbons). The maximum concentration of unsaturated hydrocarbons in the catalysate in this case is 30-35%. In an investigation of the kinetics of the dehydrogenation of alkanes in admixture with nitrogen, hydrogen, benzene, and olefins, it was found that dilution of the initial hydrocarbons with nitrogen or benzene does not affect the rate of dehydrogenation, while dilution with hydrogen and, particularly, with olefins sharply decreases the rate of formation of unsaturated hydrocarbons.

Petukhov, B. S., Krasnoschekov, E. A. and Protopopov, V. S., AN INVESTIGATION OF HEAT TRANSFER TO FLUIDS FLOWING IN PIPES UNDER SUPERCRITICAL CONDITIONS. pp. 569-78 in: "International Heat Transfer Conference, 1961. Papers, Part III, Section A." New York, American Society of Mechanical Engineers, 1961. 0716

The results of experimental investigations reveal that for small wall-to-fluid bulk temperature differences local heat transfer in the supercritical region is correlated with good approximation by well-known equations valid at constant physical properties. When the temperature differences are large the heat transfer rate depends essentially on the character of the transverse variation of specific heat, thermal conductivity and viscosity. A correlation of the available experimental data on heat transfer to carbon dioxide and water in the supercritical region is proposed. For small variations in fluid physical properties this equation reduces to one valid for constant physical properties.

Phillips, D. G. and Unterberg, W. (Marquardt Corp), AN INVESTIGATION OF HIGH-SPEED HYDROCARBON-AIR MIXTURE IGNITION BEHIND BLUFF BODIES. Pyrodynamics, 1, 41-60, (1964). 0717

A systematic investigation of the factors controlling ignition of flowing uniform hydrocarbon-air mixtures was made in a six-inch pipe. Cylindrical center bodies with re-entrant aft cavities containing the igniter were used for bluff-body flame stabilization. Lean and rich ignition limits were measured for variations in mixture velocity (250 ft/sec to sonic at 1400 ft/sec maximum), temperature (60 to 500°F) and pressure (4 to 60 psia); igniter type (spark or flare), location, and energy; and bluff-body geometry. Some 800 data points were correlated by a single parameter containing all variables. The parameter obtained successfully correlated the ignition limits of large ramjet engines with bluff-body flameholders. It should also be applicable to other high-speed, continuous-flow combustion systems, including the case of partially preburned fuel-air mixtures. It was found that the ignition range was narrowed markedly when the flow in the annulus surrounding the centerbody became sonic and expanded supersonically to the full pipe diameter.

Pichler, H. and Gärtner, R., ÜBER DEN VERLAUF DER UMSETZUNGEN BEIM KATALYTISCHEN CRACKEN IN ABHÄNGIGKEIT VOM ABSINKEN DER AKTIVITÄT DES CATALYSATORS ZWISCHEN ZWEI REGENERATIONEN. Brennstoff-Chemie, 43, no. 11, 336-40 (1962). 0718

With n-Dodecane and 1-dodecene the composition of the products obtained in a cracking period varied continuously with time because of catalyst deactivation. This was shown from the change in the composition of the C_4-fraction in the cracked product with time. The formation of coke and the simultaneous formation of hydride ions were accelerated on the freshly regenerated catalyst, more so during cracking of olefins than during cracking of the corresponding paraffins. This gave an increase in the formation of saturated hydrocarbons on fresh catalyst. The formation of C_2-C_5 hydrocarbons is discussed.

Pierotti, R. A. (Georgia Institute of Technology), THE SOLUBILITY OF GASES IN LIQUIDS. Journal of Physical Chemistry, 67, no. 9, 1840-5 (1963). 0719

The solubility, heat of solution, and partial molar volume of a number of simple gases (including methane) in benzene, carbon tetrachloride, and liquid argon were accurately predicted by a method using equations derived by Reiss et al. (J. Chem. Phys. 31:369 (1959); 32:119 (1960); and 33:1379 (1960) for calculating the reversible work required to introduce a hard sphere into a fluid. The method was also used to determine the solute-solvent interaction energy from a single measurement of gas solubility. Probably, the solute creates a site for itself, and does not simply fill existing holes or lattice vacancies in the solvent.

Pietrangeli, G. J. and Nice, E. V. (APL, Johns Hopkins University), MACH 7 TRANSPORT WAITS IN THE WINGS. SAE Journal, 69, no. 12, 47-53 (1961). See also Society of Automotive Engineers. SAE Paper 427C, October 9-13, 1961. 35 pp. 0720

The overall features of the design and operation of a Mach 7 hypersonic transport have been developed and are presented in the article. The configuration uses a delta plan form with 8 or 10 turbojet engines for acceleration to Mach 3.6 with "external expansion ramjet burners for the 3.6-7.0 range. Most of the article is devoted to propulsion requirements and the mission profile. Calculations were based on the use of kerosene as fuel, but no description of the fuel system or fuel requirements is given.

Pimsner, V. and Vasilescu, A. C., THE INFLUENCE OF THE PHYSICOCHEMICAL CHARACTERISTICS OF THE FUEL ON THE TURBOREACTOR MOTOR. Academia Republicii Populare Romine, Institutul de Energetica, Studii si Cercetari de Energetica, 10, 229-43 (1960). (CA, 55, 8810g). 0721

A study of the physicochemical character of aircraft turbomotor fuels has shown that the fuels must satisfy the requirements of various aircrafts. It is necessary to rigorously select the crude oils to obtain constant-quality fuels. It is also necessary to obtain fuels of high specific weight and caloric potential to increase the flight span. For motors of high-speed aircrafts, the problem of thermal stability is raised and partial solutions are given. The turbomotor fuel must be considered from the viewpoint of the character of the motor used.

Pines, H. and Benoy, G. (Northwestern University), ALUMINA: CATALYST AND SUPPORT. II. HYDROISOMERIZATION AND AROMATIZATION OF HYDROCARBONS IN THE PRESENCE OF MOLYBDENA-ALUMINA CATALYSTS. EFFECT OF ALUMINAS. American Chemical Society. Journal, 82, 2483-7 (1960). 0722

The catalytic effect of molybdena-alumina catalysts having aluminas of increasing acid character was studied using n-octane, methylcyclopentane, cyclohexane, 1,2- and 1,4-dimethylcyclohexane and ethylcyclohexane as model hydrocarbons. In each case it was noticed that with increasing acidity of the alumina the extent of hydroisomerization increases. The hydroisomerization of 1,2-dimethyl-C^{14}-cyclohexane was studied. Ethylcyclohexane upon hydroisomerization yielded n-propylcyclopentane as the principal single hydrocarbon. The mechanism of hydroisomerization is discussed.

Pines, H. and Chen, C. T. (Northwestern University), ALUMINA: CATALYST AND SUPPORT. IV. AROMATIZATION AND DEHYDROISOMERIZATION OF 1,1-DIMETHYLCYCLOHEXANE, 4,4-DIMETHYLCYCLOHEXENE AND OF METHYLCYCLOHEPTANE OVER CHROMIA-ALUMINA CATALYSTS. American Chemical Society. Journal, 82, 3562-6 (1960). 0723

The aromatization of 1,1-dimethylcyclohexane (I), 4,4-dimethylcyclohexene (II) and of methylcycloheptane over chromia and chromia-alumina catalyst having different intrinsic acidities was studied. It was found that chromia alone is a dual function catalyst, and has both dehydrogenation and isomerization properties. In the presence of this catalyst compounds I and II on aromatization yield toluene, xylenes and ethylbenzene. When a catalyst prepared from alumina of low intrinsic acidity was used, only toluene was produced. The effect of the various catalysts upon the aromatization of methylcycloheptane also was studied. The dehydroisomerization reaction is interpreted as deriving from the acidic character of the catalyst.

Pines, H., and Chen, C. T. (Northwestern University), ALUMINA: CATALYST AND SUPPORT. VII. AROMATIZATION OF n-HEPTANE-1-C^{14} OVER CHROMIA-ALUMINA CATALYSTS. Journal of Organic Chemistry, 26, 1057-61 (1961).

0724 The aromatization of n-heptane-1-C^{14} over chromia and chromia-alumina catalysts having different intrinsic acidities was studied. The catalysts exhibited specific activity decrease patterns and the C^{14} distribution in the product toluene was found to depend on the nature of the catalysts and change with time. The results were interpreted by mechanisms involving five-, six-, and seven-membered ring intermediates of which the relative contributions depend on the nature of the catalyst and change of time. Cycloheptane was aromatized over chromia-alumina catalysts in good yields. Ethylcyclopentane was aromatized over chromia-alumina catalyst having high intrinsic acidity but not over chromia-alumina catalyst in which the alumina had low intrinsic acidity.

Pines, H. and Chen, C. T., ALUMINA: CATALYST AND SUPPORT. VIII. AROMATIZATION OF n-OCTANE-1-C^{14} AND OF CYCLO-OCTANE OVER CHROMIA-ALUMINA CATALYSTS. pp. 367-87 in: "International Congress of Catalysis (2nd), July 1960, Paris. Proceedings, vol. 1", Paris, Editions Technip, 1961.

0725 n-Octane-C^{14} and cyclo-octane were aromatized over chromia, chromia-on-alumina with weak acidity and chromia-on-alumina with stronger acidity at 500°C and 1 atmosphere pressure. The results suggested that the dehydrocyclization of n-octane may involve five-, six-, seven-, and eight-membered ring intermediates. The C^{14} distribution pattern indicated larger ring intermediates with chromia on the less acidic alumina.

Pines, H. and Chen, C. T. (Northwestern University), STUDIES IN THE TERPENE SERIES. XXX. THERMAL REACTIONS OF 5-ETHYL- AND OF 4,5- AND 5,6-DIMETHYL-1,3-CYCLOHEXADIENES. American Chemical Society, Journal, 81, 928-32 (1959).

0726 5-Ethyl- and a mixture of 4,5- and 5,6-dimethyl-1,3-cyclohexadienes were synthesized and subjected to thermal reactions over quartz chips at 400-500° and at atmospheric pressure. The dienes underwent extensive endocyclic double bond migration at 400°. However, like the geminal dimethylcyclohexadienes they also underwent skeletal isomerization at 450-500° to form mixtures of ethyl-, 1,2- and 1,4-dimethyl-cyclohexadienes, accompanying some cracking and dehydrogenation. The 1,3-dimethyl isomers were not found in the thermal reaction mixture. Thus the previously proposed biallyl biradical mechanism has been further substantiated.

Pines, H. and Csicsery, S. M., (Northwestern University), ALUMINA: CATALYST AND SUPPORT. XIV. DEHYDROGENATION, DEHYDROCYCLIZATION AND ISOMERIZATION OF C_5- AND C_6-HYDROCARBONS OVER CHROMIA-ALUMINA CATALYSTS. American Chemical Society, Journal, 84, 292-7 (1962). 0727

Alumina per se has intrinsic acidic properties which influences the reactions of hydrocarbons over chromia-alumina catalysts. Catalysts containing alumina made from aluminum isopropoxide have relatively strong acidic sites. Extensive cationic isomerization and polymerization of the dehydrogenation products of n-pentane, n-hexane, methylpentanes and methylcyclopentane were observed over this catalyst. Dehydrogenation and dehydrocyclization proceed without appreciable isomerization and polymerization over chromia-alumina where the alumina was obtained from potassium aluminate. The reaction product of n-hexane dehydrogenation over this non-acidic catalyst contained 52 mole % benzene vs. 13 mole % over the acidic chromia-alumina catalyst. In case of 2- and 3-methylpentane and methylcyclopentane the results were reversed: the yields of benzene obtained from the acidic catalyst were higher.

Pines, H., Goetschel, C. T. and Csicsery, S. M. (Northwestern University), ALUMINA: CATALYST AND SUPPORT. XX. AROMATIZATION OF n-OCTANE-4-C^{14} OVER CHROMIA-ALUMINA CATALYST. CONTRIBUTION TO THE MECHANISM OF AROMATIZATION. Journal of Organic Chemistry, 28, no. 10, 2713-16 (1963). 0728

The aromatization of n-octane-4-C^{14} over chromia-alumina catalyst was investigated in order to demonstrate that cyclooctane adsorbed species participates in the aromatization reaction. Only a C_8-ring intermediate will lead to ethylbenzene having a labeled ethyl group in the α- and β-position. The present study provides evidence that at least 30% of the ethylbenzene produced at the beginning of the reaction proceeds via a 1,8-ring closure. The radioactivity distribution in the m- and p-xylene is in agreement with the proposed mechanism suggesting the participation of 1,7- and 1,8-ring in the transition state.

Pines, H. and Greenlee, T. W. (Northwestern University), ALUMINA: CATALYST AND SUPPORT. VI. AROMATIZATION OF 1,1-DIMETHYLCYCLOHEXANE, METHYLCYCLOHEPTANE, AND RELATED HYDROCARBONS OVER PLATINUM-ALUMINA CATALYSTS. Journal of Organic Chemistry, 26, 1052-7 (1961). 0729

The aromatization of 1,1-dimethylcyclohexane (I), 4,4-dimethylcyclohexene (II), methylcycloheptane (III), and 5,5-dimethylcyclohexadiene (IV) over platinum-alumina catalysts has been investigated. The catalysts were prepared by impregnating aluminas of various intrinsic acidities with a solution of dinitrodiammine platinum, $Pt(NH_3.NO_2)_2$. The relative acidities of the aluminas and the method of platinizing them were found to have a profound effect on the composition of the aromatized product. The aromatization of I and II was accompanied by isomerization and the extent of isomerization could be related to the intrinsic acidity of the alumina. The product of the isomerization was mainly o-xylene admixed with m- and p-xylene and in the presence of a catalyst having high intrinsic acidity, alkylcyclopentanes were also produced. The aromatization of methylcycloheptane formed ethylbenzene and xylenes; the distribution of the various aromatic compounds depended upon the acidity of the alumina used.

0730 Pines, H. and Hoffman, N. E., MECHANISM OF HYDROCARBON ISOMERIZATION. Advances in Petroleum Chemistry and Refining, 3, 127-91 (1960).

Thermal reactions, anionic reactions and cationic reaction leading to isomerization of hydrocarbon molecules are discussed. Numerous examples of each reaction type are considered from a mechanism point of view. Over 127 references are cited.

0731 Pinkel, I. I., Serafini, J. S. and Gregg, J. L., PRESSURE DISTRIBUTION AND AERODYNAMIC COEFFICIENTS ASSOCIATED WITH HEAT ADDITION TO SUPERSONIC WING. U. S. National Advisory Committee for Aeronautics, Research Memorandum No. E51 K26, February 1952. 33 pp.

The modifications in the pressure distributions and the aerodynamic coefficients associated with additions of heat to the two-dimensional supersonic inviscid flow field adjacent to the lower surface of a 5-percent-thickness symmetrical circular-are wing are presented in this report. The pressure distributions are obtained by the use of a graphic method which gives the two-dimensional supersonic inviscid flow field obtained with moderate heat addition. The variation is given of the lift-drag ratio and of the aerodynamic coefficients of lift, drag, and moment with free stream Mach number, angle of attack, and parameters defining extent and amount of heat addition. The six graphical solutions used in this study included Mach numbers of 3.0 and 5.0 and angles of attack of 0° and 2°.

0732 Pinns, M. L., Olson, W. T., Barnett, H. C., and Breitwieser, R., NACA RESEARCH ON SLURRY FUELS. U. S. National Advisory Committee for Aeronautics, Report 1388, 1958. 24 pp.

An extensive program was conducted to investigate the use of concentrated slurries of boron and magnesium in liquid hydrocarbons as fuels for afterburners and ramjet engines. Analytical calculations indicated that magnesium fuel would give greater thrust and that boron would give greater range than are obtained from jet hydrocarbon fuel alone. It was hoped that the use of these elements in slurry form would permit the improvement to be obtained without requiring unconventional fuel systems or combustors. Tests in pipe-connected combustors of various designs showed that slurried magnesium burned very readily even under conditions where jet hydrocarbon fuel itself would not burn, and the expected improvement in thrust was obtained. In contrast, the boron slurries that were prepared were more difficult to burn than jet fuel, and formed objectional deposits in the combustor.

Plank, C. J. and Nace. D. M. (Socony Mobil Laboratories), COKE FORMATION AND ITS RELATIONSHIP TO CUMENE CRACKING. Industrial and Engineering Chemistry, 47, no. 11, 2374-9 (1955). 0733

Pure cumene was cracked (dealkylated) over silica-alumina catalysts with essentially no coking. Coke did form and the reaction was inhibited by cumene hydroperoxide (present in cumene charge) or by decomposition products such as styrene or methylstyrene. The decline in cracking rate with coking appears to be due to competition of the inhibitor and cumene for adsorption sites, rather than by coke deposition on adsorption sites. Relative adsorption equilibrium constants of strongly adsorbed compounds (i.e., inhibitors) were calculated from measurement of their inhibiting effect on cumene cracking.

Plattner, C. M., XB-70A'S RESEARCH ROLE WILL CONTRIBUTE MACH 3 FLIGHT DATA FOR SST DEVELOPMENT. Aviation Week and Space Technology, 80, no. 20, 26-30 (1964). 0734

This article gives a general description of the XB-70A. The construction, configuration and control of the aircraft are discussed. The turbine blades are air cooled, and heat from the hydraulic, oil and air conditioning systems is rejected to the fuel (JP-6). Heat rejection to the fuel reaches a rate of about 30,000 Btu/min at maximum cruise speed. Approximately 4,000 lb of water also is carried as a heat sink substitute for use when the fuel flow rate is so low, or the fuel temperature is so high that it is inadequate to provide a sufficiently large heat sink. The fuel tanks on the XB-70A are pressurized with nitrogen gas to prevent the formation of a potentially explosive air-fuel mixture in the cells.

Poisson-Quinton, P. (O.N.E.R.A.), PERSPECTIVES SUR L'AVION DE TRANSPORT SUPERSONIQUE. Technique et Science Aeronautiques et Spatiales, 1962, (May/June), 189-202. 0735

In the next ten years, it is probable that transport aircraft flying between 2000 and 3500 Km/hr. will have come into operation on at least some heavily travelled routes. The new technical problems of such aircraft are briefly reviewed before describing the economic operational and human aspects of supersonic flight. Finally, the probable characteristics of actual planes are envisaged; the long range Mach 3 carrier and the intermediate range Mach 2 plane.

Politzinar, I. (Continental Oil), SOME VOLATILITY CHARACTERISTICS OF AIRCRAFT JET FUELS, Industrial and Engineering Chemistry. Chemical and Engineering Data Series, 2, no. 1, 16-21, (1957). 0736

To aid in the design of a combustion system for jet engines, certain information regarding the volatility of the various potential fuels is required. Use of the fuel as a heat sink in supersonic aircraft introduces considerable preheat before injection into the combustion chamber. The preheat and/or the pressure drop across the nozzle cause a certain portion of the fuel to vaporize. The final ratio of vapor to liquid depends on many factors, including the initial pressure, initial temperature, final pressure, and heat losses or influx from or to the fuel. The present work was undertaken in order to obtain flash equilibrium data on commercial jet fuels at pressures and temperatures characteristic of those to be expected in engine operation.

Popova. L. P., FUELS FOR AVIATION TURBINE ENGINES. Moscow, Aviatsionnyy Institut. Trudy. Sbornik Statei, 1961, no. 132, 5-14. 0737

A brief description is given, together with complete lists of specifications, of post-war Soviet jet fuels with names of nearest corresponding Western fuels. After describing the merits of different hydrocarbon-types, a specification of a new improved fuel, T-5, is given.

Powell, W. B. (Jet Propulsion Laboratory), HEAT TRANSFER TO FLUIDS IN THE REGION OF THE CRITICAL TEMPERATURE. Jet Propulsion, 27, 776-83 (1957). 0738

Heat transfer by forced convection was studied experimentally using oxygen at super-critical and at subcritical pressures in the region of the critical temperature. Near the region of the critical a minimum in the heat transfer coefficient was observed. At temperatures above the critical data were in substantial agreement with Humble, Lowdermilk, Desmon correlation. Equipment included a direct, electrically heated tube (a-c) operated at temperatures to 1600°F. This work was sponsored by the Department of the Army, Ordnance Corps, under Contract DA-04-495-Ord 18.

Prater, C. D. and Lago, R. M., THE KINETICS OF THE CRACKING OF CUMENE BY SILICA-ALUMINA CATALYSTS. Advances in Catalysis, 8, 293-339 (1956). 0739

An extensive study of the kinetics of cumene cracking over silica-alumina catalysts was carried out using both a differential and an integral reactor. Dependence of reaction rate on pressure, temperature and the influence of inhibitors on reaction rates were determined. Kinetics of coke formation and types of coke formed from both cumene and gas oil feed stocks were studied. Adsorption constants for cumene, reaction products and various inhibitors were calculated.

Predvoditelev, A. S., ed. GAS DYNAMICS AND PHYSICS OF COMBUSTION. Jerusalem, Israel Program for Scientific Translations, 1962. 168 pp. (U.S. National Aeronautics and Space Administration. NASA-TT-F-79). 0740

The book consists of a collection of papers describing work (primarily experimental) carried out in the Combustion Physics Laboratory of Institute of Energetics of the Academy of Sciences, USSR. Of particular interest are a group of papers by L. N. Khitrin, S. A. Gol'denberg, I. N. Sundukov, and V. S. Peleven dealing with problems of turbulent combustion of gaseous mixtures. These deal with flame fronts in free jets, combustion behind turbulent flame fronts, and propagation of turbulent flames in the presence of high flow velocities.

Price, E. A., Howard, P. W. and Stallings, R. L., Jr., HEAT TRANSFER MEASUREMENTS ON A FLAT PLATE AND ATTACHED FINS AT MACH NUMBERS OF 3.51 AND 4.44. U. S. National Aeronautics and Space Administration, TN D-2340, June 1964. 26 pp. 0741

Heating distributions were obtained on three fixed-sweep fins (12.87°) of different leading-edge diameters partially submerged in a turbulent boundary layer, as well as on the flat-plate surface adjacent to these fins. Heating rates were also obtained on a flat plate adjacent to a fin at sweep angles varying from 0° to 69°. Heating rates obtained on the leading edge of the fins outboard of the sidewall boundary-layer effects are in good agreement with laminar theory. Maximum stagnation-line values obtained in the region subjected to the flow of the turbulent sidewall boundary layer are in good agreement with turbulent theory. The tests were conducted at Reynolds numbers per foot ranging from 2.5×10^6 to 4.2×10^6.

Probert, R. P. (National Gas Turbine Establishment), RAM-JETS. Royal Aeronautical Society. Journal, 62, 151-73 (March 1958).

0742

The article reviews the state of the art in ramjet development, particularly the work of the NGTE at Pyestock. It includes a discussion of combustion chamber cooling using bleed air cooling. "Calculations on cooling are always depressing."

Purnell, J. H. and Quinn, C. P., (University of Cambridge), THE PYROLYSIS OF n-BUTANE. Royal Society (London). Proceedings, A270, 267-84 (1962).

0743

A detailed analytical study of the formation of the products of the pyrolysis of n-butane in the temperature range 420 to 530°C and at initial pressures between 10 and 150 mm Hg was carried out. A free-radical mechanism incorporating that originally proposed by Rice was shown to give an excellent quantitative account of the reaction occurring. Rate parameters for some of the reactions involved were calculated. The unimolecular decomposition of the ethyl radical was shown to be in its pressure dependent region throughout the range of conditions employed, and the fall-off of the rate constant with pressure was shown to be well described by the classical theory of Kassel. The important role of the ethyl radical in determining the kinetic features of paraffin pyrolyses was outlined.

Purnell, J. H. and Quinn, C. P. (University of Cambridge), THE ROLE OF SURFACES IN THE PYROLYSIS OF n-BUTANE. Chemical Society (London). Journal, 4128-32 (1961).

0744

The effects of a four-fold change of the surface:volume ratio (A/V) of the reaction vessel and of seven types of surface on the rate of pyrolysis of n-butane has been examined by gas-chromatographic product analysis. It has been found that, up to 9% conversion of n-butane, identical and reproducible rates are observed at all values of A/V and for clean, KCl-coated, and etched Pyrex vessels. A magnesium perchlorate coating leads to a large initial acceleration of rate, probably due to decomposition of the perchlorate to oxide; when this is complete the rate is less than with the other types of surface. Conditioning by carbon reduces the reaction rate considerably and the effect is cumulative. It is concluded that in clean, KCl-coated, and etched vessels the reaction is homogeneous, but that is magnesium oxide or carbon-coated vessels heterogeneous termination processes may be important.

Purser, P. E. and Bond, A. C., **NACA HYPERSONIC ROCKET AND HIGH-TEMPERATURE JET FACILITIES.** North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, Report 140, July 1957. 13 pp.

0745 This paper discusses the extension of the rocket-model research of the National Advisory Committee for Aeronautics (NACA) to hypersonic speeds and describes briefly several high-temperature jet facilities assembled by the NACA for research on structures and materials. Of the jets described, one is essentially the exhaust of a ramjet engine and provides stagnation temperatures up to 3000°F, one is a rocket engine and provides stagnation temperatures up to 4200°F, one is a 4000°F air jet using a ceramic heat exchanger, and one is an electric-arc-heated jet with stagnation temperatures of over 15,000°F.

Pyatibratov. S. N., **HEAT CAPACITY OF LIQUID FUELS AT DIFFERENT TEMPERATURES AND PRESSURES.** Moscow, Aviationnyy Institut, Trudy, Sbornik Statei, 1961, no. 132, 31-44. (CA, 58, 4177 g).

0746 An apparatus was designed for the determination of the heat capacity and density of liquids at different temperatures and pressures by the method of direct heating. The densities and heat capacities of the fuels T-5, kerosine T-1, and benzine B-70 were measured at 10° intervals from 20 to 280°.

Quinn, C. P., **THE THERMAL DISSOCIATION AND PYROLYSIS OF ETHANE.** Royal Society (London). Proceedings, A275, no. 1361, 190-9 (1963).

0747 The kinetics of methane formation during the pyrolysis of ethane have been examined experimentally. It has been shown that under the conditions commonly used for the pyrolysis of hydrocarbons, the dissociation of ethane into methyl radicals is a first-order process of velocity constant

$$\log_{10}k_1 = (17.45 \pm 0.82) - \frac{91740 \pm 1400}{2.303RT} (s^{-1}).$$

The kinetics of the free-radical chain decomposition of ethane are interpreted in the light of this and other experimental results.

0748 Quinn, R.D. and Kuhl, A.E., COMPARISON OF FLIGHT-MEASURED AND CALCULATED TURBULENT HEAT TRANSFER ON THE X-15 AIRPLANE AT MACH NUMBERS FROM 2.5 TO 6.0 AT LOW ANGLES OF ATTACK. U.S. National Aeronautics and Space Administration, TM X-939, March 1964. REPORT CLASSIFIED CONFIDENTIAL.

Turbulent heat-transfer data measured on the X-15 airplane in a flight to a Mach number of 6.0 are presented and compared with calculated values. Calculated boundary-layer thicknesses and Mach number profiles in the shear layer are also presented.

0749 Rabinovitch, B.S. and Pearson, N.S., ELEMENTARY RATES OF UNIMOLECULAR DECOMPOSITION IN A HOMOLOGOUS SERIES. Washington University, Technical Report No. 3, U.S. Navy Contract N onr 477(36), June 1964. 5 pp.

The communication presents what are believed to be the first data on the microscopic rate constants as a function of molecular structure in a series: 2-butyl, 2-pentyl, 2-hexyl, 2-heptyl and 2-octyl radicals.

0750 Radshabli-Seidova, N. A., Khromov, S. I., Dorzin, Ch., Balenkova, E. S., Treshchova, E. G. and Kazanskii, B. A., CATALYTIC CONVERSIONS OF 1-METHYL-1-PROPYLCYCLOHEXANE AND 1-METHYL-1-BUTYLCYCLOHEXANE ON AN ALUMINOSILICATE CATALYST. Journal of General Chemistry (U. S. S. R.), 29, 2185-90 (1959).

The conversion of 1-methyl-1-propylcyclohexane and 1-methyl-1-butylcyclohexane was studied on an aluminosilicate catalyst at 500°. Under these reaction conditions the alkyl substituents were removed from the quaternary carbon atom. Concurrently the processes of hydrocracking, alkylation, dehydrogenation and isomerization of the six-membered ring into a five-membered one also occurred. Aromatic hydrocarbons predominated in the catalysis products but paraffins (mainly gaseous) and five- and six-membered naphthenes were also formed. When the number of carbon atoms in the alkyl group of gem-methylalkylcyclohexane was increased, the degree of conversion of the hydrocarbon increased.

Radzhabli-Seidova, N. A., Khromov, S. I., Gitina, R. M., Balenkova, E. S., Treshchova, E. S. and Kazanskii, B. A., CATALYTIC CONVERSIONS OF 1,1-DIMETHYLCYCLOHEXANE AND 1-METHYL-1-ETHYLCYCLOHEXANE IN THE PRESENCE OF AN ALUMINOSILICATE CATALYST. Journal of General Chemistry (U. S. S. R.), 29, 2179-84 (1959). 0751

The conversions of 1,1-dimethylcyclohexane and 1-methyl-1-ethylcyclohexane were studied over a silica-alumina catalyst at 500°. Under these reaction conditions alkyl groups were removed from the quaternary carbon atom in the ring; hydrocracking, methylation, aromatization and isomerization of six-membered rings into five-membered ones also occurred. The main conversion products were aromatic hydrocarbons, while paraffinic and napthene hydrocarbons were formed to a lesser extent.

Ragozin, N. A., JET PROPULSION FUELS. London, Pergamon, 1961. 168 pp. 0752

Following a brief introduction in which classes of engines and fuel types are described the author presents a critical survey of the current situation with regard to physical and chemical properties of fuels used in turbojet and turboprop engines with special reference to the USSR, USA and Gt. Br. Specifications and standard fuel-testing methods are described together with typical fuel-test data. A short chapter on fuels for supersonic flight speeds deals only with thermal stability and vapor pressure requirements.

Rapoport, I. B., Nefedov, B. K., and Grakhova, S. G., DEHYDROGENATION OF HIGHER PARAFFIN HYDROCARBONS OVER CARBON CATALYSTS. Journal of Applied Chemistry (U. S. S. R.), 32, 1137-44 (1959). 0753

With activated carbon promoted by 1-2% Na or Li salts the dehydrogenation of paraffin hydrocarbons containing from 8 to 20 carbon atoms was effected at 450-510°C. With paraffin hydrocarbons of 10-20 or more carbon atoms dehydrogenation was accompanied by cracking. The unsaturated hydrocarbons formed as the result of dehydrogenation had the double bond in the α-position.

Raring, R.H., Freeman, J.W., Schulty, J.W. and Voorhees, H.R., PROGRESS REPORT OF THE NASA SPECIAL COMMITTEE ON MATERIALS RESEARCH FOR SUPERSONIC TRANSPORTS. U. S. National Aeronautics and Space Administration, TN D-1798, May 1963. 202 pp. 0754

Activities of the NASA Special Committee in Materials Research for Supersonic Transports during the first 19 months of its life are summarized. Detailed results from the several investigations of sheet materials for wings and fuselage made under the Committee cognizance are presented. Committee recommendations for further research are outlined.

Raykov, L G., HEATING OF AIRCRAFT IN FLIGHT. Moscow, Voyenizdat, 1962. 97 pp. 0755

The book analyzes aerodynamic heating in supersonic aircraft and resultant structural changes. Sources of heating are studied, and data on new materials and coatings capable of withstanding increased temperature loads are given, along with problems related to structural strength at high temperatures.

Reed, R. D. and Watts, J. D., SKIN AND STRUCTURAL TEMPERATURES MEASURED ON THE X-15 AIRPLANE DURING A FLIGHT TO A MACH NUMBER OF 3.3. U. S. National Aeronautics and Space Administration, TM X-468, January 1961. 23 pp. 0756

A survey of skin and structural temperatures was obtained on the X-15 airplane during a flight to a Mach number of 3.3. Fuselage, wing, horizontal-tail, and vertical-tail temperatures are presented to show temperature variations on the external surfaces and temperature differences between the skin and internal structure. The maximum temperature recorded was 440°F on an unsupported skin area on the lower vertical tail. Temperature differences of 400°F were recorded between the external skin and internal spar webs on the wing. Local external temperature differences caused by the heat-sink effect of the supporting structure were as great as 220°F. Temperature-indicating paint aided in identifying the location of areas of concentrated heating on the lower surface of the wing. No heat transfer analysis is included.

Reese, B. A. and Graham, R. W. (Purdue University), **HEAT TRANSFER AND FRICTIONAL PRESSURE DROP CHARACTERISTICS OF WHITE FUMING NITRIC ACID.** Jet Propulsion, 24, 228-33, 236 (1954). 0757

An experimental investigation was conducted to determine the heat transfer and fluid friction characteristics of white fuming nitric acid under conditions simulating its use in regenerative coiling of a rocket motor. Measurements were made over the Reynolds Number range from 55,000 to 220,000 and for heat fluxes from 0.13 to 1.4 Btu/in.^{2}-sec. The apparatus used a 24-inch length Haynes Stellite Alloy 25 tube 5/8-inch O.D., 0.043-inch thick as the test section. Electrical heating power was supplied by a 100 kw transformer connected to the ends of the test section. This work was sponsored by the NACA under Contract NAw-6129 and further work was done under Contract NAw-6286.

Reid, R. C., and Sobel, J. E. (Massachusetts Institute of Technology), **THE ESTIMATION OF SATURATED LIQUID HEAT CAPACITIES ABOVE THE BOILING POINT.** Industrial and Engineering Chemistry, 56, no. 6, 95 (1964). (Abstract of Research Results Service Manuscript 64-147. 17 pp.) 0758

Watson's equation is re-solved by using a three-parameter law of corresponding states. Volumetric properties of gas and liquid phases are assumed to be functions of reduced temperature, reduced pressure, and critical compressibility factor. The tabulated thermodynamic functions of Lydersen et al. are used in the calculations.

Reiman, P. A. (Arthur D. Little), **INVESTIGATION OF PARAMETERS AFFECTING AIRCRAFT AND MISSILES FUEL FILTRATION.** U.S. Air Force, WADD TR 60-263, Part II, Contract AF 33(616) 6386, May 1961. 49 pp. (AD 271466). 0759

The feasibility of various alternate methods of removing free water, dissolved water and solids from military aviation fuels has been investigated. Although electrostatic and centrifugal techniques are available for removal of free water and solids, these methods are combersome and expensive. They offer no real advantage over filter/separation. The removal of dissolved water may be accomplished by a number of methods for which the necessary technical knowledge is readily available. Even complete removal of soluble water would not guarantee the elimination of airborne fuel system icing, however, and the use of anti-icing additives may be more practical. The effect of electrostatic charges generated by flowing fuel on contaminant behavior has also been investigated. Although highly charged conditions were readily produced, no effects upon particle dispersion, filtration efficiency, or coalescence were observed.

Rendel, D. (Royal Aircraft Establishment, Farnborough), THERMAL PROBLEMS OF HIGH PERFORMANCE FLIGHT: A FURTHER CONTRIBUTION TO THE BRISTOL CONFERENCE ON THERMAL STRESS ORGANIZED BY THE STRESS ANALYSIS GROUP OF THE INSTITUTE OF PHYSICS. Aircraft Engineering, 26, no. 305, 220-3 (1954). 0760

Various heating and cooling problems encountered in high-speed flight are considered. Icing of the aerodynamic surfaces and the fuel must be prevented in high-altitude flight at moderate speed, while at higher speed overheating becomes a problem. Curves are presented relating skin temperature rise to Mach number, insulation thickness, and time of flight.

Rhodes, R. P. and Chriss, D. E. (ARO, Inc.). A PRELIMINARY STUDY OF STATIONARY SHOCK-INDUCED COMBUSTION WITH HYDROGEN-AIR MIXTURES. U. S. Air Force Arnold Engineering Development Center, AEDC-TN-61-36, July 1961. 39 pp. (AD 260201). 0761

A study of the shock-induced combustion of hydrogen-air mixtures was made in a small Mach number 3 wind tunnel at a total pressure level of 45 psia. Combustion was induced by a normal shock wave which resulted from the interaction of two oblique shock waves produced by wedges on the tunnel walls. Significantly different phenomena were observed when the fuel injector was moved from the subsonic portion of the nozzle into the throat. With fuel injection in the throat, ignition denoted by emission glow from the sodium introduced with the hydrogen did not occur until some distance downstream of the normal shock wave. Some data are presented showing this delay as a function of the static temperature behind the shock wave.

Rhodes, R. P., Jr., Rubins, P. M., and Chriss, D. E. (ARO, Inc.), EFFECT OF HEAT RELEASE ON FLOW PARAMETERS IN SHOCK INDUCED COMBUSTION. Society of Automotive Engineers. SAE Paper 595P, October 1961. 0762

A series of tests were conducted in the supersonic combustion tunnel to determine the efficiency of the combustion in a shock induced combustion wave, the effect of the combustible mixture temperature on the combustion efficiency, and the relationships between the total pressure loss and the amount of heat release. An aerodynamic analysis of the Mach reflected normal shock system showed a static pressure gradient behind the normal shock wave such that the flow was reaccelerated to about Mach 1.6 at 3 in. downstream of the normal wave. When test fuel was introduced, the combustion efficiency rose rapidly at first and then at a lower rate. The decrease in rate resulted from a reduction in the quantity of hydrogen available to burn and from the reduction in static temperature caused by the expansion of the gas.

Richardson, J. L., Boynton, F. P., Eng, K. Y. and Mason, D. M. (Stanford University), **HEAT TRANSFER IN REACTION SYSTEMS. HEAT TRANSFER TO N_2O_4 GAS FLOWING NORMAL TO A HEATED CYLINDER.** Chemical Engineering Science, 13, 130-42 (1961).

0763 The N_2O_4-NO_2 gas system is convenient for experimental studies at relatively low temperatures of heat transfer processes in equilibrium-type reacting systems. The thermal conductivity and specific heat of these systems are unusually large and are non-uniform functions of temperature making difficult the assignment in heat transfer correlations of effective film values of these thermal properties. Rates of forced-convective heat transfer from a cylinder to N_2O_4-NO_2 gas at 1 atm were experimentally determined at free stream velocities up to about 40 ft/sec. If specific enthalpy instead of temperature is used as the driving force for heat transport a consistent correlation of the over-all heat-transfer rate data can be obtained by dimensional analysis, employing equilibrium properties in the conventional relationship, $N_{Nu} = \phi (N_{Pr}, N_{Re})$. The advantages of using specific enthalpy as a driving force are justified from theoretical considerations. Due primarily to the high thermal conductivity of this system, values of conventional heat transfer coefficients based on a temperature driving force may be as high as eight times those for a similar non-reacting system.

Riesz, C. H. and Morritz, F. L., **CATALYSTS FOR PETROLEUM REFINING.** Advances in Petroleum Chemistry and Refining, 4, 279-322 (1961).

0764 Commercial catalysts used for petroleum refining reactions such as cracking, dehydrogenation and dehydrocyclization are considered. Various mechanisms for these reactions are discussed and the manner in which the various reactions can be influenced by choice of catalyst and reaction conditions is described. Over 70 references are cited.

Robbins, L. A. and Kingrea, C. L. (Iowa State Univ.), **ESTIMATION OF THERMAL CONDUCTIVITIES OF ORGANIC LIQUIDS OVER USEFUL TEMPERATURE RANGES.** American Petroleum Institute. Proceedings, Section III, 42, 52-61 (1962).

0765 A relatively simple method for estimating thermal conductivities of associated and nonassociated organic liquids over useful temperature ranges is presented. The method, though empirical in nature, resulted from considerations of theoretical factors involved in thermal energy transport.

Rochte, L. S., COMMERCIAL SUPERSONIC TRANSPORT DEVELOPMENT. Society of Automotive Engineers. SAE Paper 451B, January 1964. 4 pp. (Engineering Index, 1962, 47). 0766

Approach taken by Federal Aviation Agency emphasizing elements of passenger safety and comfort, compatibility with airports and air traffic control systems, economy of operation, extended utilization life, and community acceptance with regard to noise; technical and operational problems involved; future work in addition to work by NASA and military embraces research and investigation of most promising metals, propulsion research, and sonic boom problem.

Roels, R., TESTING THE OXIDATION OF MOTOR FUEL IN THE PRESENCE OF COPPER. Institute of Petroleum. Journal, 50, 22-6 (1964). 0767

A method of accelerated aging of motor fuel in the presence of copper (modification of ASTM D525) was developed. Cupric oleate, cupric stearate, and cupric acetate were tried, but the latter compound gave less reliable results.

Rogers, J. D., Jr. (E. I. du Pont de Nemours), TURBINE FUEL THERMAL STABILITY - CFR COKER AND FLIGHT EVALUATIONS. SAE Transactions, 68, 474-82 (1960). 0768

Fuel thermal stability at the operating temperatures encountered in commercial transports and military weapon systems is an important safety and performance consideration, and yet, undoubtedly, one of the most difficult jet fuel properties to measure. New research techniques have been employed to determine the threshold temperatures at which deposit-forming reactions may occur in fuels. These techniques have been applied extensively in laboratory and flight programs to establish standard procedures for use by the aviation and petroleum industries. The CFR Fuel Coker developed by the Coordinating Research Council is the best-known laboratory method relating fuel stability to service experience. Current jet fuels are thermally stable at 300/400°F. Fuels that will be thermally stable at higher temperatures will be needed for jet-powered aircraft flying at Mach 3 and above, and evaluations of hydrocarbon fuels are being extended into such areas of superstability. This paper is a report of the Fuel Thermal Stability Group, Aviation Fuel, Lubricant, and Equipment Research Committee, Coordinating Research Council, Inc.

Rogers, J. D., Krynitsky, J. A. and Churchill, A. V., JET FUEL CONTAMINATION: WATER, SURFACTANTS, DIRT AND MICROBES. SAE Transactions, 71, 281-92 (1963). 0769

This paper is a report of the Groups on Jet Fuel Icing Problems, Water Separation Characteristics, and Aircraft Fuel Tank Corrosion, Aviation Fuel, Lubricant, and Equipment Research Committee of the Coordinating Research Council, Inc. 22 references are included. In recent years, fuel contaminants have been pinpointed as the cause of several accidents in military jet aircraft and "incidents" during operation. Free water and dirt, normally filtered out and separated prior to servicing, have been recognized as the principal offenders. Recent studies have shown that the performance of filter-separator equipment can be affected significantly by slight changes in the fuel's chemical constituents. The efficiency of fuel purification can be degraded by certain additives and trace quantities of surfactants. In addition to causing direct damage, the presence of water and dirt creates an environment for growth of microorganisms.

Rogers, M. R. and Kaplan, A. M., A FIELD SURVEY OF THE MICROBIOLOGICAL CONTAMINATION PRESENT IN JP-4 FUEL AND 115/145 AVGAS IN A MILITARY FUEL DISTRIBUTION SYSTEM. U. S. Army, Quartermaster Research and Engineering Center, Microbiological Deterioration Series Report No. 6, June 1963. 36 pp. (AD 410519). 0770

This report presents the findings of a microbiological field survey as conducted on 21 through 25 May 1962 of the fuel distribution system at Pease Air Force Base, New Hampshire, and its civilian supplier, New England Tank Industries, Newington, New Hampshire. Samples of fuel (JP-4 and 115/145 Avgas) and water, when present, from seven locations in the system were cultured for microbial contamination immediately after sampling using membrane filter or standard water dilution techniques. Nine selective media were used for culturing purposes. Bacteria were present in the fuels in higher numbers than fungi. Bacterial counts ranged from a low of 3 to more than 42 per 500 ml of fuel, whereas the estimated fungal count ranged between 2 to 18 per 500 ml of fuel with no significant buildup noted at any of the sampling stations. Until a direct correlation can be made between the presence of microorganisms and the incidence of fuel problems such as fouling, filter plugging, wing tank corrosion, failure of fuels to pass specification and other tests, and excessive corrosion of pipe lines, tanks, and fuel handling equipment, a finite numerical microbial quality standard for a fuel distribution system cannot be set. 20 references on microbiological contamination are given.

Rosner, D. E. (Aerochem Research), CONVECTIVE HEAT TRANSFER WITH CHEMICAL REACTION. I. THEORETICAL DEVELOPMENT OF CORRELATION FORMULAE FOR THE PREDICTION OF HEAT FLUXES IN HIGH PERFORMANCE ROCKET MOTORS AND RELATED SYSTEMS. U. S. Air Force, ARL 99, Part I, Contract AF 33(616)-6216, August 1961. 105 pp. (AD 269816). 0771

Energy transfer in chemically reacting boundary layer flows is discussed from the point of view of the investigator, who is seeking to extend existing correlation formulae to cases in which thermochemical effects influence heat transfer rates. Emphasis is placed on the prediction of convective heat fluxes in high performance rocket motors; however, examples are also given from the field of hypersonic gas dynamics.

Rosner, D. E. (AeroChem Research), RADIATION COOLING OF AERODYNAMICALLY HEATED SURFACES AT HIGH MACH NUMBERS. in: Olfe, D. B., ed., "Supersonic Flow, Chemical Processes and Radiative Transfer." Oxford, Pergamon, 1964. (Preprint available as AD 297233). 0772

In this paper several novel aspects of radiation cooling are discussed; particularly those associated with the occurrence of surface catalyzed atom recombination at high Mach numbers. An analogy between radiation cooling and chemical surface catalysis is explored and the dominant effects resulting from interactions between these two processes are illustrated using simple mathematical models which serve to single out the important non-dimensional parameters. In connection with flight applications, altitude-velocity maps are presented which provide an overall picture of the regimes in which chemical non-equilibrium effects should be noticeable. Several unexplored areas of potential interest in the design of hypersonic lifting vehicles are outlined and related to the available literature. Interestingly enough, not all of these areas deal with thermochemical effects. Many "classical" problems remain unsolved, as illustrated by a brief discussion of the radiation cooled flat plate. This research was supported in part by the U. S. Air Force under Contract AF 49(638)-1138.

Ross, R.O., SCRAMJET GROUND TEST SIMULATION REQUIREMENTS AND FACILITIES CAPABILITIES. Marquardt Corporation, Report No. 6052, U.S. Air Force Contract AF 33(657)-10795, May 1964. 71 pp. (AD 351 290). REPORT CLASSIFIED CONFIDENTIAL. 0773

No abstract.

Rothenberg, A.J., Edwards, H. and Woodell, E.W., VOLATILITY CHARACTERISTICS OF EIGHT TYPES OF TURBINE FUEL AT TEMPERATURES UP TO 450°F. Thompson Products, Inc. Report Eng. ER-176, June 15, 1954. 65 pp. (Appendix "A" to final CRC Report for Project CFA-1-51, VOLATILITY CHARACTERISTICS OF AIRCRAFT FUELS AT ELEVATED TEMPERATURES). 0774

This report presents results of determinations of volatility characteristics of eight types of turbine fuels under simulated flight conditions up to 450°F, including determination of pressure buildup in an unvented cell with 3% air space, pressure in an unvented cell with 10% vapor loss limit, molecular weight of the vapor fraction lost at various percents evaporated and thermal expansion characteristics. Eight fuels were studied (four different JP-4 fuels, No. 2 furnace oil, JP-1, grade 100/130 aviation gasoline, and heavy diesel oil). Also given for the fuels are physical data (ASTM distillation curve, specific gravity, molecular weight, Reid vapor pressure, oxygen and nitrogen solubilities, water content, initial boiling point and air free vapor pressures.

Rothberg, S. and Jessup, R. S. (U.S. National Bureau of Standards), NET HEAT OF COMBUSTION OF AN-F-58 AIRCRAFT FUELS. Industrial and Engineering Chemistry, 43, no. 4, 981-5 (1951).

0775

The work described in this paper was undertaken at the request of the Bureau of Aeronautics of the Department of the Navy to determine whether the heats of combustion of volatile hydrocarbon liquids used as jet-propulsion fuels could be correlated with more easily measured properties of the fuels. Experimental measurements of heats of combustion were made on 32 liquid fuels meeting the specifications for AN-F-58 (now MIL-F-5624) jet-propulsion fuels. It was found that the data on these fuels and data previously reported from this bureau of 57 aviation gasolines could be represented accurately by a linear equation expressing net heat of combustion as a function of the product of aniline point in degrees Fahrenheit and gravity in degrees A.P.I. As a result of this finding it is possible to make reliable estimates of the heats of combustion of a considerable variety of hydrocarbon fuels without the necessity of making experimental determinations, which are difficult and time-consuming.

Rothenberg, R. I. and Smith, J. M. (Northwestern University), HEAT TRANSFER TO A SURFACE REACTING FLUID IN TURBULENT FLOW. Canadian Journal of Chemical Engineering, 38, 184-8 (1960).

0776

The effect of chemical reaction on heat transfer has been studied for turbulent flow in tubes of a reacting gas. The analysis is carried out for a heterogeneous, catalytic reaction occurring at the wall surface. Equations are presented for predicting the increase in heat transfer coefficient due to reaction in terms of the rate of reaction, diffusion, and operating conditions. For an exothermic reaction the total heat transfer coefficient is increased when the gas temperature is greater than the wall temperature, and decreased when the gas temperature is less than the wall value. The effect is greatest for rapid reactions; that is, when diffusion of reactants to the tube wall determines the rate of reaction. The equations are applied to the catalytic hydrogenation of ethylene. The results show that the total heat transfer coefficient can be at least ten fold larger than the coefficient for a non-reacting system at the same flow conditions. In general, the results of this study suggest that a wall-catalyzed reaction can be an effective means of increasing the heat transfer rate from gases in turbulent flow in tubes.

Row, P. V. and Fischel, J. (NASA Flight Research Center), X-15 FLIGHT-TEST EXPERIENCE. Astronautics and Aerospace Engineering, 1, June, 25-32 (1963).

0777

This article is a popular description of the X-15 research program, both with respect to its objectives and its attainments. Little quantitative information is given. A bibliography lists 32 references, all NASA publications (some classified) on the subject.

Rowe, J. T., POWER FOR THE SUPERSONIC TRANSPORT. Mechanical Engineering, 84, 40-5, (Nov 1962). 0778

The paper reviews some of the problem areas of supersonic trasnport power plants particularly with reference to the SST. With respect to the fuel system, a number of problems due to aerodynamic heating of fuel tanks and to the use of the fuel as a coolant for environmental temperature control and for cooling hydraulic and engine oil systems are pointed out. However, the discussion is brief and qualitative. Condensed from ASME Paper 62-Av-26.

Roy, M., AERODYNAMIC HEATING VERSUS SPEED: THERMODYNAMIC ASPECTS OF THE STRUGGLE. pp. 42-74 in: North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, "Fifth AGARD General Assemby, 15 and 16 June 1955. Proceedings." 0779

Serious thermal obstacles to progress in speed are encountered only from about $M_0 = 1.5$ onwards. From $M_0 = 1.5$ to $M_0 = 2$, the really important difficulties arise in the cockpit pressurization and in the cooling of certain vulnerable parts of the aircraft, such as some kinds of apparatus and equipment. At higher speeds the obstacles increase; forced cooling of many parts becomes compulsory; the cycle-cooling machines become less and less advantageous or convenient; transpiration cooling and internal cooling compete with one another, both requiring the vaporization of transported liquids, of which plain water is probably the best example; finally it appears necessary to cool the active flow of jet engines during its compression stage. Continued advances must be made in external thermal insulation and improved materials capable of resisting increasingly higher temperatures. The progress thus achieved will powerfully and continuously contribute to success in the struggle to overcome the above-mentioned obstacles.

Roy, M. (O. N. E. R. A.), PROPULSION SUPERSONIQUE PAR TURBOREACTEURS ET PAR STATOREACTEURS. Advances in Aeronautical Sciences, 1, 79-112 (1958). 0780

The paper is primarily devoted to the limitations of turbojet engines in supersonic flight and to the use of conventional ramjets. However, of particular interest is a section devoted to discussion of the possible configurations for a ramjet engine with "standing detonation wave" combustion. In subsequent discussion included with the paper, this is commented upon by R. Gross, A. Ferri, and L. Crocco.

0781 Rozengart, M. I. and Kuznetsova, Z. F., **EFFECT OF ADDED SUBSTANCES ON THE IMPROVEMENT OF CATALYSTS FOR THE DEHYDROCYCLIZATION OF PARAFFIN HYDROCARBONS.** Kinetika i Kataliz 3, 942 (1962). (C. A., 58, abstr. 7847d, 1963).

Addn. of K^+ to an Al-Mo oxide catalyst, or of Rb^+ or Cs^+ to an Al-Cr oxide catalyst, causes the yield of aromatic hydrocarbons from n-heptane to increase with time over a 4-hr. period, and thereby raises the average yield. Al-Pd and Al-Pt catalysts do not show the effect.

0782 Rozhkov, I. A. and Sablina, Z. A., **THERMAL STABILITY OF JET-ENGINE FUELS.** Vestnik Vozdushnogo Flota, 1959, no. 2, 69-72.

1) Hard particles and tarry clumps develop in jet fuels on heating in presence of air. The airdrome fuel tester used determines thermal stability in 1 hour. Aircraft engine filters clog most rapidly at temperatures from 110-190°C. Below 100-110°C impurities are still small in size and they pass through the filter. Above 200-220°C impurities partly dissolve and decrease in size. 2) Hydrogenation treatment of fuels removes sulfur, nitrogen, and metal compounds. 3) Fuels with good filtering qualities can be obtained by using gas-tight fuel tanks, with the space above the fuel surface filled with inert gas (N_2).

0783 Rubins, P. M. (ARO Equipment Corporation), **INSTALLATION AND CALIBRATION OF A SUPERSONIC COMBUSTION TUNNEL.** U. S. Air Force, AEDC-TN 60-162, Contract AF 40(600)-800 S/A 11(60-110), September 1960. 26 pp. (AD 242516).

A Mach number 3 supersonic combustion tunnel, designed, constructed, and operated by Fairchild Engine Division Research Laboratory under the auspices of the Air Force Office of Scientific Research, was transferred to the Rocket Test Facility at the Arnold Engineering Development Center. The supersonic combustion tunnel, as installed at AEDC, has demonstrated that the same type of combustion phenomena observed at the Fairchild Laboratory can be reproduced. The tunnel can now be operated over a range of pressure levels between 12 and 150 psia in the plenum, with discharge pressure controllable from ambient down to 1 psia, as compared with the single operating pressure of 120 psia at Fairchild, with ambient pressure discharge.

Rubins, P. M. and Rhodes, R. P., Jr. (ARO, Inc.), SHOCK-INDUCED COMBUSTION WITH OBLIQUE SHOCKS: COMPARISON OF EXPERIMENT AND KINETIC CALCULATIONS. AIAA Journal, 1, no. 12, 2778-84, (1963).

0784 Theoretical analyses made recently have shown the advantages of supersonic combustion for a hypersonic ramjet. The present work deals with experimental investigations of shock-induced H_2-air combustion in the constant pressure region aft of an oblique shock and with kinetic calculations for the H_2-air reaction. The concept of shock-induced combustion is defined and compared with the usual conditions where detonations are observed, and it is concluded that detonations are a special case of shock-induced combustion. Quenched gaseous components for the early parts of the chemical reaction were analyzed to determine hydrogen molecule reaction rate, and a comparison was made of the experimental H_2 reaction rate, with the current chemical kinetic computations. A portion of this work was supported by the Air Force Office of Aerospace Research.

Rudenko, A. P., Balandin, A. A., and Kachan, S. Ya., TWO MECHANISMS OF CARBON FORMATION IN THE DECOMPOSITION OF n-PARAFFINS, NAPHTHENES, AND AROMATIC HYDROCARBONS WITH SIX AND SEVEN CARBON ATOMS ON SILICA GEL. Academy of Sciences (U.S.S.R.). Bulletin. Division of Chemical Science, 1960, 917-23.

0785 Carbon formation during pyrolysis of cyclohexane, methylcyclohexane, n-hexane and n-heptane was studied at 500°-900°C over silica gel catalyst. It was postulated that carbon formation occurred mainly as a result of polycondensation of starting material or of initial conversion products. Different mechanisms for carbon formation appeared to be operating at 690°-745°C and at 785°-825°C.

Rumsey, C.B., Piland, R.O. and Hopko, R.N. (Langley Research Center), AERODYNAMIC-HEATING DATA OBTAINED FROM FREE-FLIGHT TESTS BETWEEN MACH NUMBERS OF 1 AND 5. U. S. National Aeronautics and Space Administration, TN-216, January 1960. 21 pp.

0786 Aerodynamic-heating data were obtained from temperature measurements made at a single station on each of two models. The first model provided data on a parabolic nose between Mach numbers of 2.3 and 5.0, corresponding to Reynolds numbers of 11×10^6 and 19×10^6, respectively. The corresponding ratio of skin temperature to local static temperature varied from 1.1 to 2.6. The second model provided data on a conical nose between Mach numbers of 1.1 and 4.0, corresponding to Reynolds numbers of 14×10^6 and 28×10^6, respectively, with the ratio of skin temperature to local static temperature varying from 1.0 to 2.3. The measurements are compared with the theory of Van Driest for turbulent flow.

0787

Russel, A. E. (Bristol Aircraft), SUPERSONIC TRANSPORT AIRCRAFT. De Ingenieur, 74, no. 15, L35-42 (1962).

A survey is given of the aerodynamic and structural problems to be encountered in the construction of supersonic aircraft. Moreover, the consequences of high speed effects on the aircraft systems are reviewed.

0788

Ryason, P. R. (California Research Corp.), THERMAL STABILITIES OF THE METHYL ETHYL LEAD ALKYLS. Combustion and Flame, 7, no. 3, 235-43 (1963).

The thermal stabilities of the methyl ethyl lead alkyls, are, in decreasing order, tetramethyllead > ethyltrimethyllead > dimethyldiethyllead, triethylmethyllead, and tetraethyllead (as a group); this result was obtained in measurements at 731°-931°K by means of a single pulse shock tube. Thermal stability parallels engine performance; the octane number increase rises with the number of methyl groups in the additive. The study also proved that the decomposition reaction appears to be first order over the entire temperature range only for dimethyldiethyllead. Pressures and driver gas compositions for the stability study were computed on the basis of the one-dimensional unsteady flow theory, assuming ideal gas behavior.

0789

Sablina, Z. A. and Gureev, A. A., DETERMINING THE CHEMICAL STABILITY OF FUELS. Azerbaidzhanskoe Neftyanoe Khozyaistvo, 1957, no. 2, 31-3. (CA, 52, 19079).

A new laboratory method is suggested for the determination of the chemical stability of fuels. The rate of the formation of resins is the source according to which the chemical stability of fuels is determined. In order to predict the behavior of fuel under the real conditions where the oxidation always occurs in the presence of metal, a use of Cu catalyst in the latoratory method is suggested. Study of gasoline and aviation fuel containing cracking-component showed that the gasoline after 6 hours of oxidation contained 20 mg of resins/100 ml and aviation fuel at 8 hours of oxidation contained 15 mg of resins/100 ml.

Sablina, Z. A. and Gureev, A. A., INCREMENTAL STABILIZATION OF FUELS WITH ANTIOXIDANTS. Khimiya i Tekhnologiya Topliva, 1956, no. 7, 61-4. (CA, 51, 4687 h). (Extensive summary available as AD 136124. 3 pp). 0790

It was observed that addition of large amounts of antioxidants (wood tar) to fuels is less effective than addition in small portions, spaced so that the new portion is added before the previous one is used up.

Sablina, Z. A. and Gureev, A. A., NON-HYDROCARBON COMPONENTS OF FUELS AS A BASIC SOURCE OF SEDIMENT FORMATION AT HIGH TEMPERATURES. Khimiya i Tekhnologiya Topliv i Masel, 1960, no. 7, 33-38. (Extensive summary available as AD 245001. 2 pp.) 0791

The tests consisted of pumping fuel through a filter at certain elevated temperatures (140-180°C). A predominant effect of heteroatomic compounds over unsaturated hydrocarbons was found in sediment formation.

Sablina, Z. A. and Gureev, A. A., TEST METHODS FOR THE HIGH-TEMPERATURE STABILITY OF AVIATION FUELS. Khimiya i Tekhnologiya Topliva i Masel, 1957, no. 9, 93-6. (CA, 54, 23286f). 0792

The method, described in detail, consists of heating 250 ml. fuel at 250° in a steel bomb for 1 hour. The effects obtained with 5 additives and by refining with an adsorbent are given. p-Hydroxydiphenylamine plus a metal deactivator was the most effective additive for reducing the formation of gum and solid deposits. The elementary analysis of the gum and the solid deposits and some of their other characteristics are given.

Safronov, N. Ya., Berestneva, Z. Ya., and Kargin, V. A., **THERMAL DECOMPOSITION OF BENZENE AND HEPTANE AT A HEATED MOLYBDENUM WIRE.** Colloid Journal (U.S.S.R.), 25, no.4, 391-3 (1963). 0793

Thermal degradation of benzene and heptane on an incandescent molybdenum wire was studied by passing their vapors in a stream of argon over a heated wire coil mounted in a reaction tube. The carbon formation time, calculated from the distance between the coil and the point where fumes became visible, was in no case greater than 6×10^{-4} sec. Electron microscopic study of the products showed that the benzene degradation products were spherical carbon particles joined together in the form of structures typical of the conventional carbon black. The heptane degradation products were of irregular shape and rather large particle size, and formed structures of a type appreciably different from carbon black.

Sagert, N. H. and Laidler, K. J. (University of Ottawa), **KINETICS AND MECHANISMS OF THE PYROLYSIS OF n-BUTANE. PART I. THE UNINHIBITED DECOMPOSITION.** Canadian Journal of Chemistry, 41, 838-47 (1963). 0794

The kinetics of the pyrolysis of n-butane have been studied at temperatures from 520° to 590°C, and at pressures from 30 to 600 mm Hg; the rate was followed from pressure changes and by gas chromatography. The reaction was accurately of the three-halves order; the activation energy was found to be 59.9 kcal $mole^{-1}$, and the frequency factor 3.24×10^{15} $cc^{1/2}$ $mole^{-1/2}$ sec^{-1}. The reaction is sensitive to surface; packing the vessel and "conditioning" it usually led to a decrease in rate and an increase in activation energy. The reaction is concluded to be largely homogeneous, and to occur almost entirely by a free-radical mechanism; the initiation reaction is considered to be the dissociation of a butane molecule into two ethyl radicals, in its first-order region, and termination is believed to be the second-order combination of ethyl radicals. The mechanism proposed is shown to account satisfactorily for the observed behavior. The surface ceffect is attributed to a certain amount of initiation by abstraction, by a surface atom, of a hydrogen atom from butane, and to surface catalysis of the recombination of ethyl radicals.

Sakharov, G. I., Andreyeviskiy, V. V., and Bukreyev, V. Z., **HEATING OF BODIES AT HIGH SUPERSONIC SPEEDS.** Moscow, Oborongiz, 1961. 105 pp. 0795

The authors have attempted to assemble the scattered material on the aerodynamic heating of aircraft surfaces and to present it in an intelligible form. A method is presented for calculating heat flows from the atmosphere to aircraft surfaces and from these surfaces back to the atmosphere. This method makes it possible to calculate the surface temperature for steady motion and to calculate the temperature of a high-specific-heat skin, on the basis of its thermal characteristics, for the unsteady motion (takeoff, descent, acceleration). Certain problems connected with the effect of high temperatures on aircraft structures are discussed and a brief review is given of the most important methods of surface protection against aerodynamic heating. A large number of graphs and tables are presented to aid in reducing mechanical calculations to a minimum. The proposed method for calculating thermal flows is applicable for altitudes up to 80-100 km and for speeds corresponding to Mach numbers from 2 to 15-20, with corrections for dissociation in the continuous-flow region.

Sale, B., CARBUREACTEURS A HAUTE ENERGIE VOLUMETRIQUE D'ORIGINE PETROLIERE. Paris. Institut Français du Pétrole. Revue, 17, no. 10, 1260-80 (1962). Similar paper in: Association Française des Techniciens du Pétrole. Bulletin, no. 155, 756-79 (1962). (CA, 58, 1284d). 0796

A technique is described for measuring the combustion characteristics of hydrocarbon-air mixtures in a flow system. The flame stability, products, and deposit formation were determined. Naphthenic hydrocarbons, e.g. Decalin, which have superior volumetric combustion energies, have satisfactory flame characteristics. Naphthenic fuels were prepared by the hydrogenation of catalytically reformed petroleum fractions over Raney Ni whereby polynuclear aromatics were converted into polynuclear naphthenes. These fuels showed an increase of 10-12% in volumetric combustion energy.

Salooja, K. C. ("Shell" Research, Thornton Research Centre), EFFECT OF TEMPERATURE ON THE IGNITION CHARACTERISTICS OF HYDROCARBONS. Combustion and Flame, 5, 243-7 (1961). 0797

The ignition lag/temperature relationship and the effect of fuel-air composition on this relationship have been investigated for n-heptane, methylcyclohexane, isooctane, diisobutylene, benzene and ethylbenzene, from temperatures near their minimum ignition points to 800°C. Marked changes in the ignition characteristics have been shown to occur with increasing temperature. In general, as the temperature is increased (i) ignition lag decreases, (ii) the slope of ignition lag/temperature relationship becomes less steep, and (iii) the marked effect of fuel-air composition observed near the minimum ignition point decreases and eventually tends to disappear. Although the general trend of behavior of different hydrocarbons with increasing temperature is similar, there are usually marked differences amongst them with respect to the above characteristics at all temperature levels. This often results in a change in the order of relative susceptibility to ignition of the different fuels at higher temperatures.

Salooja, K.C. (Shell Research Ltd.) "INFLUENCE OF SURFACE-TO-VOLUME RATIO OF QUARTZ REACTION VESSELS ON PREFLAME AND IGNITION CHARACTERISTICS OF HYDROCARBONS". Combustion and Flame, 8, 203-13 (1964). 0798

A number of C_6-C_8 hydrocarbons were studied in several vessels of different surface to volume ratios. Work was concentrated on low temperatures (250-700°C), rich mixtures; and preflame reaction rates and ignition delays were measured. The work is of particular significance in demonstrating the greatly different ignition delay behavior of hydrocarbons in the region of low temperatures and long ignition delays (order of 1-10 seconds) from that observed at higher temperatures.

Salooja, K. C. (Shell Research, Ltd.), THE ROLE OF COMBUSTION PROMOTERS. Institute of Petroleum. Journal, 48, no. 460, 119-29, (1962). 0799

The role played by promoters has been investigated by examining their effect on all the pre-flame stages and the ignition characteristics of hydrocarbons. It has been shown that, in general, promoters: (1) markedly lower the temperature at which oxidation reactions commence; (2) increase the extent of reaction at all preflame stages; and (3) lower the ignition temperature. Promoters also seem to increase the rate of reaction; this effect is particularly marked during the stage where the cool flame processes rise to a maximum. Different hydrocarbons vary markedly in their susceptibilities to promoter action. Different promoters, too, display marked differences in their relative effectiveness.

Salooja, K. C. ("Shell" Research, Thornton Research Centre), STUDIES OF COMBUSTION PROCESSES LEADING TO IGNITION IN HYDROCARBONS. Combustion and Flame, 4, 117-36 (1960). 0800

The extents of overall reaction at various temperatures preceding ignition and also the ignition temperature/concomitant lag relationships of a number of C_6-C_8 hydrocarbons have been studied in a quartz reaction chamber at atmospheric pressure. The hydrocarbons studied include n-heptane, methylcyclohexane, isooctane, diisobutylene, benzene, toluene, m-xylene and ethylbenzene. Marked differences exist between hydrocarbons with regard to their extents of pre-flame reactions and ignition characteristics, and also with regard to the effect of fuel-air composition on these properties. Studies of ignition characteristics reveal marked differences in the autogenous ignition tendencies of different fuels.

Salooja, K. C. ("Shell" Research, Thornton Research Centre), STUDIES OF COMBUSTION PROCESSES LEADING TO IGNITION OF ISOMERIC HEXANES. Combustion and Flame, 6, 275-85 (1962). 0801

The extent of overall reaction at various temperatures preceding ignition, and the ignition characteristics, of the isomeric hexanes have been studied in air at atmospheric pressure in a quartz reaction chamber. The degree and the position of branching, particularly when the latter involves an alteration in the number and the type of C-H bonds, markedly affect the preflame and ignition behavior. In general, the greater the degree of branching of the molecule (that is, the greater the proportion of tertiary C-H bonds to secondary C-H bonds) the higher the temperature at which reactions commence, the lower the overall extent of preflame reaction, and the higher the ignition temperature.

Sandler, S. and Lanewala, M. A. (University of Toronto), Journal of Chemical and Engineering Data, 8, no. 2, 258-60 (1963). 0802

The thermal decomposition of n-butane has been studied in the very low conversion region, 0.05 to 5%, in an isothermal flow reactor. The analytical problem was solved by the very successful application of a gas liquid chromatographic technique. An inherent weakness in the usual procedure of extrapolating relatively high conversion data to estimate incipient conversion mechanisms is demonstrated by the results. On the basis of the measured product distributions at these low conversions, it is possible to confirm earlier suggestions concerning the reaction mechanism and kinetics.

Sanin, P. I., Sher, V. V. and Chernyavskaya, L. F., METAL DIALKYL THIOPHOSPHATES AS ANTIOXIDANTS (FOR HYDROCARBONS). Acta Chimica Academie Scientiarum Hungaricae, 36, no. 1/4, 381-9 (1963). (CA, 59, 9703 h). 0803

Metal dialkyl thiophosphates $(RO)_2P(:S)SM$ and $[(RO)_2P(:S)S]_2M$, where R is C_4 and from C_{10} to C_{18} alkyl, and M is Na, K, Ca, Ba, Zn, Fe, Pb, or Ni were tested as oxidation inhibitors in a systematic study of the oxidation of an aromatic- and sulfur- free paraffinic-naphthenic hydrocarbon mixture (average molecular weight 404, d_4^{20} 0.8627, n_D^{20} 1.4740) separated by chromatography from a petroleum distillate boiling between 300 and 420°. The oxidations were carried out with oxygen in a closed system at 150° during 6-10 hours. The degree of oxidation was measured by the amount of oxygen consumed. The additives were used in amounts of 1-2 millimoles/100 g hydrocarbon (0.6-1.4%w). Both the nature of the metal and the structure of the alkyl group influence the inhibition of oxidation.

Sapon, M. F. and Lavrentyev, V. I., THERMAL STABILITY OF GASOLINE AND KEROSINE FRACTIONS AT HIGH TEMPERATURES. Grozny. Neftanoy Nauchno-Issledovatel-skiy Institut. Trudy. 1960, no. 7. 64-73. (CA, 56, abstr. 8994f, 1962). 0804

An experimental procedure is given for the determination of the heat stability of fuels, based on their oxidation at higher temperatures and the amount of gums and tars formed (mg/100 ml). Gasolines, kerosines, and gas-oil fractions of several crude oils were investigated.

0805

Sargent, W. H. and Gross, R. A. (Fairchild Engine and Airplane Corp.), **DETONATION WAVE HYPERSONIC RAMJET.** ARS Journal, 30, 543-9 (1960).

Performance of a hypersonic ramjet having a detonation wave combustion process is described. Flight speeds from Mach 2.5 to 10 are examined. Thermodynamic property changes across a detonation wave are presented. Engine cycle performance characteristics are computed including air specific impulse, specific fuel consumption and thermal efficiency. The effect of component efficiency on cycle performance is examined and the optimum place in the cycle for the detonation wave is found. The subsonic burning ramjet is shown always to have superior thermodynamic performance compared to a detonation wave engine, but the differences are often minor. Other differences and some design features are discussed.

0806

Sargent, W. H. and Gross, R. A. (Fairchild Engine and Airplane Corp.), **A DETONATION WAVE HYPERSONIC RAMJET.** U. S. Air Force, AFOSR TN 59-589, Contract AF 49(638)-15, June 1959. 39 pp. (AD 216811).

This report examines the performance of a hypersonic ramjet having a detonation wave combustion process. Flight speeds from Mach 2.5 to 10 are examined. Engine performance characteristics are presented and compared with those of a conventional ramjet.

0807

Sato, T. (Kyoto University), **HEAT TRANSFER BIBLIOGRAPHY - JAPANESE WORKS.** International Journal of Heat and Mass Transfer, 6, 243-4 (1963).

This list of recent publications on heat transfer is divided into sections on: application and outlook, boundary layers, change of phase, conduction, liquid metals, measurement techniques, natural convection, properties, radiation, and transpiration and mass transfer.

Schab, H. W., **PROBLEMS ASSOCIATED WITH WATER CONTAMINATED JET FUELS.** American Society of Naval Engineers. Journal, <u>72</u>, no. 1, 41-59 (February <u>1960</u>). 0808

The paper is primarily concerned with contamination problems in fuel systems and explaining the mechanism of difficulties caused by water. Also discussed are methods of removing water from bulk quantities of fuel.

Scherrer, R. (Ames Aeronautical Laboratory), **THE EFFECTS OF AERODYNAMIC HEATING AND HEAT TRANSFER ON THE SURFACE TEMPERATURE OF A BODY OF REVOLUTION IN STEADY SUPERSONIC FLIGHT.** U.S. National Advisory Committee for Aeronautics, TN 1300, July <u>1947</u>. 19 pp. 0809

An approximate method for determining the convective cooling requirement in the laminar boundary-layer region of a body of revolution in high-speed flight was developed and applied to an example body. The cooling requirement for the example body was determined as a function of Mach number, altitude, size, and a surface-temperature parameter. The maximum value of Mach number considered was 3.0 and the altitudes considered were those within the lower constant-temperature region of the atmosphere. The convective cooling requirements were found to be small for the range of Mach numbers considered, but increased rapidly with increasing Mach number.

Schirmer, R.M. and Aldrich, E.W., **EFFECT OF JP-5 PROPERTIES ON HOT GAS CORROSION AND FLAME RADIATION.** Phillips Petroleum Co., Report No. 3753-64R, U.S. Navy Contract NOw63-0406-d, June 1964. 132 pp. (AD 603 650). 0810

An experimental investigation was made to determine whether the maximum sulfur content of 0.4 weight per cent, currently allowed in grade JP-5 aviation turbine fuel, is a safe level for protection of the super-alloys used in high performance engines when operated in a marine environment. A second phase dealt with the effect of fuel molecular structure and volatility on the total radiant energy from combustor flames, which by contributing to the operating temperature of hot section components limits aircraft turbine engine power and durability.

0811

Schirmer, R.M. and Aldrich, E.W., MICRO BURNER STUDIES OF FLAME RADIATION AS RELATED TO HYDROCARBON STRUCTURE. Phillips Petroleum Co., Report No. 3752-64R, U.S. Navy Contract NOw63-0406-d, May 1964. 71 pp. (AD 602 153).

Measurements were made of total radiant energy from flames for a series of pure hydrocarbons, varying widely in molecular structure and boiling point. The study was conducted using the Phillips Microburner, which simulates conditions for combustion existing in an aircraft gas turbine engine; i.e., a high intensity, turbulent-diffusion type, combustion process. The Microburner tests did not differentiate among hydrocarbons (including all of the normal- and isoparaffins, the mono- and bicycloparaffins, and the straight and branch chain olefins) having hydrogen contents above about 13 weight percent, heats of combustion above about 18,200, Luminometer Numbers above about 40, and ASTM Smoke Points above about 20 mm. At lower values, the total radiant energy increased rapidly with decrease in these properties. The hydrocarbons, other than those listed above, were rated in the following order of increasing flame radiation: the cycloolefins, tetracyclododecane, tetralin and the alkylbenzenes, benzene and styrene, and methylnapthalene. The results also show that fuel volatility was not a significant factor under the test conditions.

0812

Schirmer, R. M., McReynolds, L. A., and Daley, J. A. (Phillips Petroleum), RADIATION FROM FLAMES IN GAS TURBINE COMBUSTORS. SAE Transactions, 68, 554-61 (1960). See also Society of Automotive Engineers. SAE Paper 114B, January 11-15, 1960. 11 pp.

The effect of monocyclic versus polycyclic aromatic components, in JP-5 fuels having the same ASTM Smoke Points, on total flame radiant energy was investigated. The performance of research combustors and a J79 aircraft gas turbine engine single combustor operated at low (atmospheric) pressure showed that variations in aromatic type or content within the present JP-5 specification have no significant effect on flame radiation. The performance of research combustors and a J57 aircraft gas turbine engine single combustor operated at high (5-15 atm) pressure showed that polycyclic aromatic fuel blends burn with higher flame emissivities than monocyclic aromatic fuel blends of comparable ASTM Smoke Point. Radiant heating of metal parts was shown to be a function of their location in the combustor because quenched combustion products can effectively absorb flame radiation. The use of low-luminosity fuels gave major reductions in liner temperatures in the J57 combustor. However, such fuels do not insure large reductions in heat transfer to metal parts, as shown by a reduction of only 40°F in the afterburner liner temperature of a J75 aircraft gas turbine engine obtained with "JP-150". This work was sponsored by the U.S. Navy, Bureau of Aeronautics.

0813

Schirmer, R. M., Quigg, H. T. and Mengelkamp, R. A., EFFECT OF JP-5 SULFUR CONTENT AND SEA WATER ON HOT GAS CORROSION OF SUPER ALLOYS. Phillips Petroleum Company, Report 3686-64 R, U. S. Navy Contract NOw63-0406-d, June 1964. 75 pp. (AD-602 152).

An experimental investigation was conducted to determine whether the maximum sulfur content of 0.4 weight per cent, currently allowed in grade JP-5 aviation turbine fuel, is a safe level for the protection of turbine blade alloys used in high-performance engines. Specimens of two nickel-base alloys (Inconel 713C and Sierra Metal 200) were exposed to vitiated air from the Phillips 2-inch combustor (56 air-fuel ratio) at high temperature (2,000 degrees Fahrenheit), high pressure (15 atmospheres), and high velocity (500 feet per second) during a five-hour cyclic test (55 minutes fuel-on and 5 minutes fuel-off). A statistically designed test program was used to evaluate the effect of three sulfur concentration levels in the fuel (0.0002, 0.040, and 0.40 weight per cent) at three sea salt concentration levels in the air (zero, 1.50, and 15.0 parts per million), and also any sulfur - sea salt interaction. The significance of test specimen metal losses and changes in tensile properties was established by analyses of variance, made at a confidence level of 95 per cent.

0814 Schlesinger, W., THE INFLAMMABILITY CHARACTERISTICS OF SOME LIQUIDS. U.S. War Department, Air Corps, Material Division, Memorandum report EXP-M-56-3486, May 10, 1941. 10 pp. (AD 122).

The spontaneous ignition temperatures were measured for 28 aircraft liquids. The temperatures and pressures were determined at which explosions occur upon sparking in closed systems with safety fuel PPF 654, 100-octane aviation fuel (Spec. 2-92-A), and certified isooctane (2,2,4-trimethylpentane). For each fuel a minimum pressure was observed below which explosion did not occur at any temperature as an equilibrium mixture of air and fuel was sparked. At pressures above the minimum, a maximum and a minimum temperature were observed above and below which the mixture was too rich or too lean to ignite. The minimum and maximum temperatures at which explosive mixtures formed were lowered as the pressure decreased. At atmospheric pressure, safety fuel did not form an explosive vapor-air mixture below 99°F; however, at pressures corresponding to a 20,000-ft altitude, an explosive mixture formed at fuel temperatures above 75°F. Aircraft engine oil and hydraulic fluid were considered more probable sources of fires caused by spontaneous ignition from a heated portion of the engine than 100-octane aviation fuel or ethylene glycol engine coolant.

0815 Schnitzer, H. C. (General Electric), TURBO-JET-ENGINE MECHANICAL DESIGN FOR HIGH MACH NUMBER FLIGHT. Aerospace Engineering, 17, no. 9, 35-9 (1958).

Curves of ram temperature vs Mach No. and compressor temperature rise vs mach number (for various pressure ratios) are presented. 2000°F is indicated as the upper limit for turbine and compressor materials, and cooling mechanisms for buckets are discussed. A curve of the lube system heat load vs mach number up to about $M = 4$ is given.

0816 Schott, G. L. and Kinsey, J. L., KINETIC STUDIES OF HYDROXYL RADICALS IN SHOCK WAVES. II. INDUCTION TIMES IN THE H_2-O_2 REACTION. Journal of Chemical Physics, 29, 1177-84 (1958).

The formation of OH in the shock wave induced combustion of H_2 and O_2 has been measured by oscillographically recording the absorption of ultraviolet OH line radiation. The The main features of the reaction course are: 1) the induction period whose length, t_1, varies inversely with $[O_2]$; 2) an increase in theproduct $[O_2]t_1$ as t_1 becomes short compared with the vibrational relaxation time of O_2 and 3) at the end of the induction period a sigmoid rise of [OH] to a maximum, followed by a slow decrease. t_1 has been studied over the ranges: $1100° \leq T \leq 2600°K$; $0.25 \leq H_2/O_2 \leq 5$; $0.004 \leq O_2/Ar \leq 0.20$; and $5 \leq t_1 \leq 500$ μ sec. The relation of these results to detonation experiments is discussed.

0817

Schrock, V. E. and Grossman, L. M. (University of California), LOCAL PRESSURE GRADIENTS IN FORCED CONVECTION VAPORIZATION. Nuclear Science and Engineering, 3, 245-50 (1959).

An experimental study of pressure drop in forced convection vaporization has been made in a heat transfer loop designed for the investigation of local heat transfer coefficients and local pressure gradients for water flowing vertically upward in an electrically heated tube. Data presented are for 1/8-in. i.d. 347 stainless steel tubes of 15 and 20-in. lengths with mass fluxes of 200 to 700 lb/sec ft^2, heat fluxes of 1 to 8 X 10^5 Btu/hr-ft^2, qualities at the exit up to 50% and with pressures ranging from 50 to 400 psia. A correlation of the local pressure gradients as a function of the Martinelli parameter X_{tt} has been obtained to within ±15% and a design procedure for calculating over-all pressure drop from this correlation is suggested.

0818

Schwartz, E.W. (Convair), HEAT TRANSFER TO WATER COOLANT IN CAPILLARY TUBES FOR THE LIQUID, MIXED, AND VAPOR PHASES. American Society of Mechanical Engineers. Paper 58-A-234, 1958. 15 pp.

Stainless-steel capillary tubes, heated electrically, were employed to obtain local heat-transfer coefficients, based upon bulk fluid properties, with and without a coolant-phase change. The coolant was distilled water which was forced into the tubes; the internal diameters of the tubes were 0.007 to 0.025 in. The coolant flowed from the exit section of any given tube to the atmosphere in the form of heated water, quality steam or superheated steam depending upon the heat flux and coolant flow rate. Satisfactory correlations with the theoretical and empirical equations derived by Graetz, Drew, Hottel, and McAdams were obtained for heating of water flowing inside the capillary tubes at constant mass-flow rates. However, no correlation was observed with these equations when a coolant-phase change occurred within the tubes.

0819

Schwartz, F. G. and Eccleston, B. H., SURVEY OF RESEARCH ON THERMAL STABILITY OF PETROLEUM JET FUELS. U. S. Bureau of Mines, Information Circular 8140, 1962. 102 pp.

This circular summarizes information found in nearly 100 reports concerning the thermal stability of jet fuels. Many of these reports resulted from work sponsored by defense agencies and have had only limited circulation. In addition, the circular includes information gained from interviews with representatives of over 35 companies or agencies actively interested in research in this field. The discussion includes sections on stability as related to fuel composition, effects of additives, effect of storage and fuel tank blanketing, deposit formation, and test methods for determining thermal stability.

0820

Schwartz, F. G., Ward, C.C., and Smith, H. M. (U. S. Bureau of Mines), **WHY DISTILLATE FUELS DETERIORATE IN STORAGE.** SAE Journal, 62, no. 2, 107-9 (1954).

On the basis of results obtained the following conclusions are stated: 1. Straight-run fuels are the most stable, catalytically cracked fuels are intermediate, and thermally cracked fuels are least stable. 2. Iron does not, but copper does catalyze gum formation. 3. Oxygen is necessary for gum formation. 4. Almost half the blends of fuel were incompatible after 39 weeks storage at 110°F. Several blends showed supercompatibility and others were simply compatible. 5. No blends showed immediate incompatibility. Only fair correlation exists between storage at 110°F and at ambient temperature.

0821

Schwartz, F. G., Whisman, M. L., Allbright, C. S. and Ward, C. C., **STORAGE STABILITY OF GASOLINE, FUNDAMENTALS OF GUM FORMATION, INCLUDING A DISCUSSION OF RADIOTRACER TECHNIQUES.** U. S. Bureau of Mines, Bulletin 626, 1964. 44 pp.

Variables of composition and environment affecting storage stability of gasoline-type fuels were studied, utilizing radioactive tracers and other analytical techniques. Changes in gasoline composition brought about by aging were determined and correlated with gum formation. The data show that sulfur compounds, nitrogen compounds, polycyclics, and olefins enter into gum-forming reactions. Results of this study indicate that the aromatic constitutents of gasolines may contribute substantially and directly to gum formation. A mixture of tetralin and indan-type compounds is reactive, and this mixture appears to be the main aromatic portion entering into gum formation. A secondary but significant amount of naphthalenes also appears to have reacted in the gum-forming process.

0822

Scott, S. J., (Langley Research Center), **SUBSONIC AERODYNAMIC HEAT TRANSFER TO A SURFACE RECESSED WITHIN A FORWARD STAGNATION REGION SLIT.** U.S. National Aeronautics ans Space Administration, TN D-2034, December 1963. 9 pp.

Experimental studies were conducted to investigate heat transfer to a surface recessed within a slit in the forward stagnation region of a 3-inch-diameter flat-faced cylindrical body. The investigation was conducted in a high-temperature (7000°R) subsonic (Mach number, 0.18) arc jet exiting to the atmosphere. The surface was recessed at depths of 0.020 inch to 0.080 inch within a 0.010-inch by 0.500-inch slit in the leading face of the model. Room-temperature air was injected over the recessed surface at various flow rates and exited through the slit into the test stream. Heat-transfer rates to the recessed surface were reduced to less than 10 percent of the leading-face heat-transfer rate at certain recession depths and air-flow rates.

Seader, J. D. and Wolf, H. (Rocketdyne), THEORETICAL ANALYSIS OF HEAT TRANSFER TO GASES IN SMOOTH, ROUND TUBES UNDER CONDITIONS OF TURBULENT FLOW AND HIGH FLUX. ARS Journal, 31, 650-2 (1961). 0823

A comprehensive theory which accounts for the variation of fluid physical properties caused by large radial temperature gradients has been developed by Deissler. It has been quite successful in correlating experimental results for the heating of gases, but it is difficult to attach a simple quantitative meaning to the parameter which accounts for the temperature gradient effect. Successful empirical correlations have also been made using the ratio of wall-to-bulk-fluid temperatures as a parameter. In this paper a theoretical relationship between the two parameters is developed.

Semenov, N. N., pp. 1-78 in: SOME PROBLEMS IN CHEMICAL KINETICS AND REACTIVITY, Vol. 2. Princeton, Princeton University Press, 1959. 0824

The mechanisms for thermal cracking of hydrocarbons are considered. The effect of additives such as nitric oxide, oxygen, peroxides, and halogens on chain length and reaction rate is discussed in detail. Over 100 references are cited on kinetics of chain reactions.

Sen Gupta, A. and Thodos, G. (Northwestern University), TRANSITIONAL BEHAVIOR FOR THE SIMULTANEOUS MASS AND HEAT TRANSFER OF GASES FLOWING THROUGH PACKED AND DISTENDED BEDS OF SPHERES. Industrial and Engineering Chemistry Fundamentals, 3 no. 3, 218-20 (1964). 0825

Simultaneous mass and heat transfer associated with the evaporation of water from the surfaces of Celite spheres were experimentally studied at high Reynolds numbers ranging from $N_{Re} = 1935$ to $N_{Re} = 10,300$. The resulting values of εj_h and εj_d (where ε is the void fraction of the bed and j_d and j_h are the mass and heat transfer factors, respectively) decreased with increasing Reynolds numbers for $N_{Re} < 4000$ and $N_{Re} > 5000$. In the interval $4000 < N_{Re} < 5000$, the εj vs N_{Re} relationships exhibited a double reversal of slopes with maximum values of εj occurring near $N_{Re} = 4800$. This unexpected transitional behavior presents a novel feature that has not been encountered previously in similar studies.

0826

Serbinov, A. I., Troshin, Ya. K., and Shchelkin, K. I., KINETIC PARAMETERS FOR THE PROCESSES OF DETONATION, SELF-IGNITION, AND ISOTHERMAL OXIDATION OF BENZENE. Academy of Sciences (U. S. S. R.). Proceedings, Physical Chemistry Section, 145, 602-5 (1962).

The authors report ignition delays derived from experiments on detonations of benzene-oxygen mixtures. These are correlated with other data from the literature on ignition delays of similar mixtures.

0827

Sergienko, S. R., Garbalinskii, V. A., Medvedeva, V. D., and Petrova, A. A., SELECTIVE DEHYDROGENATION OF PARAFFINS ON A ZINC CHROMATE CATALYST. Akademiya Nauk Turkmenskoi SSR. Izvestiya. Seriya Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk, 1963, no. 1, 30-7. (C.A. 58, 13674f, 1963).

Production of normal olefins by catalytic dehydrogenation of normal C_7-C_{16} paraffins was attempted with a Zn chromate catalyst on ZnO carrier, presumed to give no aromatization side reactions. Such a conversion can be achieved at 500° and a space velocity of 1.5/hr. In the cases of n-heptane and n-hexadecane, no aromatic compds. were formed and the olefin contents of the reaction products were 10 and 25-27%, resp. The Raman spectra of the heptenes showed that 25% consisted of 1-heptene and 75% of 2-heptene and 3-heptene, with approx. equal amts. of cis and trans isomers. Two thirds of the olefins obtained from n-hexadecane consisted of C_{16} compds., and $^1/_3$ had shorter chains.

0828

Setchkin, N. P., SELF-IGNITION TEMPERATURES OF COMBUSTIBLE LIQUIDS. Journal of Research of the National Bureau of Standards (U.S. National Bureau of Standards), 53, no. 1, 49-66 (1954).

The methods previously used for determination of the ignition temperature of liquids are briefly reviewed, and the large discrepancies in reported values noted. Various factors which affect the determined values of ignition temperature are discussed. A practical ignition apparatus consisting in part of an insulated spherical flask, designed to provide conditions favorable to low ignition temperature values, is described, and data obtained with this apparatus on a considerable number of combustible liquids are presented. The usefulness of time-temperature curves of a thermocouple junction placed in mixtures of combustible liquid and air, as a means of studying the preignition reactions in such mixtures is illustrated.

Sevastyanov, Yu. G., Bulanov, L. A., Smirnov-Averin, A. P., Kaplan, E. P., Nefedov, O. M., Cheletsova, M. A., and Petrov, A. D., THERMAL RADIATION STABILITY OF CERTAIN AROMATIC COMPOUNDS. Atomnaya Energiya, 14, no. 6, 555-8 (1963). 0829

The radiation stability and thermal stability of a series of isopropyl-and phenyl-substituted biphenyls, naphthalenes and terphenyls; polyphenyls with methylene bridges between the rings; and also isomeric phenoxydiphenyls were studied. The greatest stability was found for biphenyl and the terphenyl isomers, by virtue of which those compounds may find applications as coolants in nuclear reactors.

Shabtai, J., CATALYTIC ACTIVITY OF 18/8 STAINLESS STEEL. Chemistry and Industry, 1962, 1282-3. 0830

n-Heptane was pyrolyzed in a stainless steel tube and a copper tube at 550° and 630°C. The product distributions suggest that in the copper tube the reaction is of the non-catalytic type, while in the stainless steel tube hydrogen transfer reactions occur, primarily due to a concentration of chromic oxide in the surface layer of the metal.

Shamblin, J. E. and Johnston, R. K., A STUDY OF JET FUEL STABILITY AND TEST METHOD DEVELOPMENT. Southwest Research Institute, Report AvD 246, U. S. Navy Contract No as 55-540-C Amendment 1, June 1957. 57 pp. 0831

This report describes work done on improving the repeatability and reproducibility of the CFR fuel coker. The most significant improvement was in control of temperature during the warmup period by using a definite schedule of heat input vs. temperature. Additional work was done on investigation of other test methods for thermal stability. This included developing improved procedures and configurations for the CFR coker and work on various simplified small scale screening tests.

Shamblin, J. E. and Johnston, R. K., A STUDY OF JET FUEL STABILITY AND TEST METHOD DEVELOPMENT. Southwest Research Institute, Report No. RS-282, U. S. Navy Contract NOas 55-540-C Amendments 2 and 3, August 1958. 68 pp.

0832 A number of test methods have been developed for the evaluation of fuel thermal stability. These methods have been studied in relation to the standard CFR fuel coker test. One of the principal methods developed is a modification of the standard fuel coker using a step-temperature procedure and Pyrex preheater to permit continuous observation of deposits. This test gives maximum information on a fuel's limiting temperatures in a single test, and correlates quite well with standard fuel coker results. In addition, a hot-tube test has been developed to rate the effect of fuel degradation on heat transfer rates. Studies have been made of fuel thermal stability in small-scale bomb tests, including preliminary work on the effect of air availability. A modified bomb has been designed for CRC evaluation. A survey has been made of the thermal stability of current JP-5 fuels and the effect of corrosion inhibitors. It is indicated that most of the fuels would meet the filter plugging requirement. Most of the currently available corrosion inhibitors improve filterability but aggravate the problem of preheater deposits.

Sharp, J.G. and Richards, L.J., THE EFFECTS OF SOME FUEL CHARACTERISTICS ON GAS TURBINE COMBUSTION EFFICIENCY. Shell Thornton Research Centre, Report No. M.37/49, U.K. Ministry of Supply Contract No. 6/Gen/653 FC 14(b), October 1949. 12 pp.

0833 Combustion efficiency tests were carried out on a variety of fuels representing a range of physical properties and chemical composition of practical interest, using a typical atomizer-type aero gas turbine combustion chamber operated at throughputs representative of engine conditions. The results of the tests have been related with both the physical properties and chemical composition of the fuels.

Sheard, R. C., SST FUELS AND LUBRICANTS. Materials Research and Standards, 3, no. 10, 820-4 (1963).

0834 Fuels and lubricants for the Mach-3 supersonic transport present difficult problems. The primary problem comes from the high temperatures of Mach-3 flight. The lubricant program is primarily directed toward finding base stocks and additives that will meet the rigid requirements of the SST. Fuels are available with satisfactory performance, but there is a problem in finding suitable fuels that are cheap enough for economical operation. A large scale test rig is being used to evaluate various fuels under SST environmental conditions.

"Shell" Research Limited, FUELS FOR SUPERSONIC TRANSPORTS. Shell Aviation News, no. 305, 20-1 (1963). 0835

This very general article briefly treats these questions in terms of experimental approaches and results: 1) How rapidly will fouling of heat exchanges occur in service, and how will it affect the heat transfer efficiency? 2) How is heat exchanger fouling related to fuel thermal stability? 3) Are present standards of filtration and quality control adequate for Supersonic Transport fuels? 4) If heat exchanger fouling does occur, will it be possible to clean the fouled surfaces easily?

Shelton, J. R., MECHANISM OF ANTIOXIDANT ACTION IN THE STABILIZATION OF HYDROCARBON SYSTEMS. Journal of Applied Polymer Science, 2, 345-50 (1959). 0836

Four antioxidant classifications, based on differences in the method by which they exert their effect, are noted. The mechanism of chain-stopping action is discussed in terms of four different reactions which have been proposed. The participation of the antioxidant in the mechanism of inhibited thermal oxidation is reviewed. The hydrogen donation mechanism as the first step in the chain-stopping mechanism has been investigated by observing the effect of replacing the active hydrogen of the antioxidant by deuterium. Contrary to the findings of some prior workers, a kinetic isotope effect has been demonstrated with a secondary aryl amine antioxidant as well as with phenols. Abstraction of hydrogen from the antioxidant is indicated as the initial step in the usual mechanism of antioxidants.

Shimonoyev, G. S., Churshukov, Ye. S., and Rozhkov, I. V., THE DETERMINATION OF THE THERMAL STABILITY OF FUELS. Khimiya i Tekhnologiya Topiv i Masel, 1958, no. 4, 46-51. 0837

The paper describes a method of determining thermal stability of fuels under static conditions at temperatures to 250°C. The effect of temperature on deposit formation in kerosene is given. Amount of deposits is only slightly affected by metals. Largest deposits are formed in presence of steel.

Shtekher, S. M., Skuratov, S. M., Daukshas, V. K., and Levina, R. Ya., HEATS OF COMBUSTION OF SOME BRANCHED ALKANES. Academy of Science (U. S. S. R.). Proceedings. Chemistry Section, 127, 621-3, (1959). 0838

Existing data for 2,2,4,4,tetramethyl pentane indicated a need to incorporate a correction factor to usual methods of calculation of heats of combustion by additive schemes. Experimental work was carried out to see if other paraffins with β separated quaternary carbons showed similar deviations from additivity rules. Several such compounds were synthesized and tested for heat of combustion. All showed approximately +5 kcal deviation from predicted heats of combustion. Several compounds with γ-separation of quaternary carbons showed substantial agreement with predicted heats of combustion.

Shtern, V. Ya., THE GAS-PHASE OXIDATION OF HYDROCARBONS. New York, Pergamon, 1964. 0839

This book gives a comprehensive treatment of cool flames and oxidation processes of hydrocarbons at temperatures up to about 500-600°C. However, the recent studies at higher temperatures, particularly using shock tubes for study of rapid reactions, have been excluded from consideration.

Shuikin, N. I. and Naryshkina, T. I., CATALYTIC SYNTHESIS OF CYCLOPENTADIENE HYDROCARBONS. World Petroleum Congress (Fifth). Proceedings, (IV), 109-19 (1959). 0840

Hydrocarbons of cyclopentadiene series were obtained by dehydrogenation of 5-carbon cyclanes and cyclenes and by dehydrocyclization of 1,3-alkadienes over platinized carbon and potassium promoted chromia-on-alumina catalysts, respectively. Highest yields were obtained at about 600°C and 20-25 mm pressure.

0841 Shuikin, N. I., Timofeeva, E. A., Dobrynina, T. P., Plotnikov, Yu. N., Petryaeva, G. S., and Gaivoronskaya, G. K., CATALYTIC DEHYDROGENATION OF BRANCHED C_6 PARAFFINS. Academy of Sciences (U.S.S.R.). Bulletin. Division of Chemical Sciences, 1960, 1353-61.

The dehydrogenation of C_6 paraffins was carried out in a flow system at 500°C and 1 atm pressure over a potassium promoted chromia on alumina catalyst. 2-Methylpentane, 3-methylpentane and 2,3-dimethylbutane gave the corresponding olefins in 32%-40% yield. Some isomerization of the dimethylbutane product was observed.

0842 Shuikin, N. I., Timofeeva, E. A., Dobrynina, T. P., Plotnikov, Yu. N., Petryaeva, G. S., and Kleimenova, V. M., TRANSFORMATIONS OF C_5-C_9 n-ALKANES IN PRESENCE OF AN ALUMINA-CHROMIA-POTASSIA CATALYST. Academy of Sciences (U. S. S. R.). Bulletin. Division of Chemical Sciences, 1958, 870-1.

A brief study was made of the reaction of C_5-C_9 n-alkanes over an alumina-chromia-potassia catalyst at 500°C. It was shown that, under the given conditions, catalyzates containing 8-29% of unsaturated hydrocarbons and 39-50% of aromatic hydrocarbons were obtained from these alkanes.

0843 Shuikin, N. I., Timofeeva, E. A., Plotnikov, Yu. N., Dobrynina, T. P., Petryaeva, G. S., and Smirnov, V. S., PREPARATION OF C_6-C_{10} ALKENES BY THE CATALYTIC DEHYDROGENATION OF ALKANES. Petroleum Chemistry U.S.S.R., 2, 328-40 (1963).

Using 2-methylpentane, 3-methylpentane, and 2,3-dimethylbutane as examples, it was shown that C_6 alkanes the main chain of which contains less than 6 carbon atoms are relatively smoothly dehydrogenated on an aluminium-chromium-potassium catalyst at 500° and a space velocity of 0·5 hr^{-1} to give 32-40% of alkenes in the catalyzate. With 2,2-dimethylbutane equilibrium yields of 3,3-dimethylbut-1-ene were obtained. The existence of two types of active centres in an aluminium-chromium catalyst--dehydrogenating and dehydrocyclising centres--has been shown experimentally. The activity of the dehydrocyclising centres can be substantially reduced by treating the catalyst with cyclopentadiene or furfural with subsequent regeneration.

Shuikin, N. I. and Tulupova, E. D., DEHYDROGENATION OF GASOLINES AND THEIR NARROW FRACTIONS IN PRESENCE OF NICKEL ON VARIOUS CARRIERS. Academy of Sciences (U. S. S. R). Bulletin. Division of Chemical Sciences, 1960, 1166-70. 0844

The chemical nature of the carrier has a substantial effect on the catalytic properties of a nickel catalyst for the dehydrogenation of cyclohexane reaction. The most active and stable catalysts are obtained by the deposition of nickel on alumina. However, even mixed catalysts having alumina as a component ($Al_2O_3 + SiO_2$ and $Al_2O_3 + Fe_2O_3$) were relatively active and stable dehydrogenating catalysts.

Shuikin, N. I. and Tulupova, E. D., HIGHLY ACTIVE NICKEL - ALUMINA CATALYST FOR THE DEHYDROGENATION OF THE CYCLOHEXANE RING. Academy of Sciences (U. S. S. R.). Bulletin. Division of Chemical Sciences, 1960, 668-74. 0845

A method is proposed for the preparation of an active, stable, and reproducible nickel-alumina catalyst for the dehydrogenation of cyclohexane. The essential factor in the preparation of this catalyst is the presence of an excess of nickel ions in the reaction medium at the end of the precipitation of nickelous and aluminum hydroxides. A 30% nickel-alumina catalyst prepared by this improved method preserves high activity for a long time (249 hours), without regeneration, in the aromatization of unfractionated Surakhan gasoline.

Shuler, R. L., Krynitsky, J. A. and Carhart, H. W., A STUDY BY LIGHT SCATTERING OF THE EFFECT OF HIGH TEMPERATURE ON THE FORMATION OF INSOLUBLES IN JET FUELS. U. S. Naval Research Laboratory, Report 5553, October 1960. 17 pp. 0846

An investigation of the chemical behavior of JP-4 and JP-5 fuels and pure hydrocarbon solutions heated to high temperatures (300° to 700°F) has been undertaken using light scattering and gas chromatography as the primary research tools. In the temperature range studied, the oxidation of small amounts of nonhydrocarbon substances present in the fuel, e.g., sulfur and nitrogen compounds, gives rise to insoluble materials. The possibility of pyrolysis as a major decomposition process has apparently been eliminated by (a) the absence of particle formation in a fuel heated in an oxygen-free atmosphere and (b) an infrared spectral analysis which shows no gross changes in hydrocarbon structure after heating the fuel. If the intensity of light scattering is used as a measure of high-temperature stability, it indicates that olefins and cycloparaffins tend to stabilize synthetic fuel mixture, whereas aromatics have a degrading effect. However, gas chromatographic studies have shown that there is a direct reaction between these hydrocarbons and a disulfide present in the mixture to produce soluble products in the presence of olefins and cycloparaffins and insoluble products in the presence of aromatics.

Sieg, R. P., Constabaris, G. and Lindquist, R. H. (California Research Corp.), VIBRATING SAMPLE MAGNETOMETER STUDIES OF SUPPORTED NICKEL CATALYSTS. American Chemical Society, Abstracts of Papers, 145th Meeting, September 1963, p. 19 I. 0847

Vibrating sample magnetometer studies of supported nickel catalysts indicate that the method provides a rapid and sensitive determination of the concentration of magnetic material. Striking differences in the amount of metallic nickel on silica, alumina, and silica-alumina supports, studied by this technique as a function of heat treatment and environment, were found. Magnetic measurements correlated with the catalytic activity. The present method is compared with other techniques for measuring nickel on supported catalysts.

Silverstein, A. and Hall, E.W., LIQUID HYDROGEN AS A JET FUEL FOR HIGH-ALTITUDE AIRCRAFT. U. S. National Advisory Committee for Aeronautics, RM E55C28a, April 1955. 56 pp. 0848

Analytical and experimental studies of the use of liquid hydrogen as a jet-engine fuel are reviewed, and the possible extension of aircraft performance that will follow an adequate research and development effort is discussed. Use is made of assumptions regarding performance and weight of components that are believed consistent with the state of the art and the progress anticipated.

Simakova, T. L., Strigaleva, N. V., et al, ROLE OF BACTERIA IN THE TRANSFORMATION OF THE HYDROCARBON AND ASPHALT-TAR COMPONENTS OF PARAFFINIC OIL UNDER ANAEROBIC CONDITIONS. Leningrad. Vsesoyuzni Neftyanoi Nauchno-Issledovatelskii Geologorazvedochnyi Institut. Trudy, no. 174, 77-97 (1961). (CA, 57, 1165h). 0849

Several mixed bacterial populations were studied with respect to their assimilation of various hydrocarbon components. The use of hydrocarbons by bacteria depends on the composition of the hydrocarbons and the distribution of rings and radicals in their structures. It also depends on the make-up of the bacterial biocenosis.

0850

Simon, H. A. and Eckert, E. R. G. (University of Minnesota), **LAMINAR FREE CONVECTION IN CARBON DIOXIDE NEAR ITS CRITICAL POINT.** International Journal of Heat and Mass Transfer, 6, no. 8, 681-90 (1963).

The heat transfer coefficient and the thermal conductivity both went through a maximum as the critical density was approached in an experimental study on the laminar free-convection heat transfer from a heated plate to carbon dioxide. Thermal conductivity was shown to be a function of the heat rate as well as of density and temperature, and it appears to increase linearly with the latter. The technique permitted a closer approach to the critical state with smaller changes in temperature than in previous experiments. A correlation for the heat flux under conditions similar to the experiments is presented.

0851

Simonis, E. A. (de Havilland Engine Company), **FUEL SYSTEMS FOR SUPERSONIC ENGINES** Royal Aeronautical Society Journal, 62, 654-8 (1958).

The requirements of the supersonic aircraft, particularly as regards the very wide range of fuel flow rates that have to be covered and the considerable use to which the fuel is needed for cooling purposes, necessitates a revision of existing systems and a reconsideration of the engine control problem from its fundamentals. Such a study has recently been made, and this paper deals with some of the broader aspects and requirements of the fuel system as visualised at the time of the study.

0852

Sinfelt, J. H. and Rohrer, J. C. (Esso Research and Engineering), **REACTIVITIES OF SOME C_6-C_8 PARAFFINS OVER Pt-Al_2O_3.** Journal of Chemical and Engineering Data, 8, no. 1, 109-11 (1963).

Data are presented showing the effects of molecular size and structure on the rates of dehydrocyclization and hydrocracking of some C_6-C_8 paraffins over a 0.3% platinum on alumina catalyst. Increasing the length of the carbon chain from 6 to 8 carbon atoms increased the rate of dehydrocyclization several fold, but had surprisingly little effect on the rate of hydrocracking. The rates of dehydrocyclization of the normal paraffins were appreciably higher than those of the branched paraffins of the same molecular weight, whereas the reverse was true for hydrocracking. The results appear to be consistent with a carbonium ion mechanism for the reactions.

Singer, J. M. and Grumer, J., **CARBON FORMATION IN VERY RICH HYDROCARBON - AIR FLAMES.** U. S. Bureau of Mines, RI 6007, 1962. 80 pp.

0853

Tests using ethylene and propane as fuels were carried out to identify the smoke limits of gaseous fuel-air mixtures and to obtain and evaluate basic chemical information on the formation of smoke in very rich flames near the smoke limit. The mechanism of carbon formation in weakly smoking flames is the same for premixed and diffusion flames of gaseous hydrocarbons; acetylene is a key material in carbon formation in weakly smoking flames. It appears with the onset of yellow, and its concentration falls as solid carbon is formed. Conversion of carbon monoxide to carbon and carbon dioxide under special conditions of temperature and perhaps catalyzed by suitable metal or carbonaceous surfaces can also be a source of carbon from flames. Carbon formation in weakly smoking flames does not occur through polymerization and dehydrogenation reactions, nor through oxygenated hydrocarbons. An extensive bibliography is included.

Sipple, H. B. and Wald, G. G. (Lockheed Aircraft), **THE HOT AIRPLANE.** Mechanical Engineering, 79, 925-7 (1957).

0854

The paper gives a popular presentation of some of the problems in meeting the materials (primarily structural materials) requirements of supersonic aircraft.

Skinner, G. B. and Ruehrwein, R. A., **SHOCK TUBE STUDIES ON THE PYROLYSIS AND OXIDATION OF METHANE.** Journal of Physical Chemistry, 63, 1736-42, (1959).

0855

A shock tube has been used to study the pyrolysis and oxidation of methane in the range 1200-1800°K under homogeneous reaction conditions. Induction times were measured for several CH_4-O_2 mixtures of 10% or less O_2 content, in the range of 1 to 10 milliseconds. The experimental activation energy for pyrolysis is 101,000 cal/mole. With addition of oxygen, the activation energy decreases.

Slaiby, T. G. and Staubach, R. L. (United Aircraft), PROPULSION SYSTEMS FOR SUPERSONIC TRANSPORTS. Society of Automotive Engineers, SAE Paper 586A, October 1962. 6 pp. (International Aerospace Abstracts, 3, no. 2, 73 abstr. A 63-10721). 0856

Study of design considerations involved in determining the optimum propulsion system for SST aircraft. The total system includes the inlet and exhaust nozzle as well as the engine. In particular, the influence of engine airflow scheduling with Mach number, as it affects the overall performance and weight of the propulsion system, is discussed. For the purposes of the study, the engine is assumed to be a duct-heating turbofan with Mach 3 cruise capability having a conical-centerbody, axisymmetric inlet.

Smith G. G., GAS TURBINES AND JET PROPULSION; 6th ed. London, Iliffe, 1955. 412 pp. 0857

A comprehensive treatment of gas turbine engines for aircraft is given in the manner of a textbook. The treatment of fuels and fuel systems is appropriate to the publication date and does not include characteristics desirable for supersonic aircraft. Rather great attention is given to hardware details of specific systems.

Smith, J. O., Fabuss, B. M., Borsanyi, A. S., and Lait, R. I. (Monsanto Research), EVALUATION OF MATERIALS AS ENDOTHERMIC AVIATION FUELS. U.S. Air Force, WADD TR60-841, Part II, Contract AF 33(616)-7845, December 1961. 91 pp. (AD 273833). 0858

Seven pure hydrocarbons were evaluated as potential endothermic fuels. The rating of these compounds was summarized from the standpoint of conversion, gas formation, coke deposit formation, and heat sink capacity. The fuels were: cetane, cyclohexane, ethylbenzene, p-xylene, decalin, soltrol-170, and tetraisobutylene. The rating reported applied only to the operating ranges investigated, and showed that cetane, decalin, soltrol-170, and cyclohexane could be used as endothermic fuels at the higher temperature levels whereas tetraisobutylene is best suited for the lower level. Direct measurement of heat inputs showed that the calculated heats of reaction were of the proper order. The overall heat transfer coefficient was calculated and used to obtain a comparison between calculated and measured conversion. The feasibility of coke removal from the reactor tube walls by steam injection was established. Three paraffinic CRC fuels were evaluated. The heat of reaction was 100-400 Btu/lb converted material at conversions of 40-60% and they could be as successfully applied as the best pure hydrocarbons.

0859 Smith, J. O., Fabuss, B. M., Borsanyi, A. S. and Lait, R. I. (Monsanto Research), RESEARCH ON MATERIALS FOR USE AS ENDOTHERMIC FUELS. U. S. Air Force, WADD TR 60-841, Part III, Contract AF 33(616)-7845, October 1962. 62 pp. (AD 400 601).

The evaluation of six selected CRC fuels showed that the paraffinics are to be preferred to the naphthenics as endothermic fuels. Heat sink capacities were obtained. Petroleum fractions are as suitable for this use as the best pure hydrocarbons. High temperature alloys, Hastelloy L-605 and Inconel-X promoted coke formation to a greater extent than did stainless steel. Hydrogen sulfide pretreatment of the tubing and carbon disulfide as an additive reduced the coke forming activity of these superalloys without affecting the course or rate of the cracking reactions. High temperature experiments showed the feasibility of carrying out endothermic reactions up to a reactor wall temperature of 1580°F. A practical method for calculating the bulk fuel temperature and comparing it with the reactor wall temperature and estimating the fuel conversion was developed. A study of the effect of tube geometry on the cracking process showed the important role of the laminar boundary layer on heat transfer and coke formation.

0860 Smith, J. O., Fabuss, B. M., et al (Monsanto Research), EVALUATION OF HYDROCARBONS FOR HIGH TEMPERATURE FUELS. PART II. VOLUME I. CORRELATION STUDIES, THERMAL STABILITY, AND CONTAMINANT EFFECTS. U. S. Air Force, WADC TR 59-327, Part II, Vol I, Contract AF 33(616)-5799, February 1962. 294 pp. (AD 277397).

The chemical and physical properties of 146 pure hydrocarbons and petroleum fractions were determined. Best prospective fuels were selected. Correlation methods were developed for estimating properties of pure hydrocarbons. For 15 selected saturated hydrocarbons the rates of decomposition and rates of particle formation were determined under static and dynamic test conditions at 800°F and in the 1000°-1100°F temperature range, respectively. The structural effect of hydrocarbons on their stability was investigated. The effect of oxygen, oxygen-, and sulfur-containing contaminants on the decomposition process was investigated. Contaminants showed a selective action with hydrocarbons belonging in different groups: they showed the same inhibiting or promoting effect on decomposition and particle formation.

0861 Smith, J. O., Fabuss, B. M., et al (Monsanto Research), EVALUATION OF HYDROCARBONS FOR HIGH TEMPERATURE JET FUELS. PART II. VOLUME II. HYDROCARBON PROPERTIES. U.S. Air Force, WADC TR 59-327, Part II, Vol II, Contract AF 33(616)-5799, February 1962. 70 pp. (AD 277398).

The physical and thermodynamic properties of 146 hydrocarbons are tabulated. The properties are given in order of molecular structures: separated rings, condensed rings, spiro compounds, paraffinic hydrocarbons, olefinic hydrocarbons, petroleum fractions. Molecular structures, serial numbers, empirical formulas and all possible names of each hydrocarbon are included. Estimated minimum over-all purity of the hydrocarbon samples is indicated.

Smith, J.O., Wilson, G.R., Klein, D. and Harrington, E.O. (Monsanto Research Corp.), EFFECTS OF SELECTED STRAINS OF MICROORGANISMS ON THE COMPOSITION OF FUELS AND LUBRICANTS. U.S. Air Force, ASD-TDR 63-4117, Part I, Contract AF 33(657)-9814, March 1964. 65 pp. 0862

A total of 35 jet fuel samples, one lubricant, and 44 pure hydrocarbons have been screened for growth and nongrowth support for 16 aerobic bacterial cultures. Thirty of these jet fuels, the one lubricant, and eleven of the pure hydrocarbons were also screened against five fungal cultures. Only one of the jet fuel samples completely resisted bacterial attack. All 30 jet fuel samples showed varied growth support for the five fungal cultures. Only n-cetane of the pure hydrocarbons screened (Naphthenes and n-cetane) supported fungal growth. Removal of n-alkanes from a series of bacterial growth-supporting jet fuels significantly reduced their growth-supporting properties. The residual growth is due either to incomplete removal of all n-alkanes or to the presence of other growth-supporting components in the fuels. Future experiments are designed to resolve this question.

Smith, S. R. and Gordon, A. S. (U. S. Naval Ordnance Test Station), A STUDY OF THE PYROLYSIS OF CYCLOHEXENE. Journal of Physical Chemistry, 65, 1124-8 (1961). 0863

The pyrolysis of cyclohexene has been studied over the temperature range 425-535°. There are three concurrent homogeneous decomposition processes: selective cracking to ethylene and butadiene, dehydrogenation to cyclohexadiene and hydrogen, and non-selective cracking to light products. The first two processes are intramolecular and have been established to be first order with specific rate constants 1.4×10^{17} exp [$-72700/RT$ sec.$^{-1}$], and 1.9×10^{16} exp [$-71200/RT$ sec.$^{-1}$], respectively. The third decomposition path is via a free radical mechanism which accounts for 10% or less of the total cyclohexene decomposed. The specific rate constant for the over-all decomposition is $k_0 = 7.7 \times 10^{15}$ exp ($-67600/RT$ sec.$^{-1}$). Mechanisms consistent with the data are proposed. Of especial interest is the interpretation of the data which shows that the energy of activation for the two intramolecular paths is the same within experimental error.

Sneed, R.W., Ballentine, O.M. and Winterhaulter, J.H., ACCELERATED STORAGE STABILITY OF AVIATION FUELS. U.S. Air Force, WADC TR 55-138, March 1957. 30 pp. (AD 118109). 0864

This work is a study of aviation fuels of various base stocks, containing several different additives, and stored under accelerated conditions in two different type containers; the purpose was to obtain data on the deterioration which may be expected during the storage of aviation fuels at desert temperature. Wide variations were found in the rates of deterioration of the fuels. Phenylene diamine appears to be the best oxidation inhibitor and the C_3 and C_4 alkylate base stock is more stable than the straight run fuel; copper definitely accelerates gum formation.

0865

Snitserov, Yu. V., **THE INFLUENCE OF CERTAIN ADDITIVES ON THE FORMATION OF DEPOSITS IN FUEL AT ELEVATED TEMPERATURES.** Khimiya i Tekhnologiya Topliv i Masel, 1961, no. 11, 55-59.

It is pointed out that besides the quantity of deposits, the particle size and shape are important. The influence of certain primary amines in stabilizing fuels against deposit and resin formation was investigated. The amine concentration for optimum benefit was about 0.1%w amine. Amines with C_{12} and C_{15} radicals are most effective in suppressing deposits. However, for color, C_7-C_9 radicals were most effective, while C_{15} radicals were least effective. It is possible that at some temperatures the amines are dispersants, while at higher temperatures coagulation of deposit particles occurs.

0866

Sobel, J. E. (Massachusetts Institute of Technology), **ESTIMATION OF LIQUID HEAT CAPACITIES IN THE CRITICAL REGION.** S. M. Thesis, Massachusetts Institute of Technology, June 1963. 61 pp.

This thesis proposes a technique for estimating the heat capacity of saturated liquids at reduced temperatures above 0.70. This work is based on a rigorous thermodynamic equation first suggested by Watson relating the heat capacity of the saturated liquid to the heat capacity of the vapor in the ideal state and corrections for the deviations from ideality. The method was tested on 16 compounds over the temperature range $0.70 < T_r < 0.98$.

0867

Sokolik, A. S., **SPONTANEOUS COMBUSTION, FLAME, AND DETONATION IN GASES.** Moscow, Izdatelstvo Adademii Nauk SSSR, 1960.

The book is a comprehensive textual treatment of the subjects of spontaneous combustion, flame propagation and detonations in gases. Thermal and chain processes of ignition and detonation are discussed in detail. Mechanisms of combustion in cool and hot flames, and diffusion flames in laminar and turbulent flow regimes are treated. Shock and detonation waves are also discussed.

0868

Sokolov, S. N., and Tarlakov, Yu. V., HEAT CAPACITY AT CONSTANT PRESSURE OF THE VAPORS OF THE AVIATION FUELS BENZINE B-70, KEROSINE T-1 AND FUEL T-5. Moscow. Aviatsionnyi Institut. Trudy. Sbornik Statei, 1961, no. 132, 15-30. (CA, 58, 4177 f).

An apparatus was constructed for the determination of the heat capacity at constant pressure, C_p, with a precision of 0.3% at temperatures $\leq 300°$ and at pressures of about 1 atm. The C_p of the vapors of the aviation fuels benzine B-70, kerosine T-1, and fuel T-5 were determined at 16 temperatures between 130 and 280°.

0869

Solomon, I. J., Klein, M. J., and Maguire, R. G. (IIT Research Institute), EXCHANGE REACTIONS OF ETHYLDIBORANES AND HIGHER BORANES. American Chemical Society, Abstracts of Papers, 145th Meeting, September 1963, p. 10N.

The reactions of pentaborane-11 with either ethydiborane or sym-diethyldiborane occurred with practically no degradation and were best explainable as an exchange of BH_3 and $C_2H_5BH_2$ to yield ethylpentaborane-11 and diborane; the reaction is reversible since ethylpentaborane-11 and diborane yield ethyldiborane and pentaborane-11. No exchange was observed in the reactions of sym-diethyldiborane with tetraborane, pentaborane-9, or decaborane. The reactions of these three hydrides with ethylborane were also studied.

0870

Sorokin, A. F. and Kolach, T. A., EFFECT OF SOME FACTORS ON BOILING HEAT TRANSFER IN PIPES. Moskovskii Energeticheskii Institut. Trudy, 1956, no. 24, 41-63. (CA, 53, 12764 a).

The boiling of water and of aqueous sugar solutions in a vertical pipe and the determination of average values of the heat transfer coefficient along sections of the pipe were experimentally investigated. Heat fluxes from 10^3 to $1.5 X 10^6$ kcal/m^2-hr and a range of pressures were covered. The variation of the average value of heat transfer coefficient for the whole pipe as a function of heat flux is given as well as a generalized equation for the middle zone where distinct boiling on the whole surface prevails. It was found that the heat transfer coefficient is insensitive to the fraction vaporized up to a steam content of 80-90%. Above 95% vapor in the stream the heat transfer coefficient decreases sharply.

Sousa, M. A., Joy, W., Smith, D. L., and Schmitt, R. J. (General Electric Company), PERFORMANCE AND ECONOMIC EVALUATION OF SUPERSONIC TRANSPORTS OPTIMIZED FOR VARIOUS PROPULSION SUBSYSTEMS. Aerospace Engineering, 21, no. 3, 42-53, 1962. 0871

Because the commercial supersonic transport presents a new frontier of technology, and because the requirements to be placed on the engine are expected to be rather severe, an extensive analysis of the supersonic transport has been undertaken. The intent of the analysis effort is to find out how the airframe, engine operational requirements, and economics are interrelated. Although these studies are of a continuing nature, sufficient work has been completed to provide significant insight on this subject. However, it is concluded that it is not yet possible to identify the exact airframe/engine combination which will produce an optimum supersonic transport, inasmuch as mission and noise requirements have not yet been fully formulated.

Southwest Research Institute. BIBLIOGRAPHY OF FUEL STABILITY, SUPPLEMENT I. U.S. Army, Ordnance Fuels and Lubricants Research Laboratory, Contract DA 23-072-ORD-934, April 1957. 65 pp. (AD 150851). 0872

This survey covers fuel stability publications for the period 1952-57. Information is presented as an annotated bibliography divided into two sections. The first covers published material available from normal civilian sources and from ASTIA. The second summarizes patent information and was compiled from a search of "Chemical Abstracts" Included are test methods for determining fuel stability, development of fuel antioxidants, stabilizers, corrosion inhibitors, etc., factors influencing gum and deposit formation, and fuel stabilizing treatments. Fuels considered include gasoline, jet fuels, distillate fuels from cracked stocks and residual oils.

Spengler, G., Zimmer, M. and Gemperlein, H., RELATIONSHIP BETWEEN PROPERTIES AND POWER OF FUELS FOR AIR JET ENGINES. Deutsche Versuchsanstalt fuer Luftfahrt, Report 210, 1962. Translated as Great Britain, Ministry of Aviation, Report TIL/T.5460, December 1963. 20+ pp. (AD 430 844). 0873

The influence of various chemico-physical data of fuels on the thrust of a small test ramjet engine is investigated. Characteristics influencing the preparation of the fuel are combined under the definition "heat preparation" and their influence on combustion behavior determined. A method of calculating the power data of jet fuels with partial combustion is discussed.

Spivack, J. D. and Pines, R. M. (Geigy Research Laboratories), SALICYLALDEHYDE SCHIFF BASES OF TERTIARY-AMINOALKYLAMINES AS STABILIZERS FOR HYDROCARBONS. American Chemical Society. Division of Petroleum Chemistry. Preprints, 5, no. 1, 87-97 (March 1960). 0874

The paper presents data on salicylaldelyde Schiff bases of certain tertiary aminoalkylamines as stabilizers for hydrocarbons subject to metal catalytic oxidation in an oxygen atmosphere. Oxidation experiments were run in three different hydrocarbons: (a) cyclohexene, (b) a straight-run gasoline and (c) a solvent extracted paraffin-type lubricating oil. Two of the most effective deactivators in cyclohexene, N, N, N'-tetrakis-(2-salicylideneaminoethyl) ethylenediamine and nitrilotris-(2-salicylideneaminoethane), are also effective deactivators for heterogeneous catalysis by copper in a mineral lubricating oil and in gasoline containing soluble copper.

Squire, L.C., SOME NOTES ON TURBULENT BOUNDARY LAYERS WITH FLUID INJECTION AT HIGH SUPERSONIC SPEEDS. Great Britain, Royal Aircraft Establishment, RAE TN AERO 2904, July 1963. 19 pp. (AD 421 965). 0875

Transpiration cooling has been suggested as a research topic for the High Supersonic Speed wind tunnel ($M = 2.5$ to 5.0) at R.A.E. Bedford. In these notes a brief review of existing work on this subject is given and regions where more experimental work is needed are pointed out. Using existing data an attempt is made to assess the importance of transpiration cooling for a long range aircraft flying at high supersonic speeds.

Stack, J., THE SUPERSONIC TRANSPORT. International Science and Technology, no. 22, 50-63 (October 1963). 0876

The paper presents a popular exposition of the problems in development of a commercial supersonic aircraft. Materials problems and temperature limitations of materials are discussed. The use of fuel as a coolant is mentioned, but there is no quantitative treatment of this design aspect.

0877 Stallings, R.L., Jr., Burbank, P.B. and Howell, D.T. (Langley Research Center), HEAT-TRANSFER AND PRESSURE MEASUREMENTS ON DELTA WINGS AT MACH NUMBERS OF 3.51 AND 4.65 AND ANGLES OF ATTACK FROM -45° to 45°. U.S. National Aeronautics and Space Administration, TN D-2387, August 1964. 176 pp.

Measurements were obtained on both sharp- and blunt-nose delta wings having 70° sweep and dihedral angles of 0° and 24.3°. The tests were conducted at nominal Reynolds number per foot of 2.9×10^6 and 4.1×10^6. Comparisons of the experimental data with existing theories and correlation parameters are presented. Complete tabulations of the experimental results are included.

0878 Stallings, Robert L., Jr. and Howard, P. W., HELIUM CONCENTRATIONS DOWNSTREAM OF A VENT EXHAUSTING HELIUM AT SONIC VELOCITY INTO A SUPERSONIC STREAM OF AIR AT MACH NUMBERS OF 3.51 AND 4.50. U.S. National Aeronautics and Space Administration, TN D-1787, May 1963, 20 pp.

Concentrations were obtained at 7.2, 14.4, and 21.7 vent diameters downstream of the vent for ratios of vent static pressure to free-stream static pressure from approximately 4 to 18, and helium stagnation temperatures of approximately 550°R and 260°R. Either increasing the ratio of vent pressure to free-stream pressure or decreasing the vented-gas stagnation temperature resulted in an increase in the concentration profiles at all three measuring stations.

0879 Starkman, E.S. Whitney, L.M. and Bollo, F.G., DEVELOPMENT OF A LABORATORY METHOD FOR EVALUATION OF FUELS FOR GAS TURBINE ENGINES. Shell Development Co., S-13186, U.S. Air Force Contract AF 33(038)-688, Final Report. April 1950. 38 pp. plus figures and tables.

The quantity of carbon that accumulates in a given gas turbine combustor, and the amount of smoke in the exhaust, have been demonstrated to be functions of the carbon-hydrogen ratio and volatility of the fuel. The correlation with the specific gravity of the fuel is also quite satisfactory. Evidence from the tests described indicated that fuel wetting of the combustor wall was a primary cause of carbon deposition. Fuels of widely different oxidation stability still satisfied the correlation with carbon-hydrogen ratio and volatility. Operating variables far overshadow the effect of fuel factors in determining the rate of carbon deposition and the amount of smoke.

Steinberg, M. and Kaskan, W. E., IGNITION OF COMBUSTIBLE MIXTURES BY SHOCK WAVES. pp. 664-72 in: Symposium (International) on Combustion, 5th, University of Pittsburgh, August 30-September 3, 1954. New York, Reinhold, 1955. 0880

Ignition of stoichiometric hydrogen-oxygen and propane-air mixtures by shock waves was studied. It was found that ignition phenomena were more reproducible behind shocks reflected from the end plate of the shock tube than behind incident shocks. Hence, extensive data were collected only for ignition upon reflection from the end of the tube. The lowest temperatures at which ignition was observed for the hydrogen-air mixture were in the range 775°K to 825°K. Ignition delays of essentially 0 to 380 µsec. were observed. For propane-air the ignition limit was approximately 1200°K for a pressure of 7 atmospheres, and decreased with increasing pressure. The longest ignition delays were 470 µsec. Lower ignition temperatures and longer delays might have been observed in a longer shock tube since the arrival of a rarefaction wave would have been postponed. The anomalously low temperatures previously reported for ignition by shock waves are explained as due to imperfection in experimental apparatus.

Steiner, H., CATALYTIC CYCLIZATION AND AROMATIZATION OF HYDROCARBONS. pp. 529-60 in: Emmett, P. H., ed., "Catalysis, Vol. IV", New York, Reinhold, 1956. 0881

The dehydrocyclization of normal paraffins to aromatics is extensively treated. Mechanisms for the dehydrogenation and cyclization reactions are developed. Kinetic equations for the formation of toluene from n-heptene using the proposed mechanisms are derived.

Stenning, A. H. (University of Miami), INSTABILITIES IN THE FLOW OF A BOILING LIQUID. American Society of Mechanical Engineers. Transactions. Series D. Journal of Basic Engineering, 86, no. 2, 213-17 (1964). 0882

The time-varying flow of a boiling liquid through a series of ducts and heaters is considered for the case where the flow rate is controlled by a downstream orifice. It is shown that oscillatory flow will exist for a variety of configurations, provided that the density ratio across the system exceeds a critical value which depends on the geometry and the heat-transfer relationship. Upstream orificing will help to damp out these oscillations, as will frictions, inertia, and a pump with a falling head-flow relationship. The analysis presented is applicable not only to boiling, but also to heating of a gas or a supercritical fluid provided that the frictional pressure drop is small and the volume change is large.

Stephan, K., **MECHANISMUS UND MODELLGESETZ DES WÄRMEÜBERGANGS BEI DER BLASENVERDAMPFUNG.** Chemie-Ingenieur-Technik, 35, no. 11, 775-84 (1963). (International Aerospace Abstracts, 4, no. 4, 216 abstr. A64-11653, 1964). 0883

Development of a model concept for the mechanism of heat transfer between boiling liquids. The formation of vapor bubbles on solid walls is studied, and the results are extended to an investigation of the effect of bubble formation upon heat transfer. It is shown that this approach leads to the establishment of dimensionless heat transfer coefficients. Described are experiments to derive a model law for the determination of the effect of heating-surface roughness upon heat transfer.

Stepukhovich, A. D., **KINETICS AND MECHANISM OF DELAYED AND INITIATED CRACKING OF HYDROCARBONS.** pp. 230-57 in: "Mezhvuzovskoe Soveshchaniye po Khimii Nefti, 1956. Sbornik Trudy". Moscow, Izdatelstvo Moskovskogo Universiteta, 1960. (CA, 55, abstr. 12830h). 0884

A review with 33 references.

Stepukhovich, A. D., **KINETICS AND MECHANISM OF THE INHIBITED AND INITIATED CRACKING OF PARAFFINIC HYDROCARBONS.** Saratov. Gosudarstvennyi Universitet. Uchenye Zapiski, 69, 177-201 (1960). (CA, 57, 11453a). 0885

Systematic investigations were carried out on the effect of various substances on the kinetics and the mechanism of decomposition of individual gaseous alkanes under low-pressure conditions. Various processes were considered and mathematical expressions were derived that define thermal cracking as a self-inhibiting process, deal with the kinetics and mechanism of inhibited cracking and the initiation and acceleration of the reactions, and deal with the overall kinetics of inhibition and initiation of cracking.

Stepuchovich, A. D., THE KINETICS AND MECHANISM OF THE SENSITIZED CRACKING OF PARAFFINIC HYDROCARBONS. Zhurnal Fizicheskoy Khimii, 30, 556-65 (1956). (Canada, National Research Council, Technical Translation 767). 0886

A mechanism is proposed for the sensitized cracking of hydrocarbons. This mechanism explains the observations that sensitizing agents can accelerate or retard hydrocarbon decomposition. A kinetic equation is deduced and integrated for the rate of sensitized cracking.

Stepukhovich, A. D., MECHANISM OF THE INHIBITION OF HYDROCARBON CRACKING BY INHIBITORS. Zhurnal Fizicheskoi Khimii, 32, 2571-4 (1958). (CA, 53, 14482f). 0887

Inhibition of alkane cracking by olefins (propylene, isobutylene) probably proceeds by replacement of the more active radicals (H, Me) with the less active allyl-type radicals. H is removed from a Me group with a weak C—H bond caused by the effect of neighboring double bonds. The inhibitor effect increased with an accumulation of Me groups in the olefins.

Stepukhovich, A. D., Kosyreva, R. V., and Petrosyan, V. I., KINETICS AND MECHANISM OF HYDROCARBON DECOMPOSITION. I. MECHANISM OF THERMAL PROPANE CRACKING. Zhurnal Fizicheskoy Khimii, 35, no. 3, 600-4 (1961). 0888

The authors studied the thermal propane cracking reaction as dependent on the degree of decomposition, pressure, and temperature. Propane cracking at 590°C was found to give equal amounts of H_2 and C_3H_6, as well as CH_4 and C_2H_4 at low pressures (20 mm Hg) and low conversion (about 10%). With increasing conversion and pressure, propane cracking mainly yields methane and ethylene, with increased yield in hydrogen, propylene, and ethane. The formation of ethane in thermal propane cracking is explained with a radical chain mechanism. The formation of methane and ethylene in propane cracking is explained as the decomposition of propyl radicals. At high conversions (60-70%), less ethylene is formed due to secondary reactions (polymerization, hydrogenation). The formation of propylene and hydrogen is explained as the decomposition of isopropyl radicals.

Stepukhovich, A. D. and Nikitin, E. E., THE KINETICS AND THE MECHANISM OF DECOMPOSITION OF TETRAMETHYLETHYLENE. Zhurnal Fizicheskoy Khimii, 31, 2400-2 (1957). (CA, 52, 9729i). 0889

The mechanism and kinetics of decomposition of $(Me_2C:)_2$ is discussed on the basis of a heterogeneous radical rather than a chain mechanism.

Stepukhovich, A. D. and Nikitin, E. E., THEORY OF THE RETARDATION AND ACCELERATION OF THE CRACKING OF PARAFFIN HYDROCARBONS BY TETRAMETHYLETHYLENE. Zhurnal Fizicheskoi Khimii, 31, 1676-86 (1957). (CA, 52, 6772f). 0890

A general scheme for hydrocarbon cracking is proposed which takes into consideration both the accelerating and retarding effect of some additives. The mathematical expression changes at limiting acceleration values to the Dintses and Frost equation. Inhibition and acceleration of the cracking process are interconnected, and can be explained only by taking the acceleration into account, which alters the usual approach to the system and requires 2 separate terms in the equations.

Stepukhovich, A. D. and Tatarintsev, V. V., INITIATION OF CRACKING OF PARAFFINIC HYDROCARBONS BY ADDITION OF AZOMETHANE. Akademiya Nauk SSSR. Doklady, 99, 1049-52 (1954). (C. A. 49, 13630h, 1955). 0891

Azomethane is a chain initiator and forms CH_3 radicals as a first step in the chain reaction. Cracking tests were run at 364 and 368°C with partial pressure ratios of MeN_2 to hydrocarbon ranging from 0.13 to 0.057. The effects of partial pressure and of time on the extent of cracking, and of the relative concentration of MeN_2 on the cracking of isobutane are shown graphically. Cracking of isobutane was greater than that of C_3H_8.

Sterba, M. J. and Haensel, V. (Universal Oil Products), PYROLYTIC AND CATALYTIC DECOMPOSITION OF HYDROCARBONS. Industrial and Engineering Chemistry, 45, no. 9, 2034-41 (1953). 0892

In the field of hydrocarbon decomposition reactions, the year ending in May 1953 has shown a continual growth in the three main subjects of thermal cracking, catalytic cracking, and catalytic reforming. As indicated by the literature, there is a considerable interest in processes for ethylene and acetylene manufacture by thermal methods. In catalytic cracking, the problems of proper catalyst testing and catalyst contaminants have retained the interest of many investigators. In catalytic reforming, a considerable expansion of the work using supported precious metal catalysts, particularly platinum, is very much in evidence. 65 references are given.

Sterba, M. J. and Haensel, V. (Universal Oil Products), PYROLYTIC AND CATALYTIC DECOMPOSITION OF HYDROCARBONS. Industrial and Engineering Chemistry, 46, no. 9, 1888-94 (1954). 0893

This review is a summary and brief digest of publications appearing in the literature during the year ending May 1954, and covers the fields of thermal cracking, catalytic cracking, and catalytic reforming. Continued studies have been reported on the mechanism and rates of thermal decomposition of hydrocarbons. The fluidized coking process has appeared during the past year to help solve the problem of converting heavy residual oils into distillates and coke. The field of catalytic cracking has enjoyed continued expansion in capacity during the past year although no new catalyst or processes have been announced. In the rapidly expanding field of catalytic reforming continued interest has been shown in the application of supported precious metal catalysts. 95 references are given.

Sterman, L. S., Stiushin, N. G. and Morozov, V. G., AN INVESTIGATION OF THE DEPENDENCE OF CRITICAL HEAT FLOW ON THE RATE OF CIRCULATION. Soviet Physics - Technical Physics, 1, 2250-4 (1957). (CA, 52, 13330b). 0894

The thermal flux at which the reverse transition from film to bubble boiling is observed was determined as a function of the circulation velocity for ethyl alcohol at 2-atmospheres input pressure and circulating velocities from 0.3 to 7.5 meters/sec, and for water at 2.5-atmospheres and 0.4 to 3.0 meters/sec. Some experiments with water were conducted at 7-atmospheres. In the work with water the change in heat flow had to be rapid because prolonged film boiling could not be maintained. This increased the spread of experimental points, particularly at 7-atmospheres. The critical thermal flux was determined for ethyl alcohol at 2-atmospheres input pressure and circulating velocities from 0.27 to 6.95 meters/sec.

Stern, A. B. and Babitz, M., STORAGE STABILITY OF THERMALLY REFORMED MOTOR GASOLINE. Israel. Research Council. Bulletin. Section C, 6C, 227-34 (1958). (CA, 53, 11809f). 0895

The effect of prolonged storage on the chemical and physical properties of a straight-run gasoline and a thermal reformate of 79 octane was studied. Both gasolines were leaded and inhibited with N,N'-di-sec-butyl-p-phenylenediamine; the reformate contained varying amounts of inhibitor. The properties of the straight-run gasoline remained almost unchanged, whereas the reformate gradually increased in gum content and decreased in oxidation stability. An inhibitor concentration of about 80 p.p.m. seems to be the optimum for maintaining the reformate specifications.

Stewart, D. G., COMBUSTION IN RAM JET ENGINES, Electrical and Mechanical Engineering Transactions, 3, 43-51 (May 1961). 0896

Review article on current problems in ramjet combustor design. Mentions supersonic combustion and high energy fuels as possible solutions to dissociation problems.

Stone, J. P., Ewing, C. T. and Miller, R. R. (U. S. Naval Research Laboratory), HEAT-TRANSFER STUDIES ON SOME STABLE ORGANIC FLUIDS IN A FORCED CONVECTION LOOP. Journal of Chemical and Engineering Data, 7, no. 4, 519-25 (1962). 0897

Stable organic fluids used as coolant moderators have been under study for a number of years; physical, chemical, nuclear, and engineering properties of many of these fluids, relative to this use, have been investigated. At U. S. Naval Research Laboratory a forced convection, out-of-pile loop was used to study heat-transfer properties. Special emphasis was placed on film coefficient measurements and on possible fouling of heat-transfer surfaces. The system was designed to facilitate these studies at heat-transfer surface temperatures to 850°F., with heat fluxes approaching 500,000 Btu/hr sq. ft., and with fluid velocities approaching 50 feet/sec. The film coefficients measured for seven fluids have been correlated by an equation of the Dittus-Boelter type, and this equation is recommended for that estimation of film coefficients of polyphenyl and aliphatic oils for specified conditions of flow and temperatures.

Stormont, D. H., DO JET FUEL BACTERIA CAUSE SLIME, CORROSION? Oil and Gas Journal, 59, no. 27, 82-4 (1961). 0898

This general article discusses the interrelation between bacterial activity and corrosion in jet fuel tankage and some of approaches being used to solve the problems of corrosion and filter plugging.

Strauss, H., CONFERENCE ON HIGH TEMPERATURE FUEL STABILITY --SEPTEMBER 27, 1954. U. S. Air Force, Wright Air Development Center, Technical Note WCLP 54-193, October 1954. 0899

This report contains a brief summary of proceedings at the Conference on High Temperature Fuel Stability held at WADC, September 27, 1954, including presentations concerning development by participating laboratories of standard laboratory method for evaluating thermal stability of jet fuels, minutes of discussions, list of fuels selected for use in laboratory rigs, conditions for running the Erdco rig.

Street, J. C. and Thomas, A. (Shell Petroleum, Thornton Research Centre), CARBON FORMATION IN PRE-MIXED FLAMES. Fuel, 34, no. 1, 4-36 (1955). 0900

The critical concentration of air required to suppress carbon formation in pre-mixed flames at constant pressure has been determined for a large number of fuels, by the use of a bunsen type burner from which secondary air was excluded. Fuels of low varpour pressure were burnt as mists. The effects of varying the oxygen concentration in the air supply, pre-heating the unburnt gases and adding small quantities of other substances to the unburnt mixture have also been studied. The recent literature on the chemical mechanism of carbon formation is reviewed, and current theories are compared. It is suggested that carbon forms in pre-mixed flames in much the same manner as in diffusion flames, but that oxygen, by combination with carbon atoms, prevents those atoms from participating in the process.

Street, J.C., Thomas, A., and Williams, R.A., CARBON FORMATION IN PRE-MIXED FLAMES. Shell Thornton Research Centre, Report K.113, U.K. Ministry of Supply Contract No. 6/Engs/4668/CB.II(a), September 1953. 52 pp. 0901

The air/fuel ratio at which carbon formation is completely suppressed has been determined for constant pressure flames of a large number of fuels and pure hydrocarbons using a Bunsen type burner from which secondary air was excluded, and the effects of certain additives on carbon formation have been determined. A hypothesis explaining the role of oxygen in suppressing carbon formation has been put forward, and the results obtained during the present work have been discussed in the light of this hypothesis.

Streets, W.L., CHARACTERISTICS OF FLAME RADIATION OF HIGH TEMPERATURE HYDROCARBON FUELS. Phillips Petroleum Company, Research Division, Report 2307-59R Summary Report, U.S. Air Force Contract AF 33(616)-5543, March 1959. 39 pp. 0902

Investigation of the effects of a monocyclic and several polycyclic hydroaromatic high temperature hydrocarbon fuels on flame radiation and flame tube metal durability has been conducted in a two-inch laboratory scale combustor under several pressure conditions. Isoparaffinic and aromatic fuels were also included for reference purposes. Although differences in transverse flame radiation, flame tube metal temperatures and flame tube metal losses were observed among the polycyclic fuels tested, these appear significant only in the cases of isopropyl bicyclohexyl and dimethano decalin at high pressure. Diethylcyclohexane exhibited relatively low radiation fluxes, making it appear comparable to the isoparaffinic reference fuels at all test conditions. A correlation plot of flame tube metal losses versus transverse flame radiation showed this relationship to be mildly useful in predicting metal losses.

Streets, W. L., GAS TURBINE AND JET ENGINE FUELS. Phillips Petroleum Company - Research Division, Report 3185-62R, U. S. Navy Contract NOw 61-0590-d, May 1962. 56 pp. (AD 282 793). 0903

Tests were run in a two-inch combustor to evaluate the effect of sea water ingestion and fuel sulfur contamination on the durability of turbojet engine "hot section" components. Injection of synthetic sea water into the combustor caused no significant change in combustor liner metal loss, either with or without sulfur in the fuel. Natural Gulf sea water did cause increased liner loss in both cases, and this was found to be due to trace amounts of dissolved copper and nickel in the Gulf sea water. Simulated turbine guide vanes of various alloys were exposed to the hot exhaust from the combustor and some detrimental effects were observed for sulfur-containing fuel and for synthetic sea water ingestion, independently. Flame radiation and combustor liner temperature data showed that the performance characteristics of the 2-inch combustor simulate those of full-scale turbojet engine combustors satisfactorily for studying the burning quality of jet fuels, and that no significant reduction in flame radiation or liner temperature results from the use of fuels having Luminometer ratings above 100. A brief study of the thermal stability of a typical JP-5 fuel with sulfur compounds added showed thermal stability to be much more sensitive to mercaptans than other sulfur compounds.

Streets, W. L. and Schirmer, R. M., GAS TURBINE AND JET ENGINE FUELS. Phillips Petroleum Company - Research Division, Report 3529-63R, U. S. Navy Contract N600(19)-58219, July 1963. 81 pp. (AD 414 467).

0904

The primary effort of this study has been evaluation of the effects of fuel sulfur and ingested sea water on hot gas corrosion of turbine inlet guide vanes using specimens fabricated from five typical current-generation alloys including Udimet 500, Waspalloy, Rene 41, Hastelloy R-235 and Haynes Alloy 25. A second project consisted of a study of test methods for evaluating the burning quality of jet fuels. Twelve-hour duration tests were conducted with the Phillips 2-Inch Research Combustor operated at a pressure of 12 atm and 2000F exhaust gas temperature showed that: (1) guide vane metal loss is approximately a linear function of time; (2) a fuel sulfur content of 1.0 per cent had no detrimental effect on the rate of metal loss; (3) only Haynes Alloy 25 exhibited significantly more loss in tensile strength with sulfur than without; (4) all alloys suffered marked losses in ductility, though no sulfur effect was indicated; (5) photomicrographs suggested predominantly intergranular attack, which was not increased by the addition of sulfur to the fuel.

Stubbeman, R. F. and Gardiner, W. C., Jr. (University of Texas), SHOCK TUBE STUDY OF ACETYLENE-OXYGEN REACTION. Journal of Physical Chemistry, 68, no 11, 3169-76 (1964).

0905

The reaction of acetylene with oxygen was studied over the temperature range 1500-2500°K, using shock tube techniques. Observations were made of ultraviolet and visible chemiluminescence, and of the hydroxyl radical by absorption spectroscopy. The ratio of oxygen to acetylene varied from 0.84 to 7.3. Previous findings about the appearance of the chemiluminescence were in general confirmed. Comparison of the temporal behavior of OH concentration and visible chemiluminescence showed that OH appearance was substantially delayed. Consequences of the phase relationship between OH and chemiluminescence are discussed with reference to current proposals for the mechanism of the branching reactions. Proposals are made for the origin of the chemiluminescence which are in agreement with conclusions from other studies.

Stubbs, F. J. and Hinshelwood, C. N., THE THERMAL DECOMPOSITION OF HYDROCARBONS. Faraday Society. Discussions, 10, 129-36 (1951).

0906

The following topics are discussed in the course of a general survey of the decomposition reactions of the normal paraffins: the nature of the radical-chain reactions, the probability that the residual reaction after nitric oxide inhibition of chains is a molecular reaction, the rate-pressure law which indicates that the mechanism is kinetically composite, the variation of activation energy with pressure, the relative probability of rupture of the carbon chain at various points, and the interpretation of experiments on the composition of products. Further questions about energy-entropy relations in unimolecular reactions arise in connection with these various matters.

Surugue, J., Ed., EXPERIMENTAL METHODS IN COMBUSTION RESEARCH, A MANUAL. New York, Pergamon, 1961. (Published for North Atlantic Treaty Organization, Advisory Group for Aeronautical Research and Development). 0907

The manual on "Experimental Methods in Combustion Research" is constituted by contributions from researchers who have specialized each in a particular technique and present here the results of their thinking and individual experience. Its loose-leaf form furthers an early publication of the authors' contributions and makes it possible to supplement the volume and keep it up to date on the evolution of methods, certain branches of which are apt to sudden emphasis and make amazingly quick progress. The initial edition comprises 32 papers; the first part of the work deals with measuring methods for fundamental data in combustion research, the second part concerns combustion research techniques and the third part is devoted to research facilities.

Suzuki, M., Miyama, H., Fujimoto, S., Kase, T., THE IGNITION OF METHANE-OXYGEN BY REFLECTED SHOCK WAVE. Chemical Society of Japan. Bulletin. 35, 316-18, (1962). 0908

Ignition temperatures and pressures measured behind reflected shock waves in methane-oxygen mixtures were found to correlate closely with these same factors for mixtures of oxygen with other light paraffins.

Svehla, R.A. (Lewis Research Center). ESTIMATED VISCOSITIES AND THERMAL CONDUCTIVITIES OF GASES AT HIGH TEMPERATURES. U.S. National Aeronautics and Space Administration, TR R-132, 1962. 130 pp. (AD 272963). 0909

Viscosities and thermal conductivities, suitable for heat-transfer calculations, were estimated for about 200 gases in the ground state from 100° to 5000°K and 1-atm pressure. Free radicals were included, but excited states and ions were not. Calculations for the transport coefficients were based upon the Lennard-Jones (12-6) potential for all gases. Intermolecular force constants for this potential were obtained from experimental viscosity data or were estimated when data were not available. The same set of constants was used to calculate both viscosity and conductivity. An Eucken-type correction for exchange between internal and translational energies was made for thermal conductivities of polyatomic gases.

Swanson, A. G. and Rumsey, C. B., AERODYNAMIC HEATING OF A WING DETERMINED FROM A FREE-FLIGHT ROCKET-MODEL TEST TO MACH NUMBER 3.64. U. S. National Advisory Committee for Aeronautics, RM L56F11a, September 1956. 33 pp. 0910

A wing having an aspect ratio of 2.9, a 30° swept leading edge, an unswept trailing edge, and a hexagonal airfoil section was flight tested on a rocket-propelled model to a Mach number of 3.64 and a Reynolds number 31.9×10^6 based on wing mean aerodynamic chord of 1.52 feet. Temperature data reduced to Stanton number were in fair agreement with the Van Driest theory for flat plates with turbulent boundary layers.

Swarts, D.E. and Frank, C.E. (University of Cincinnati), EFFECT OF HYDROCARBON STRUCTURE ON REACTION PROCESSES LEADING TO SPONTANEOUS IGNITION. U.S. National Advisory Committee for Aeronautics, TN 3384, July 1955, 23 pp. 0911

The present study compares the reaction processes of other aliphatic hydrocarbons with those of the heptane and isooctane previously studied. A study of the behavior of olefins and some exploratory work on the effect of the ratio of surface to volume on the extent of oxidation in the early stages was also included.

Swarts, D. E. and Orchin, M. (University of Cincinnati), SPONTANEOUS IGNITION TEMPERATURE OF HYDROCARBONS. Industrial and Engineering Chemistry, 49, no. 3, 432-6 (1957). 0912

An attempt was made to relate the spontaneous ignition temperature of a series of hydrocarbons with the behavior of these same hydrocarbons toward vapor-phase oxidation in a flowing system under condition such that only a small portion of the hydrocarbon is attacked. Eight hydrocarbons, representing a variety of structural types, were used for the study. These included toluene, heptene-3 and a variety of C_6-C_8 paraffins. S. I. T.'s were related to pressure and surface-to-volume ratio of the apparatus for each hydrocarbon/oxygen mixture. A rank-order correlation was obtained between spontaneous ignition temperature and ease of vapor phase oxidation.

Swarts, D. E. and Orchin, M., VAPOR-PHASE OXIDATION AND SPONTANEOUS IGNITION - CORRELATION AND EFFECT OF VARIABLES. U. S. National Advisory Committee for Aeronautics, TN 3579, April 1956. 32 pp. (AD 91380). 0913

The spontaneous ignition temperatures of eight structurally different hydrocarbons were determined and correlated with the behavior of the same hydrocarbons toward vapor-phase oxidation. Since good correlation of the two phenomena was obtained, it is likely that similar oxidative mechanisms are operative in both.

Swatek, F. E. (Long Beach State College), FUNDAMENTALS OF MICROBIOLOGICAL CONTAMINATION OF LIQUID HYDROCARBON FUELS. Society of Automotive Engineers. SAE Paper 651A, January 1963. 7 pp. 0914

A brief review of the problems associated with the modification of liquid hydrocarbon fuels by contaminants is given. The role of the bacteria and fungi in this process is considered. Emphasis is placed on the role of the organisms in modification and utilization of the environments in maintaining a dynamic environment which permits continually changing populations of organisms to flourish. Possibilities of the interactions between separate groups of organisms and other contaminants in this environment are considered. The end results of these dynamic processes are discussed in relation to the practical field problems of fuel handling and storage.

Swatek, F. E. (Long Beach State College), MICROORGANISMS BUG AIRCRAFT FUELS, TOO, SAE Journal, 71, no. 4, 49 (1963). 0915

Serious microbal contamination of aircraft fuel is associated with the vigor and conscientiousness of maintenance of the sump tanks. A single fueling with microbiologically contaminated fuel and its immediate use in flight probably contribute an insignificant amount to the overall problem of detrimental corrosion in the aircraft. Numerous exposures of the tanks to contaminated fuel and accumulation of water, living and dead cells, and iron rust seem to create the real problems.

Swithenbank, J. (Sheffield University), DESIGN OF THE HYPERSONIC AIRCRAFT. Shell Aviation News, no. 310, 11-12 (1964).

Probable developments in the field of air breathing power plants for both cruise and boost aircraft in the Mach 5+ range are discussed. Emphasis is placed on the developments in the field of supersonic combustion ramjets. 0916

Talantov, A. V., ON THE OPTIMUM OPERATION CONDITIONS OF DIRECT-FLOW COMBUSTION CHAMBERS IN FLIGHT. Kazan. Aviatsionnyy Institute. Trudy, 1960, no. 55, 47-61. (Referativnyy Zhurnal. Mashinostroyeniye, 1961, no. 14, 24, abstr. 14I180).

The relation between flight altitude and flight speed of aircraft with ram-jet engines operating at a constant heat liberation in the combustion chamber is analyzed. It is concluded that the combustion process does not limit the utilization of ram-jet engines at altitudes up to 60 km at M>3. There are 9 references. 0917

Talk, W.S., INVESTIGATION OF FUEL DIFFUSION AND MIXING WHEN INJECTED INTO A SUPERSONIC STREAM. General Dynamics, Ordance Aerophysics Lab., Report No. 679-1, U.S. Navy Contract NOw 63-0405-c, May 1964. 2 pp. (AD 351 590). REPORT CLASSIFIED CONFIDENTIAL.

No abstract. 0918

Tamagno, J. and Lindemann, O. (General Applied Science Labs., Inc.), EXPERIMENTAL RESULTS ON SUPERSONIC COMBUSTION. U. S. Air Force, AFOSR Technical Report 322, Contract AF 49(638)-991, December 1962. 32 pp. (AD 294809). 0919

This report describes a basic experimental study conducted at GASL to investigate supersonic combustion of air and hydrogen in a short time duration facility (shock-tunnel). In addition, a comparison is made between the experimental results and a theoretical analysis for the combustion of hydrogen-air mixing. For these tests, a model, which was located in the center of a conical nozzle, was designed and fabricated. The model consisted of a cylindrical inlet region, followed by a downstream facing annular fuel injector and then a cylindrical instrumented burner region. A series of tests were performed at approximately 11,000 ft/sec. for a large range of burner static pressures (.07 to .9 atm.) and static temperatures ranging from 1000°K to 1800°K.

Taniewski, M. (University of Oxford), INVESTIGATIONS ON THE THERMAL DECOMPOSITION OF OLEFINS. Royal Society (London). Proceedings, A265, 519-37 (1962). 0920

It was shown that at 530°C there was practically no decomposition of olefins not possessing a C—C bond β to the double bond. The rate constants for the decomposition of various olefins at 530°C over the range of p_0 from 25 to 300 mm were measured. The relative rates of decomposition and polymerization of ethylene at 530, 600 and 630°C have been studied. Analysis of the reaction products both in the presence and in the absence of nitric oxide suggested that the ethane formed came mainly from the secondary decomposition of polymers.

Taylor, J., BEATING THE HEAT BARRIER. Gt. Brit. Aeronautical Research Council. Current Paper 545 (1961). 13 pp. (AMR, 14, 978, Abstr. 6872). 0921

A short survey is made of the characteristics of aerodynamic heating at supersonic speeds and of the properties of a typical aluminum alloy when exposed to increased temperatures for prolonged periods. With this information, an estimate is made of the minimum combined weight of cooling and insulation required for an aluminum aircraft structure; the study extends to $M = 10$, height of 250,000 ft and a range of 5000 miles.

Taylor, L. T., THE INFLAMMABILITY CHARACTERISTICS OF LIQUID FUELS. U. S. Air Force, AF-TR-5895, July 1949. 93 pp. (AD 65983). 0922

This report is a review of all of the laboratory work accomplished by the Air Material Command for the period 1941-1948 to determine the relative inflammability characteristics of liquid fuels. Autoignition temperatures and combustible mixture limits are presented for a variety of fuels.

Taylor, M. F. and Kirchgessner, T. A. (NASA, Lewis Research Center), MEASUREMENTS OF HEAT TRANSFER AND FRICTION COEFFICIENTS FOR HELIUM FLOWING IN A TUBE AT SURFACE TEMPERATURES UP TO 5900 R. ARS Journal, 30, 830-2, 889-92 (1960). 0923

Measurements of average heat transfer and frction coefficients and local heat transfer coefficients were made with helium flowing through electrically heated smooth tubes with length-diameter ratios of 60 and 92 for the following range of conditions: Average surface temperature from 1457 to 4533 R, Reynolds number from 3230 to 60,000, heat flux up to 583,200 Btu per hour per ft^2 of heat transfer area, and exit Mach number up to 1.0. The results indicate that, in the turbulent range of Reynolds number, good correlation of the local heat transfer coefficients is obtained when the physical properties and density of helium are evaluated at the surface temperature. The average heat transfer coefficients are best correlated on the basis that the coefficient varies with $[1 + (L/D)^{-0.7}]$ and that the physical properties and density are evaluated at the surface temperature. The average friction coefficients for the tests with no heat addition are in complete agreement with the Karman-Nikuradse line. The average friction coefficients for heat addition are in poor agreement with the accepted line. Experimental apparatus and instrumentation are described.

Templin, A. W., SUPERSONIC TRANSPORT DEVELOPMENT. Society of Automotive Engineers. SAE Paper S314, September 1961. 8 pp. See also SAE Journal, 70, no. 1, 79-81 (1962). (Engineering Index, 1962, 47). 0924

Studies made by General Dynamics/Convair investigating different configurations of canard-delta wing type; additional market analysis of 37 aircraft that covered Mach number range of 2.0-3.5 passenger capacities of 70-130, and ranges of 1500-3500 nautical mi; supersonic transport bearing 130 passengers over 4000 mi range at cruise speed of Mach 3 appeared most economical; development factors falling into operational, technical, and economical aspects are examined.

Tendeland, T., EFFECTS OF MACH NUMBER AND WALL-TEMPERATURE RATIO ON TURBULENT HEAT TRANSFER AT MACH NUMBERS FROM 3 TO 5. U. S. National Aeronautics and Space Administration, TR R-16, 1959. 0925

Heat-transfer data were evaluated from temperature time histories measured on a cooled cylindrical model with a cone-shaped nose and with turbulent flow at Mach numbers 3.00, 3.44, 4.08, 4.56, and 5.04. The experimental data were compared with calculated values using a modified Reynolds analogy between skin friction and heat transfer. Theoretical skin-friction coefficients were calculated using the method of Van Driest and the method of Sommer and Short. The heat-transfer data obtained from the model were found to correlate when the T' method of Sommer and Short was used. The increase in turbulent heat-transfer rate with a reduction in wall to free-stream temperature ratio was of the same order of magnitude as has been found for the turbulent skin-friction coefficient.

Terao, K., SELBSTZÜNDUNG DES n-HEXAN-LUFT-GEMISCHES IN STOSSWELLEN. Physical Society of Japan. Journal, 15, no. 6, 1113-22 (1960). 0926

The ignition lag of n-hexane-air mixtures in shockwaves was measured, under different conditions, in order to analyze its fluctuations statistically. The probabilities of ignition of the mixtures were thus calculated. The ignition was considered to consist of two steps: the initiation reaction and the secondary reaction. The activation energies of both these steps were calculated in each case. These values were then used in an attempt to explain some aspect of the mechanism of ignition.

Terao, K., SELBSTZÜNDUNG VON KOHLENWASSERSTOFF-LUFTGEMISCHEN IN STOSSWELLEN. Physical Society of Japan. Journal, 15, no. 11, 2086-92 (1960). 0927

The ignition mechanism of hydrocarbon-air mixtures is discussed. Thus, the ignition probabilities of various hydrocarbon-air mixtures were computed from the fluctuations of their ignition lags in shock waves. From these ignition probabilities, the activation energies of the primary and secondary reactions were calculated. Next, the activation energies for the C-H and C-C bonds in the reaction with oxygen are estimated, as well as the amount of heat liberated for secondary reactions. The mean ignition lags of other n-paraffin-air mixtures were, in accord with the experimental conditions, estimated from the above determined values.

Terao, K. (University of Yokohama), DIE WIRKUNG DES BLEITETRAÄTHYLS AUF DIE ZÜNDUNG DES n-HEPTANE-LUFT-GEMISCHES IN STOSSWELLEN. Japanese Journal of Applied Physics, 2, no. 6, 364-9 (1963). 0928

The ignition delay behind reflected shock waves was measured for a pure n-heptane/air mixture and one containing tetraethyl lead. The ignition probabilities were obtained, from which the activation energies of ignition reaction were calculated. The effect of lead on ignition is discussed by considering the differences in the ignition probabilities and activation energies between these two mixtures. It is suggested that lead does not effect the ignition by its chain breaking action but its oxidation.

Tereshchenko, Ye. R., et al, THERMAL STABILITY AND CORROSIVE ACTIVITY OF SULFUR-CONTAINING FUELS AT ELEVATED TEMPERATURES. pp. 231-5 in: "Sbornik Khimiya Seraorganicheskikh Soedinenii, Soderzhashchikhsya v Neftyakh i Nefteproduktakh, v. 4", Moscow, Gostoptekizdat, 1961. (Referativnyi Zhurnal, Khimiya, 1962, no. 3, 489, abstr. 3M193). 0929

Fuels containing cracking components and high mercaptan concentrations have lowest thermal stability, resulting in rapid filter clogging. Fuel purified by hydrotreating gave highest thermal stability.

Tereshchenko, Ye. P., Zaloga, B. D., and Maksimov, S. M., EVALUATION OF THE COMBUSTION CHARACTERISTICS OF AVIATION GAS TURBINE FUELS ON A SMALL-SIZED SINGLE-COMBUSTION-CHAMBER RIG. Khimiya i Tekhnologiya Topliv i Masel, 1960, no. 11, 64-70. 0930

The principal characteristics of an aviation gas turbine that depend on the quality of the fuel are: starting, limits of stable combustion, completeness of combustion and deposit formation in the combustion chamber. These properties were accordingly tested.

Tetanyi, P. and Babernics, L., ON THE KINETICS OF THE CATALYTIC DEHYDROGENERATION OF HYDRO-AROMATIC COMPOUNDS. V. KINETICS OF THE DEHYDROGENATION OF CYCLOHEXANE IN THE PRESENCE OF PLATINUM CATALYST. Acta Chimica Academiae Scientiarum Hungaricae 35, no. 4, 419-32 (1963). (CA 59, 4991 b). 0931

The kinetics of Pt-catalyzed dehydrogenation of cyclohexane was investigated. A linear correlation was found between the degree of dilution with argon or H and the reciprocal of reaction rate. From the experimental data, the bond energies between the reacting atoms and Pt were estimated to be $Q_{HPt} = 65.6$ cal./atom, $Q_{CPt} = 13.5$ cal./atom, and $Q_{OPt} = 33.6$ cal./atom.

Tetenyi, P., Babernics, L. and Thomson, S. J., ON THE KINETICS OF THE CATALYTIC DEHYDROGENATION OF HYDROAROMATIC COMPOUNDS. VI. INVESTIGATION OF THE MECHANISM OF DEHYDROGENATION OF CYCLOHEXANE WITH THE AID OF RADIOACTIVE CARBON. Acta Chimica Academiae Scientiarum Hungaricae, 34, 335-8 (1962), (CA, 59, 394 f). 0932

The formation of cyclohexene and cylcohexadiene during the dehydrogenation of cyclohexane to benzene over nickel catalyst was investigated. A 1:1 mixture of cyclohexane and cyclohexene was subjected to dehydrogenation under conditions that both these substances remained in excess. Using labeled cyclohexane, the cyclohexene present in the catalyzate was examined for radioactivity. The results showed that the dehydrogenation of cyclohexane on metallic catalysts takes place through the formation of intermediate products.

Tetenyi, P. and Schächter, K., ON THE KINETICS OF CATALYTIC DEHYDROGENATION OF HYDROAROMATIC COMPOUNDS, III. COMPARISON OF THE DEHYDROGENATION RATE OF VARIOUS CYCLIC HYDROCARBONS. Academia Scientiarum Hungaricae. Acta Chimica, 29, 199-206 (1961). 0933

The dehydrogenations of cyclohexane, cyclohexene, methylcyclohexane, tetralin and decalin were studied over a nickel catalyst. Reaction rates and temperature coefficients were different for the various compounds except that the rates for cyclohexane and methylcyclohexane were the same. It appeared that the slow step was not the desorption of the reaction products.

0934 Tetenyi, P. and Schächter, K., **STUDY OF THE EFFECT OF THE METHOD OF PREPARATION ON THE ACTIVITY OF NICKEL CATALYSTS.** Academy of Sciences (U.S.S.R.). Proceedings. Chemistry Section, 146, 847-50 (1962).

Nickel catalysts prepared by different methods showed varying activity for the dehydrogenation of cyclohexane and isopropyl alcohol and for the dehydration of tertiary butyl alcohol. The most active catalyst for dehydrogenation was not prepared in the same manner as the most active catalyst for dehydration.

0935 Thomann, G. E. A. and Erb, R. B., **SOME EFFECTS OF INTERNAL HEAT SOURCES ON THE DESIGN OF FLIGHT STRUCTURES.** North Atlantic Treaty Organization, Advisory Group for Aeronautical Research and Development, Report 208, October 1958. 62 pp. (AD 237621).

A survey is given of the problems which arise due to heating of a structure. The magnitude and accuracy of the heat sources and their effects on the structure are discussed. This is followed by a more complete assessment of the engine-bay problem, its heating, structural effects and design considerations. Conclusions relating to this latter problem are drawn. In the appendices, the analytical treatments of the transient and steady state temperature distributions are given, as well as an analysis of the thermal stresses in a typical jet engine bay structure.

0936 Thomas, B. W. (Texas Butadiene and Chemical), **DEVELOPMENT OF HIGH TEMPERATURE HYDROCARBON JET FUELS.** U.S. Air Force, ASD TR 61-139, Contract AF [illegible](616)-6884, August 1961. 162 pp. (AD 263637).

80 hydrocarbon samples were synthesized and evaluated as potential high-temperature fuels for high-speed jet planes. Each fuel comprised an isomeric mixture of dicycloalkyl alkanes which had been prepared by alkylation, distillation, hydrogenation and final rerun distillation. Most important considerations in the fuel evaluation were thermal stability, cost, heat of combustion, and viscosity. These data as well as density, freezing point, boiling point, and detailed compositional analysis are reported.

0937 Thompson, S. A. W., Hills, S. R., Brown, N. P. H., and Lewis, A. (Shell International Petroleum), SILVER CORROSION BY AVIATION TURBINE FUELS. Institute of Petroleum. Journal, 50, no. 483, 61-72 (1964).

Fuel pump failures associated with sulphiding of the silver-plated components have occurred in civil aircraft with aviation turbine fuels which fully meet the relevant specification requirements and in particular the appropriate ASTM-D130 copper strip corrosion test. It has been confirmed in the laboratory that such fuels can differ in their ability to cause sulphide corrosion of silver and a simple laboratory silver corrosion test for control purposes has been devised. This test has been correlated with full-scale laboratory pumping tests under simulated operating conditions and with practical aircraft operating experience.

0938 Thrush, B. A., FREE RADICALS. Nature, 199, no. 4895, 750-1 (1963).

The 6th International Symposium on Free Radicals (Cambridge 7/2-5/63) included papers on dissociations in the gas phase induced by electron bombardment; the electron spin resonance spectra of trapped radicals produced by the irradiation of solids; the use of electron spin resonance to study the chemical reactions of radicals produced by the irradiation of polymers, those of organic diradicals, and those of radicals produced by photosensitized decomposition, cryogenically, or by photolysis; other methods of studying solid-state chemical reactions; and electron spin resonance and other studies of radicals in liquid systems. Many of the materials studied were hydrocarbon monomers or polymers. Brief summaries of the major topics and of some of the individual papers are given.

0939 Timby, E.A., CABIN WALL COOLING SYSTEMS FOR VERY HIGH SPEED FLIGHT VEHICLES. Great Britain, Royal Aircraft Establishment, RAE TN MECH ENG 396, March 1964. (AD 442 169).

Cabin wall cooling systems are considered for vehicle equilibrium skin temperatures in the range 400 to 1000K with emphasis on the upper end of the range. The effects of variables such as insulation conductance, cooling duct heat transfer coefficient and duct temperature are investigated. Different cooling media are considered and system weights, volumes and power requirements assessed. In a practical design there is likely to be an optimum primary insulation conductance of about 0.25 CHU/HR per sq ft per degree C for both vapour cycle and expendable coolant wall cooling systems. System weight is considerably affected by the heat leakage around the insulation and the temperature variation that is acceptable on the cabin wall inside surface. More information is required on the values of these variables and on heat transfer in rectangular ducts in the transition zone between laminar and turbulent flow conditions.

Timofeeva, E. A., Shuikin, N. I., and Dobrynina, T. P., DEHYDROGENATION OF 2,2,4-TRIMETHYLPENTANE OVER ALUMINA-CHROMIA-POTASH CATALYST. Academy of Sciences (U.S.S.R.). Bulletin. Division of Chemical Sciences, 1961, 797-800. 0940

Isooctane (2,2,4-trimethylpentane) was dehydrogenated over potassium promoted chromia on alumina catalyst at 450°-550°C, space velocities of 0.3 to 1.1 hr^{-1}, under continuous flow conditions. At low conversions reaction was highly selective at 450°C giving trimethylpentene-1 and trimethylpentene-2. At 500° xylenes, toluene and traces of benzene were observed. At 550° the starting material fused to 1,1,3-trimethylcyclopentane.

Timofeeva, E. A., Shuikin, N. I., Dobrynina, T. P., Plotnikov, Yu. N., and Petryaeva, G. S., DEHYDROGENATION OF HYDROCARBONS OVER ALUMINA-CHROMIA CATALYSTS CONTAINING ADDITIONS OF CERTAIN METAL OXIDES. Academy of Sciences (U. S. S. R.). Bulletin. Division of Chemical Sciences, 1960, 447-50. 0941

A study was made of the dehydrogenation of isopentane, hexane, and cyclohexane in the presence of a chromia on alumina catalyst containing additions of lithium, sodium, potassium, rubidium, cesium, zinc, and lead oxides at 500° at a space velocity of 0.5 $hour^{-1}$. Catalysts containing sodium, potassium, rubidium, and cesium oxides are almost identical in activity in the dehydrogenation of isopentane and hexane. The catalysts with the highest dehydrocyclizing power were those with additions of potassium, rubidium, and cesium oxides. Of all the catalysts investigated, the alumina-chromia-lithia and the alumina-chromia-litharge catalysts were the best from the point of view of high yields of unsaturated hydrocarbons.

Timofeeva, E. A., Smirnov, V. S. and Plotnikov, Yu. N., EFFECT OF TEMPERATURE AND SPACE VELOCITY ON THE DEHYDROGENATION OF n-HEXANE UNDER AROMATIZATION CONDITIONS. Academy of Sciences (U. S. S. R.). Bulletin. Division of Chemical Sciences, 1959, 1382-5. 0942

The effect of temperature and space velocity on the conversion of n-hexane over an aluminum-chromium-potassium catalyst was studied. It was found that the yields of hexenes depended little on changes in temperature and space velocity while the benzene yields increased with a rise in temperature and a decrease in space velocity. The experimental yield of hexenes was 73% of the equilibrium value in the best case.

Tine, G. (Universita Di Napoli), GAS SAMPLING AND CHEMICAL ANALYSIS IN COMBUSTION PROCESSES. 1961. 94 pp. (North Atlantic Treaty Organization, AGARDograph No. 47). 0943

This AGARDograph is devoted to a review of an experimental technique, "Gas Sampling and Chemical Analysis", as applied to combustion phenomena of interest in aeronautics.

Tippets, F. E., (General Electric), ANALYSIS OF THE CRITICAL HEAT-FLUX CONDITION IN HIGH-PRESSURE BOILING WATER FLOWS. American Society of Mechanical Engineers. Transactions. Series C. Journal of Heat Transfer, 86, 23-37 (1964). 0944

Based on the two-phase flow patterns shown in high-speed motion pictures of the process a general working equation is derived which relates the critical heat flux for high-pressure bulk boiling of water in forced convection to the significant local parameters and fluid properties. The equation is applied to a representative selection of several hundred data points from the major available sources for the purpose of investigating trends in the data and to test the validity of the equation. This work was sponsored by the U.S. Atomic Energy Commission under Contract AT (04-3)-189, P.A. 11.

Tippets, F. E., (General Electric), CRITICAL HEAT FLUXES AND FLOW PATTERNS IN HIGH PRESSURE BOILING WATER FLOWS. American Society of Mechanical Engineers. Transactions. Series C. Journal of Heat Transfer, 86, 12-22 (1964). 0945

High speed motion pictures were taken of boiling water flow patterns in conditions of forced flow in a vertical heated channel in the range of mass velocities of 50 to 400 pps ft^2, fluid states from bulk subcooled liquid to bulk boiling at 0.66 steam quality, and heat fluxes up to and including the critical heat flux. The pictures provide evidence on the general arrangement of flow in conditions of bulk boiling at high pressure with fluxes near the critical heat flux level. This work was sponsored by the U.S. Atomic Energy Commission under Contract AT(04-3)-189, P.A. 11.

Tippets, F.E., "CRITICAL HEAT FLUX AND FLOW PATTERN CHARACTERISTICS OF HIGH PRESSURE BOILING WATER IN FORCED CONVECTION", General Electric Co., GEAP 3766, U.S. Atomic Energy Commission, Contract AT(04-3)-189, P.A. 11, April 1962. 231 pp.

High speed motion pictures of boiling water flow patterns in conditions of forced flow at 1000 psi pressure in a vertical heated rectangular channel were taken over the range of mass velocities from 50 to 400 pps/ft^2, fluid states from 170 Btu/lb bulk enthalpy to 0.66 bulk steam quality, and heat fluxes up to and including the critical heat flux level. The motion pictures show substantial but not indisputable, evidence that the general arrangement of the flow, in conditions of bulk boiling, at heat fluxes near and including the critical heat flux level, is characteristically a wavy turbulent liquid film, in which there is vapor formation, flowing along the channel walls with the balance of the liquid being carried as either dispersed droplets or as an emulsion with the vapor in an adjacent more rapidly and steadily moving core. Eighty valid critical heat flux determinations were made. Theoretical analysis resulted in a useful working equation which related the critical heat flux to the significant local fluid properties and flow parameters. 0946

Toll, T. A., and Fischel, J. (NASA Flight Research Center), THE X-15 PROJECT: RESULTS AND NEW RESEARCH. Astronautics and Aeronautics, March 1964, 20-28.

This article concerns the implementation of X-15 flight tests, the research results, and the total value of the program. 0947

Tolstopyatova, A. A. and Balandin, A. A., CATALYTIC PROPERTIES OF CERIUM DIOXIDE IN DEHYDROGENATION AND DEHYDRATION OF ALCOHOLS AND IN CYCLOHEXANE DEHYDROGENATION. Zhurnal Fizicheskoi Khimii, 32, 1831-41 (1958). (CA, 53, 7052e).

Tests were run in a flow apparatus with CeO_2 as catalyst at 25% conversion and less. The dehydrogenation activation energy of cyclohexane over CeO_2 was 32.0 kcal./mole. 0948

Tolstopyatova, A. A., Balandin, A. A. and Yu, C., CATALYTIC PROPERTIES OF LANTHANUM OXIDE IN THE DEHYDROGENATION AND DEHYDRATION OF ALCOHOLS AND DEHYDROGENATION OF TETRALIN. Russian Journal of Physical Chemistry, 37, no. 9, 1102-6 (1963). 0949

The activation energies for the dehydrogenation of tetralin and for the dehydrogenation and dehydration of ethanol, n-propanol, isopropanol, n-butanol, and isobutanol have been determined, using lanthanum oxide catalyst. The bonding energies of C, H, and O with La_2O_3 have been determined by a kinetic method. It was shown that alkyl substituents at the α-carbon atom have an appreciable influence both on the activation energy and on the bonding energy.

Tolstopyatova, A. A., Pi-Hsiang, P., and Balandin, A. A., KINETICS OF DEHYDROGENATION AND DEHYDRATION OF ISOPROPYL ALCOHOL AND DEHYDROGENATION OF TETRALIN ON YTTERBIUM OXIDE. Academy of Sciences (U.S.S.R.). Bulletin. Division of Chemical Sciences, 1962, 1242-9. 0950

As part of a study of the catalytic properties of rare earth oxides, the dehydrogenation of tetralin and the dehydrogenation and dehydration of isopropyl alcohol were studied over ytterbium oxide. Bond energies between C, H, and O atoms and the catalyst surface were calculated by the kinetic method.

Topchiev, A. V., Mamedaliev, G. M., and Aliev, S. M., CATALYTIC TRANSFORMATIONS OF INDIVIDUAL PARAFFINS AND OLEFINS IN THE PRESENCE OF BENZENE OVER SYNTHETIC ALUMINUM SILICATES. Academy of Sciences (U. S. S. R.). Bulletin. Division of Chemical Sciences, 1959, 1879-86. 0951

The transformations of heptane, 2,2,4-trimethylpentane, hexadecane, octene, and a mixture of amylenes in presence of benzene over synthetic aluminum silicates was studied. At 500-525° and 15 atm the main reaction products were toluene, xylenes, and other alkylbenzenes of low molecular weight. Other reactions observed were destructive alkylation of benzene, isomerization, hydrocracking, and autodestructive alkylation of aliphatic hydrocarbons and their decomposition products.

Topchiev, A. V., Mamedaliev, G. M., Kislinskii, A. N., Ilatovskaya, M. A., Anikina, G. N., and Sidorenko, V. I., CONVERSION OF CYCLOPENTENE, DECALIN AND TETRALIN TO AROMATIC HYDROCARBONS IN THE PRESENCE OF ALUMINOSILICATE. Petroleum Chemistry USSR, 1, 132-43 (1962). 0952

The catalytic conversion of cyclopentene, decalin, and tetralin was studied over an aluminosilicate catalyst. At 350-360°C about 50% of cyclopentene was converted into naphthalene and alkylbenzenes through the successive stages of its transformation into the dimer and then into decalin and octalin. A reaction mechanism is proposed.

Topchiev, A. V., Polak, L. S., Chernyak, N. Ya., Glushnev, V. E., Vereshchinskii, I. V. and Glazunov, P. Ya., ON THE RADIOLYSIS OF HYDROCARBONS AT ELEVATED TEMPERATURES. Academy of Sciences (U. S. S. R.). Proceedings. Chemistry Section, 130, 145-7 (1960). 0953

Liquid heptane in sealed glass spheres was radiated with 900 k-ev electrons at various temperatures (about 2 x 10^{19} ev per second per ml of heptane). At 400°C it appeared that the overall yield of low molecular weight hydrocarbons was about 2000 molecules per 100 ev radiation, of which 62% were unsaturated. Reaction products were H_2, CH_4 and C_2-C_5 hydrocarbons.

Topchieva, K. V., Romanovskii, B. V., and Tchoang, H., THE KINETICS OF CUMENE CRACKING ON 10X ZEOLITE. Academy of Sciences (U. S. S. R.) Proceedings. Physical Chemistry Section, 149, 271-3 (1963). 0954

The course of cumene cracking on a crystalline aluminosilicate, zeolite 10X was shown to be the same as on amorphous aluminosilicate catalysts. Study of the reaction kinetics established that there are several differences in the kinetics and in the adsorption mechanism of the process.

0955 Topper, L. (Johns Hopkins University), RADIANT HEAT TRANSFER FROM FLAMES IN A TURBOJET COMBUSTOR. Industrial and Engineering Chemistry, 46, no. 10, 2551-8. (1954).

The paper gives results of an experimental study of radiation in a single tubular jet combustor operated with MIL-F-5624 (grade JP-4) fuel. Observations were made of black body temperature and red brightness temperature through quartz windows. The effects of air flow rate, fuel-air ratio, pressure and added carbon particles in fuel (as a source of luminosity) were studied. Radiant intensity varied with smoke density of exhaust. Little contribution by radiation from CO_2, or water, was indicated. The rate of radiant heat transfer to the liner in the primary zone was as large as corresponding to a convective coefficient of 50 Btu/hr-ft^2-°F.

0956 Totten, J.K., THE CALENDAR YEAR 1963 RAMJET TECHNOLOGY PROGRAM, VOLUME 5. NEW AND NOVEL ENGINE CONCEPTS. Marquardt Corporation, Final Summary Technical Report, Report No. 25116, vol. 5, U.S. Air Force Contract AF 33(657)-12145, June 1964. 169 pp. (AD 351 398). REPORT CLASSIFIED CONFIDENTIAL.

No abstract.

0957 Tower L. K., ANALYTICAL EVALUATION OF EFFECT OF INLET-AIR TEMPERATURE AND COMBUSTION PRESSURE ON COMBUSTION PERFORMANCE OF BORON SLURRIES AND BLENDS OF PENTABORANE IN 1-OCTENE. U. S. National Advisory Committee for Aeronautics, RM E55A31, 1955. (CA, 55, abstr. 23987b).

The theoretical ramjet combustion performance of boron and pentaborane blends with 1-octene in all concentrations was calculated for a range of inlet-air temperatures of 100-900°F at combustion pressures of 0.2 and (or) 2 atmospheres. The air-specific-impulse and theoretical combustion data show that increasing pentaborane or boron concentration increases thrust performance. Methods are given for applying the data to other inlet conditions and for determining both fuel consumption at a given level of air-specific-impulse and combustion efficiency for experimental combustors. In a subsequent report (SUPPLEMENT 1. INFLUENCE OF NEW BORIC OXIDE VAPOR-PRESSURE DATA ON CALCULATED PERFORMANCE OF PENTABORANE. U. S. NACA, RM E56D02, 1956. 11 pp.) new data on B_2O_3 vapor-pressure are used to recalculate the data reported above. The new vapor-pressure data are markedly lower and indicate that lower pentaborane fuel consumption relative to 1-octene can be attained. A simplified method for obtaining approximate combustion temperatures and thrust performance is given.

0958 Tower, L. K., Breitwieser, R. and Gammon, B. E., THEORETICAL COMBUSTION PERFORMANCE OF SEVERAL HIGH-ENERGY FUELS FOR RAMJET ENGINES. U. S. National Advisory Committee for Aeronautics, Report 1362, 1958. 18 pp.

An analytical investigation of the theoretical ramjet performance of magnesium, magnesium-octene-1 slurries, aluminum, aluminum-octene-1 slurries, boron, boron-octene-1 slurries, carbon, hydrogen, α-methylnaphthalene, diborane, pentaborane, and octene-1 is presented herein. Combustion temperature, air specific impulse, and fuel specific impulse data are presented for each fuel over a range of equivalence ratios at an air inlet temperature of 560°R and a combustion pressure of 2 atmospheres. The effects of inlet air temperature and combustion pressure are investigated for some of the fuels.

0959 Townend, L. H. (Royal Aircraft Establishment), EFFECTS OF EXTERNAL HEAT ADDITION ON SUPERSONIC CRUISE PERFORMANCE. Aeronautical Quarterly, 13, 203-11, (August 1962).

Heat addition in the external flow around a supersonic aircraft may produce a field of increased pressure and thereby a propulsive and a lifting force. Less specifically, such effects could be produced by alternative processes involving the gradual expenditure of energy stored in an aircraft, and, according to the process, could be available at hyper- super-, or subsonic speeds. A generalised study is made of associated effects on cruising range. Results are presented as performance "frameworks," within which future experimental or analytic data should define regions of feasibility for particular systems.

0960 Trushin, Yu. M., INVESTIGATION OF COMBUSTION IN FLOW AT HIGH INITIAL TEMPERATURES. 3-e Vsesoyuzni Soveshchanik po Teorii Goreniya, Moscow, 1, 79-85 (1960). (AMR, 16, 743, abstr. 5449, 1963).

The induction period of a kerosene-air mixture is measured by the time of stay in a cylindrical chamber from the injection place to a section of the chamber. It is shown that: (1) heat evolution is absent at the induction period, (2) the fuel concentration does not affect the induction period, (3) the time for which the air-fuel mixture burns under these conditions basically approximates the time of the induction period, (4) the results are covered by the known formula.

Tschinkel, J. G., PHYSICO-CHEMICAL PROPERTIES OF KEROSENE. U.S. Army, Ballistic Missile Agency, C & F Memo 46, February 1956. 15 pp. (AD 123954). 0961

General and military specifications for JP-1 and JP-5 kerosenes are given, as well as data collected from various sources on the following properties: specific gravity, compressibility and thermal expansion, viscosity, thermal conductivity, specific heat, heat of vaporization, vapor pressure, heat of combustion, and critical properties.

Turner, R. B. (Dept. of Chem., Rice Univ.), HEAT OF HYDROGENATION OF BICYCLO(2.2.2)-OCTA-2,5,7-TRIENE. American Chemical Society, Journal 86, 3586-7 (Sept. 5, 1964). 0962

The compound ("barrelene") was hydrogenated and the heat of hydrogenation measured at -93.78 ± 0.31 Kcal/mol. With the known heat of hydrogenation of bicyclo(2.2.2)octa-2,5-diene at -56.21 ± 0.10 Kcal/mol, the heat of hydrogenation of the additional bond is calculated 37.6 Kcal/mol, the highest known value for an ethylenic linkage.

Tyler, S. R. and Turner, H. G. (Dowty Fuel Systems Limited), FUEL SYSTEMS AND HIGH SPEED FLIGHT. Shell Aviation News, no. 233, 14-8, (1957). 0963

Fuel systems, pressure and temperature characteristics; effect of reheat shut-down on fuel temperature; typical performance characteristic of a Dowty spill burner; effects of fuel temperature on gas turbine control systems and on specific gravity of turbine fuels; relationships between specific gravity and fuel calorific content; supersonic engine requirements and fuel system performance with fuels at various temperatures; and effect of pump arrangement on temperature rise are discussed.

Tyuryaev, I. Ya., Mukhina, T. N., Pavlova, V. B., and Kolyaskina, G. M., THE SPEED OF REACTION OF THE DEHYDROGENATION OF PROPANE ON A FIXED-BED CATALYST. Zhurnal Fizicheskoi Khimii, 31, 1676-86 (1957). (CA, 52, 6772f). 0964

The kinetics of the reaction $C_3H_8 \rightleftarrows C_3H_6 + H_2$ and the side reactions that form CH_4, C_2H_4, C_2H_6, and free C, were studied. Equations were proposed for the velocities of the dehydrogenation of propane, the velocity of cracking and the speed of deposition of C on the catalyst.

Uchiyama, M., Tomioka, T. and Amano, A. (Tohoku University), THERMAL DECOMPOSITION OF CYCLOHEXENE. Journal of Physical Chemistry, 68, no. 7, 1878-81 (1964). 0965

Thermal decomposition of cyclohexene was studied in a flow system at a pressure of 25 mm., temperatures ranging from 814 to 902°K., and contact times ranging from 0.57 to 5.4 sec. The main reaction is a simple unimolecular splitting to form ethylene and butadiene with selectivity of no less than 96%. From the temperature dependence of the first-order rate constants, values of the A-factor and activation energy are assigned to be 1.5×10^{15} $sec.^{-1}$ and 66 kcal./mole, respectively. These values are consistent with those of the reverse reaction and also with the assumption of a six-membered cyclic activated complex. It is further suggested by calculation that the secondary dimerization of butadiene is not a serious cause of a small stoichiometric deficiency of butadiene as compared with the amount of ethylene.

Universal Oil Products Company, FINAL REPORT. U.S. Navy, Bureau of Aeronautics Contract NOas 52-225-C, 1 November 1954. 4 pp. 0966

This contract covered evaluation of the effects of high gum content fuels in the operation of jet engine fuel systems. A full-scale jet-engine fuel system test apparatus consisted essentially of a fuel nozzle ring from a J-34-WE-34 engine, a Holley fuel control coupled to a 300 hp dynamometer, an aircraft fuel booster pump mounted in the sump of the nozzle-spray tank, a fuel heat exchanger, a primary fuel filter, fuel flow meters, backpressure valve, dump valve and a vacuum and pressure system for supplying varying pressures to the control capsule for simulating altitude and speed conditions. Data obtained in the first two runs indicated that a fuel with high soluble gum content had no effect on the satisfactory operation of a full-scale jet-engine fuel system when operated for periods up to 190 hours at room temperature on a continuous schedule of alternate two-hour periods of sea level and 30,000 ft. altitude. Later work on the high-temperature stability of jet fuels in the presence of air and metallic materials indicated the importance of the high-temperature stability problem.

U. S. Air Force, Aerospace Technology Division, NEW COMBUSTION PROCESSES. ATD P64 49; TT 64-71230, August <u>1964</u>. 52 pp. (AD 604 176). 0967

A report on surveys of Soviet-bloc scientific and technical literature. The purpose of the report is to present material related to unconventional combustion processes which might be used in the development of hypersonic ramjet and supersonic combustion processes. A literature search revealed one article directly related to shock-induced combustion and several articles on a new detonative combustion process. Other sections deal with subjects indirectly related to shock-induced combustion, such as reaction kinetics, ignition delays, and some shock and detonation wave characteristics. A general survey and discussion of studies in the field of detonation research and related subjects is given. High-velocity diffusional combustion is not covered.

U.S. Air Force, Nuclear Aircraft Research Facility, FIRST SEMI-ANNUAL 125A RADIATION EFFECTS SYMPOSIUM. 22-23 May <u>1957</u>. ANP. Doc. No. NARF-57-19T FZK-9-118, 4 volumes. 0968

These reprinted papers contain several papers devoted to radiation effects on aircraft lubricants, fuels and hydraulic fluids, in addition to one paper on the radiation effects on aircraft turbojet engines.

U.S. Defense Documentation Center, THE B-70 AIRCRAFT. AD 237 124. REPORT CLASSIFIED SECRET. 0969

A compilation of abstracts relating to the B-70 aircraft.

U.S. Department of Defense, COMMERCIAL SUPERSONIC TRANSPORT AIRCRAFT REPORT, June 1961. 48 pp. (AD 266750). 0970

This publication contains a brief letter report with attached Annex (two appendices) describing configuration, performance, technical problem areas, projected design features and projected program and financing of the commercial SST.

U.S. Federal Aviation Agency, "SUPERSONIC TRANSPORT". June 19, 1963. 62 pp. 0971

This report describes the program for the development of a commercial supersonic transport aircraft. No mention is made of aircraft cooling requirements although projected airframe temperatures at various speeds are given. With respect to environmental influences, mention is made of high ozone concentrations to be expected at high altitude and of radiation from solar disturbances.

U.S. Federal Aviation Agency, "SUPERSONIC TRANSPORTS, A PRELIMINARY STUDY OF STANDARDS FOR AIRWORTHINESS, OPERATIONS AND MAINTENANCE", a report of the Supersonic Transport Group, Bureau of Flight Standards, March 1961. 121 pp. 0972

This report is the first Bureau of Flight Standards report on supersonic transports. It presents results of a study to determine areas in which further research and development should be accomplished. Significant recommendations include: 1) continued study of sonic boom problems; 2) continued work by NASA and other groups on economically feasible airframe configurations; 3) expanded work on propulsion cycles; and 4) continued work by FAA to develop adequate flight standards.

U. S. Library of Congress, Air Information Division, THERMAL STABILITY OF JET FUELS. AID Report 61-107. July 1961. 4 pp. (AD 261 448). 0973

This translation of a Russian article covers a study of the effect of mercaptans on the formation of insoluble sediment in jet fuels at elevated temperatures. The study was conducted in three experimental series. Series 1 involved the testing of TC-1 fuels to determine the temperature of maximum sediment formation. Series 2 delat with the effects of mercaptans and catalytic metals on sediment formation at 150 C. Series 3 extended the experiments of series 2 to the 100-300 C range. Sediment formation increased with increasing mercaptan content, and the temperature of maximum sediment formation was 150 C.

U.S. National Advisory Committee for Aeronautics, NACA CONFERENCE ON HIGH-SPEED AERODYNAMICS. A Compilation of the Papers Presented at the Ames Aeronautical Laboratory, March 18-20, 1958. (AD 310591). REPORT CLASSIFIED CONFIDENTIAL. 0974

This document contains reproductions of technical papers presented by staff members of the NACA Laboratories at the NACA Conference on High-Speed Aerodynamics held at the Ames Aeronautical Laboratory of the NACA, March 18, 19, and 20, 1958. The primary purpose of the conference was to convey to the military services and their contractors the results of recent research and to provide those attending with an opportunity to discuss the results. The papers in this document were prepared for presentation at the conference and are considered to be complementary to, rather than substitutes for, the Committee's more complete and formal reports.

U. S. National Aeronautics and Space Administration, Staff of the Langley Research Center, THE SUPERSONIC TRANSPORT--A TECHNICAL SUMMARY. U. S. National Aeronautics and Space Administration, TN D-423, June 1960. 94 pp. 0975

Discussions are included of various problem areas in supersonic transport design. Problems discussed included performance, noise, materials, structures, loads, flying qualities, landings, airway traffic control, and use and effects of variable geometry.

U.S. Naval Ordnance Testing Station, BIBLIOGRAPHY OF NOTS TECHNICAL PUBLICATIONS - 1959 SUPPLEMENT (U). NAVORD Report 5034. 1959 Supplement. NOTS TP 2376. January 1960. (AD317020). REPORT CLASSIFIED CONFIDENTIAL. 0976

The 1959 Supplement to the Bibliography of NOTS Technical Publications, a companion volume to the Technical Program Review 1959 (NOTS TP 2374, in press), lists the official technical publications of the U.S. Naval Ordnance Test Station placed in distribution during the year. Whenever available, the abstract cards distributed with the publications have been reproduced in the serial listings.

U.S. Office of Technical Services, HEAT TRANSFER AND HEAT EXCHANGERS. OTS Selective Bibliography 450. n.d. 33 pp. 0977

The reports list in this partially annotated bibliography were added to the OTS collection during the period 1950 to January 1961. The bibliography is subdivided into sections covering Heat Transfer, Translations on Heat Transfer, Heat Exchangers, Translations on Heat Exchangers, and AEC Reports on Heat Transfer and Heat Exchangers. There is broad subject coverage within each section.

Usov, Yu. N. and Kuvshinova, N. I., AN INVESTIGATION INTO THE CONVERSION OF 2, 2, 4-TRIMETHYPENTANE AND n-OCTANE ON A PLATINUM CATALYST. Kinetics and Catalysis (U.S.S.R.), 3, 814-19 (1962). 0978

The dehydrocyclization of 2, 2, 4-Trimethylpentane and n-octane was studied over an industrial platinum catalyst. For systems not containing a completed chain of six carbon atoms, the presence of a strongly branched hydrocarbon structure considerably facilitates hydrocarbon decomposition, and the formation of gaseous and aromatic products that have fewer carbon atoms in the molecule than the original hydrocarbon.

Usov, Yu. N., Kuvshinova, N. I. and Ivanova, S. M., **AROMATIZATION OF BINARY ALKANE-CYCLANE MIXTURES ON A PLATINUM CATALYST.** Neftekhimiya, 2, no. 5, 666-9 (1962). (CA, 59, 7394 h). 0979

The influence of the alkane-cyclane content on the aromatization of hydrocarbon fractions with an industrial platinum catalyst was studied. Hexane-cyclohexane, heptane-methylcyclohexane, and octane-dimethylcyclohexane mixtures as well as the individual alkanes and cyclanes were aromatized. The amounts of aromatic hydrocarbon in the product increased proportionally with the cyclane content in the mixture. The molecular weight or structure of the initial hydrocarbons had little effect on the aromatization. The amount of alkenes formed in the process was proportional to the alkane content in the initial mixture.

Usov, Yu. N. and Mettsel, N. G., **TRANSFORMATIONS OF HYDROCARBONS IN THE PRESENCE OF OXIDE CATALYSTS. VIII. TRANSFORMATION OF n-HEXADECANE OVER A MOLYBDIC CATALYST.** Journal of General Chemistry (U. S. S. R.), 27, 1826-9 (1957). 0980

n-Hexadecane was converted to numerous alkyl benzenes using a molybdena catalyst at 530°C. A mechanism is proposed that gives the observed reaction products.

Usov, Yu. N. and Skvortsova, E. V., **AROMATIZATION OF n-HEPTANE AND n-OCTANE ON A MOLYBDENUM CATALYST.** Uchenye Zapiski Saratovskogo Gosudarstvennogo Universiteta Imeni N. G. Chernyshevskogo 71, 167-74 (1959). (C. A., 56, 5856d, 1962). 0981

A study was made of the aromatization over Mo of n-octane at 460-530° and of n-heptane at 500-50°. Tables were given showing effects of changes in contact time. It was established that dehydrogenation to olefins occurred simultaneously with dehydrocyclization and coke formation, the latter two being the main reactions. An apparent energy of activation for the aromatization reaction was determined.

Usov, Yu. N., Skvortsova, E. V. and Klyushnikova, G. G., DEHYDROGENATION OF METHYLCYCLOHEXANE ON ALUMINA-CHROMIA AND ALUMINA-MOLYBDIA CATALYSTS. Neftekhimiya, 3, no. 3, 320-5 (1963). (CA, 59, 8557 b). 0982

Methylcyclohexane was passed over the catalysts (12.5% Cr_2O_3 or 9.3% MoO_3 on Al_2O_3) at 410-500° with a space velocity of flow 0.25-2. At 490°, 76% of aromatic hydrocarbons, principally toluene, was obtained with chromia and 62% with molybdia catalyst. The kinetics of the dehydrogenation were studied. 21 references.

Usov, Yu. N., Skvortsova, E. V., Kuvshinova, N. I., and Elovatskaya, L. A., PYROLYSIS OF PROPANE AND n-BUTANE IN PRESENCE OF ADDED ORGANIC SUBSTANCES. Journal of Applied Chemistry (U.S.S.R.), 34, 908-11 (1961). 0983

Propane and n-butane were pyrolysed at 700-800°C in the presence of organic additives. Chloroform and dichloroethane enhanced the rate of pyrolysis of propane; ethylene oxide, dichloroethane and ethyl chloride accelerated the pyrolysis of n-butane. With organic additives the yield of olefins was greater than when no additive was used.

Valenti, A. M., Molder, S., and Salter, G. R. (McGill University), GUN-LAUNCHING SUPERSONIC-COMBUSTION RAMJETS. Astronautics and Aerospace Engineering, 1, Dec., 24-29 (1963). 0984

The article presents the results of a preliminary study of the feasibility of using a launching gun (such as that at the McGill Univ. High Altitude Research Project at Barbados) to give supersonic combustion ramjets an initial launch velocity at Mach 5. This means is considered for launching test vehicles for flight condition tests since such tests tax the capabilities of wind tunnel and impulse-type facilities. It is concluded that the method is feasible for short duration test, the principle drawback being the low altitude at which high Mach numbers are attained.

Van Dolah, R. W., Zabetakis, M. G., Burgess, D. S., and Scott, G. S., REVIEW OF FIRE AND EXPLOSION HAZARDS OF FLIGHT VEHICLE COMBUSTIBLES. U. S. Bureau of Mines, IC 8137, 1963. 80 pp. 0988

This circular is a compilation of the available data on flammability and related characteristics for a series of combustibles and oxidants of current interest. Vapor pressure data are presented for fluorine, oxygen, chlorine trifluoride, nitrogen tetroxide, nitric acid, hydrogen peroxide, ethylene oxide, hydrogen, ammonia, pentaborane, unsymmetrical dimethylhydrazine, monomethylhydrazine, hydrazine, and a series of hydrocarbons including decalin, tetralin, bicyclohexyl and other high-density fuels. In addition, flammability characteristics diagrams are included for each of the fuels in contact with air and, where available, other oxidants (for example, oxygen and nitrogen tetroxide). To assist in understanding these data, sections on definitions and theory and applications have been included. Each section is complete in itself and can be used separately.

van Driest, E. R. (North American Aviation), THE PROBLEM OF AERODYNAMIC HEATING. Aeronautical Engineering Review, 15, no. 10, 26-41 (1956). 0989

The origin and some of the consequences of aerodynamic heating are discussed, with emphasis on calculation of the rate of transfer of heat from the air into the surface of a high-speed vehicle and on boundary-layer control by surface cooling.

Van Dyke, J. D., Jr. (Douglas Aircraft), AN INVESTIGATION OF STRUCTURAL CONCEPTS FOR MACH 3-PLUS SUPERSONIC TRANSPORT WING. Society of Automotive Engineers, SAE Paper 751A, September 1963. 15 pp. See also SAE Journal, 72, no. 11, pp 86-8. 0990

The design, fabrication and testing of elemental specimens representing several approaches for structure of a Mach 3 class vehicle have been completed. The static and fatigue strengths obtained were promising for all arrangements except for the resistance welded titanium corrugated core sandwich construction. Fabrication problems were somewhat less severe than originally anticipated. Fabrication of the welded titanium integral skin and stringer panels appears to be practical for quantity production at a cost substantially lower than brazed steel honeycomb panels. The fuel characteristics are very important in formulating the structural requirements relative to thermal protection of the fuel and necessary access for cleaning the interior of the tanks. Bulk fuel temperature does not appear to be a severe problem, but local hot spots and trapped fuel do present problems since deposit formation by kerosene-type fuels becomes more severe as surface temperatures exceed the auto-ignition temperature. Elastomer sealants for fuel tanks are not currently adequate for temperatures exceeding 400-450°F. Based on these conditions it appears that a design cruise Mach number of 2.7 is practical with available sealants and fuels.

van der Linden, A. C., Heringa, J. W. and Thijsse, G. J. E. (Shell Research N. V), TRANSFORMATION OF ALIPHATIC HYDROCARBONS BY PSEUDOMONAS. Paper presented at the Second International Congress on Fermentation, London, April 13-17, 1964. 0985

The microbial oxidation of several paraffinic and olefinic hydrocarbons by pseudomonas has been studied. The degradation routes have been determined by analysis for intermediates and through the use of inhibitors of adaptations such as Chloramphenical. The methods which were used to accumulate intermediates are emphasized.

van der Linden, A. C. and Thijsse, G. J. E., (Koninklijke/Shell - Laboratorium, Amsterdam), THE MECHANISMS OF MICROBIAL OXIDATION OF PETROLEUM HYDROCARBONS. in: "Advances in Enzymology", New York, Interscience, volume to be published. 0986

This paper presents an extensive review of petroleum microbiology. Nearly 300 references are cited.

Van Dolah, R. W., Zabetakis, M. G., Burgess, D. S., and Scott, G. S. (U.S. Bureau of Mines), REVIEW OF FIRE AND EXPLOSION HAZARDS OF FLIGHT VEHICLE COMBUSTIBLES. U.S. Air Force,ASD TR 61-278, Contract DO 33(616)-60-8, April 1961. 105 pp. (AD 262989). 0987

Vapor pressure data are presented for fluorine, oxygen, chlorine trifluoride, nitrogen tetroxide, nitric acid, hydrogen peroxide, ethylene oxide, hydrogen, ammonia, pentaborane, unsymmetrical dimethylhydrazine, monomethylhydrazine, hydrazine and a series of hydrocarbons including decalin, tetralin, bicyclohexyl and other high density fuels. In addition, flammability characteristics diagrams are included for each of these fuels in contact with air and where available, for other oxidants (e.g., oxygen and nitrogen tetroxide). Also included are sections on definitions and theory and applications. Each section is complete in itself and can be used separately. Many references are included.

Van Hook, W. A. and Emmett, P. H. (Johns Hopkins University), CATALYTIC CRACKING OF HEXADECANE. II. THE NATURE OF CARBONIUM ION-FORMING STEPS AND THE EXCHANGE OF HYDROCARBONS WITH RADIOACTIVE COKE. American Chemical Society. Journal, 84, 4421-7 (1962). 0991

The ratios of the number of moles of propylene to the number of moles of propane produced and of the radioactivity of the propylene to the radioactivity of the propane were examined as a function of time in differential and integral reactors during cracking of n-hexadecane over a silica-alumina catalyst in the presence of radioactive propylene as a tracer. The rate of coking of the catalyst with n-hexadecane and the rate of exchange of carbon between the coke and several hydrocarbons were measured at 372°. The coking rate observations are in general agreement with those previously published. The rate of exchange of carbon from coke with either isoöctane or cetane was very low.

Van Hook, W. A. and Emmett, P. H. (Johns Hopkins University), CATALYTIC CRACKING OF HYDROCARBONS. III. PRODUCT DISTRIBUTION OBTAINED IN CRACKING CETANE OVER A SILICA ALUMINA CATALYST AT 372°. American Chemical Society. Journal, 85, 697-702 (1963). 0992

The carbonium ion theory of Greensfelder, Voge and Good is applied with a few modifications to the catalytic cracking of hexadecane at 372°. Temperature is introduced into the calculation by use of the Boltzmann distribution and the estimated energies of formation of gaseous carbonium ions. Tracer results are employed to estimate the fraction of the initial olefin products undergoing further decomposition, alkylation and polymerization. Product distributions as a function of carbon number are calculated at 372 and 500°.

Van Hook, W. A. and Emmett, P. H. (Johns Hopkins University), TRACER STUDIES WITH CARBON-14. I. SOME OF THE SECONDARY REACTIONS OCCURRING DURING THE CATALYTIC CRACKING OF n-HEXADECANE OVER A SILICA-ALUMINA CATALYST. American Chemical Society. Journal, 84, 4410-21 (1962). 0993

Some secondary reactions in the n-hexadecane-aluminosilicate system at 372° have been examined in an integral reactor with carbon-14 tracers in the presence of an inert helium diluent. The reactions of the primary products propylene, propane, n-butane, 1-heptene and n-heptane were traced and their importance in determining the final product distribution assessed. Product and radioactivity analyses were made through carbon number twelve with the use of gas chromatography and static (carbon dioxide) counting, respectively. The results may be briefly summarized by pointing out that the tracer olefins, propylene and heptene, undergo as secondary reactions very extensive alkylation, isomerization, polymerization and cracking during the cracking of the hexadecane. Propylene seems to play an important part in the formation of aromatics and also in the formation of the higher saturated C_8- to C_{12}-hydrocarbons. On the other hand, the saturated tracer hydrocarbons propane, n-butane and n-heptane are relatively inactive during the hexadecane cracking runs and come through the reactor almost unchanged.

van Reijan, L. L., Sachtler, W. M. H., Cossee, P., and Brouwer, D. M., THE ACTIVE SITES ON CHROMIA/ALUMINA DEHYDROGENATION CATALYSTS. International Congress on Catalysis, 3d, Amsterdam, 1964. Preprints, Section I, Preprint 52. 12 pp. 0994

The active sites on shromia/alumina dehydrogenation catalysts, were studied by measurements of catalyst magnetic susceptibility, electron spin resonance, carbon monoxide and hydrogen chemisorption, and weight changes during the reduction treatment, as well as of the rate of dehydrogenation of cyclohexane, on chromia, chromia-alumina, and chromia-silica catalysts. The surface chromium ions may be either Cr^{2+} or Cr^{3+}, depending on equilibrium conditions. The system becomes an active catalyst under those conditions which favor the presence of the Cr^{2+} ion, which is apparently superior to the Cr^{3+} ion with respect to incomplete coordination of the surface metal ions and the formation of metal-carbon bonds of sufficient stability. Both of these factors may be important in dehydrogenations catalyzed by transition-metal ions at oxide surfaces. Dissociative chemisorption of the hydrocarbon, with the formation of a metal-carbon and a surface hydroxyl bond, is apparently the rate-determining step

Van Sickle, D. E. and Mavo. F. R. (Stanford Research Institute), American Chemical Society, Abstracts of Papers, 145th Meeting, September 1963, p. 26Q. 0995

The rates and products from the low-temperature, 2,2'-azobis(2-methylpropionitrile)-initiated, liquid-phase oxidation of cyclopentene, cyclohexene, and cyclooctene were compared, and the products were accounted for in terms of a competition between an addition and an abstraction reaction for a peroxy radical with an olefin molecule. As the olefin ring size increased, the over-all oxygen consumption rate decreased, and the fraction of oxygen appearing in products ascribed to the addition mechanism increased. Thus, in cyclopentene, the monomeric hydroperoxide predominated (86%), and only 7% of the peroxy radicals added to the double bond. With cyclooctene, only 30% of the oxygen appeared as hydroperoxide groups (both on monomeric hydroperoxide and on "dimer" and "trimer" peroxides). The mechanism for cyclohexene oxidation is intermediate in character. The results are tentatively correlated by assuming that the rates for termination and propagation by addition are nearly the same throughout the series, but that propagation by hydrogen abstraction is sensitive to olefin structure.

Van Stralen, S.J.D., HEAT TRANSFER TO BOILING BINARY LIQUID MIXTURES. PART III. British Chemical Engineering, 6, no. 12, 834-40 (1961). 0996

The existence of a critical temperature of the heating surface limits the region of nucleate boiling, which follows from a number of experimental data, and can also be deduced theoretically; the onset of film boiling can also be predicted by a criterion based on the vaporization of a molar fraction G in the neighbourhood of the heating surface, at a maximum superheat θ_{max}. A generalized equation is derived for determination of boiling curves. It is deduced that the regions of convection and nucleate boiling of a boiling curve can be calculated from three only heat flux values, and from the nucleation function. In this way the effect on heat transfer is shown of the number of active nuclei generating vapour bubbles on unit area of heating surface. The generalized equation is applied to water boiling at atmospheric pressure. It is shown for boiling liquids that the favourable effect of vapour bubbles on heat transfer is caused by their periodic disturbance of the liquid boundary layer at the heating surface, and not by their direct transport of energy from the heating surface to the liquid-level surface.

Van Stralen, S.J.D., HEAT TRANSFER TO BOILING BINARY LIQUID MIXTURES. PART IV. British Chemical Engineering, 7, no. 2, 90-7 (1962). 0997

A survey of conditions affecting the convection and nucleate boiling regions of a "boiling curve". The effects of sub-cooling and pressure, along with the behaviour of the peak flux in nucleate boiling, are discussed. The peak flux in surface boiling has been determined for water and - at pressures above 50 atm - for the binary systems: water-ethanol, water-1-propanol, water-1-butanol, water-1-pentanol and water-methylethylketone. The absolute values and the ratio of the maximum peak flux occurring in mixtures to the peak flux in water at the same pressure and at equal sub-cooling are shown to decrease gradually with increasing pressure. The peak flux for a 20 per cent w/w mixture of 1-propanol exceeds the corresponding value for water with 35 per cent in the range from 50-125 atm. The possible practical utilization of liquid mixtures as cooling media in heterogeneous nuclear power reactors is also discussed.

van Wijk, W. R., WÄRMEÜBERTRAGUNG AN SIEDENDEN ZWEISTOFFGEMISCHEN. Dechema Monograph, 28, 63-74 (1956). (C. A., 51, abstr. 12569h, 1957). 0998

The maximum value of the heat transfer within the range of evaporation of binary mixtures was determined as a function of concentration. There was found to be a maximum for a definite composition in each binary mixture which is explained from the difference in volatility of the constituents in the mixture. Theoretical conclusions give the relative value of the maximum heat current for different numbers of a homologous series, e.g., aliphatic alcohols in solutions containing water as a second constituent. Using a mixture of 1-pentanol/water, a maximum heat current was measured which produced a value of more than three times that of pure water. The maximum heat current was also exceeded with several other mixtures.

van Wijk, W. R. and van Stralen, S. J. D., HEAT TRANSFER TO BINARY LIQUID MIXTURES BOILING UNDER PRESSURES FROM 0.1 to 50 ATMOSPHERES. Dechema Monographien, 32, 94-106 (1959). (CA, 54, 11h). 0999

The maximum heat flux for nucleate boiling is highest at minimum bubble size. This occurs at $\Delta\tau = \delta - \Delta T = 0$; δ is superheat of the liquid above the boiling point (T) of the liquid. ΔT is the difference between the dew point of the vapor bubbles and T, and $\Delta\tau$ is the superheat of the liquid with reference to the dew point. A graphical method on the equilibrium diagram, based on assuming that δ is constant for each system and pressure, and that ΔT varies only with concentration at small fractions vaporized at the heating surface, correctly predicts the concentration of the more volatile liquid in the mixture for highest maximum flux. Data are plotted for systems of water with: ethanol, 1-pentanol, 1-butanol, 1-propanol, acetone, methylethylketone, and ammonia at several pressures.

1000

Vanpée, M. and Bruszak, A. E., THE IGNITION OF COMBUSTIBLE MIXTURES BY LAMINAR JETS OF HOT GASES. U.S. Bureau of Mines, RI 6293, 1963, 84 pp.

This study by the Bureau of Mines is concerned with ignition produced by a continuous jet of gas (hot) flowing into a practically quiescent cold mixture. The two streams ideally come into contact at a given point. Beyond this point a mixing process sets in because of shear, molecular diffusion and heat transfer. Combustion starts in the mixing zone where combustible material has been brought to a high temperature, and if the reaction obeys the Arrhenius law, ignition will always occur at some distance downstream of the initial mixing point. However, this distance varies exponentially with the temperature of the hot gas, and if the temperature is too low, the ignition distance becomes so large that ignition does not occur within the dimensions of the actual apparatus. In the experimental work, the first phase consisted of taking ignition temperatures under variable conditions of jet diameter, flow velocities, contact times, ambient pressures and compositions. The second phase involved a detailed analysis of the ignition process. This work was sponsored in part by the Department of the Navy under Contract Nonr 1858(25) NR-098-038.

1001

Vanpee, M., Bruszak, A. E. and Wolfhard, H. G. (U. S. Bureau of Mines), THE PROCESS OF IGNITION BY HOT GASES. Project SQUID, Technical Report BUM-29-P, U. S. Navy Contract Nonr 1858(25), NR-098-038, March 1960. 24 pp.

It is the development of this combustion process initiated by contact of the two streams that the present paper studies experimentally, based on temperature, concentration and velocity profiles taken in the mixing zone prior to ignition. A previously developed two-dimensional model, solved for the plane case, that is to say, for two parallel streams of infinite dimensions, was used to examine results for jets of axial symmetry. However, if the jet diameter is not too small, the analogy between the two cases is close enough to permit some conclusions from the comparison of existing theories with the experimental data presented here.

1002

Vanpee, M. and Wolfhard, H. G. (U. S. Bureau of Mines), IGNITION BY HOT GASES. Project SQUID, Technical Report BUM-30-R, U. S. Navy Contract Nonr 1858(25), NR-098-038, August 1960. 12 pp. (PB 156824).

Experimental studies were made of ignition temperatures for hot jets of air into pure fuel or hot jets of inert gas into fuel-air mixtures. A discussion of the processes determining ignition is included. Experimental results are compared with those of other investigations.

1003

Vasiliu, J., **TURBULENT MIXING OF A ROCKET EXHAUST JET WITH A SUPERSONIC STREAM INCLUDING CHEMICAL REACTIONS.** Journal of the Aeronautical Sciences, 29, 19-28, (1962).

The equations for the turbulent mixing of a two-dimensional supersonic jet issuing into an ambient supersonic stream are formulated. Both streams consist of a mixture of chemically active and possibly reacting gases, therefore any heat release by chemical reaction is included; the net mass of production of species is obtained on the assumption that the reaction rate constant is given by an expression reducible to the classical Arrhenius law. A method of obtaining initial and boundary conditions from available inviscid jet flow solutions is discussed. The equations are programmed for calculation on an IBM-704 computer. Finally, one typical case is considered, and plots of velocity, temperature, and concentration profiles are given for the initial stages of development of the mixing layer.

1004

Viktorin, J., **HEAT TRANSFER IN BOILING LIQUIDS.** Chemicky Prumysl, 12, 413-18 (1962). (C. A., 58, abstr. 4183f, 1963).

The temperature difference between the boiling liquid and the electric heated surface of a stainless steel tube, or of a dull Ni-plated, or Cu-plated, or heavily-oxidized tube surface (by annealing in the air), respectively, was measured with a differential Cu-Constantan thermocouple. When a glass tube was used, the tube was filled with a silicone oil and internally heated with a heating element of Constantan wire. The liquids used were water, CCl_4, Freon 112, Freon 13, heptane, and benzene. The heat flux was gradually increased up to $q \cong 10^6$ kcal./sq. m. hr. and again gradually lowered. Measured values of the heat transfer coefficient $\alpha = q/\Delta t$, approach the values for a stainless steel surface calculated from the correlation of Bonilla and Perry and, with the exception of water, from the correlation of Kruzhilin.

1005

Virasoro, E. and Capeletti, R., **DEHIDROGENACION CATALITICA DE DIETILBENCENO.** (Rosario, Argentina, Universidad Nacional del Litoral. Facultad de Quimica Industria y Agricola. Revista, 29, 95-104 (1960).

A laboratory study of the dehydrogenation of diethylbenzene over chromia on alumina catalyst was carried out over the temperature range of 490° to 710°C and liquid hourly space velocities of 0.30 to 0.575. Optimum temperature was 600-605°C which gave 40-45% yield of divinylbenzene and ethylvinylbenzene in varying ratios. Considerable coke was formed during reaction.

Voevodsky, V. V., THE THERMAL DECOMPOSITION OF PARAFFIN HYDROCARBONS. Faraday Society. Transactions, 55, 65-71 (1959). 1006

The thermal decomposition of Propane with and without added oxygen and together with deuterium exchange was studied at 570°-610°C and at pressures of 25 and 100 mm. The results suggest that the chain propagation step is homogeneous while the chain initiation step is heterogeneous with the reactor wall.

Voevodsky, V. V., and Soloukhin, R. I., (Novosibirsk University), ON THE MECHANISM AND EXPLOSION LIMITS OF HYDROGEN AND OXYGEN CHAIN SELF-IGNITION IN SHOCK WAVES. "Symposium (International) on Combustion, 10th, Cambridge, England. August 17-21, 1964." Pittsburgh, Combustion Institute, 1964. 1007

The self-ignition lags of 1:1 hydrogen oxygen mixtures behind reflected shock waves were measured at pressures of 0.5-3.5 atm in the temperature range of 750-1650°K. The explosion limits of self-ignition were established. The quantitative evaluation of induction lags based on the chain scheme of reaction is in good agreement with the experimental data up to the second explosion limit. In the region between the second and third explosion limits, measured induction lags were less than those theoretically calculated. This effect is explained by the influence of reactions of oxygen molecules vibrationally excited in shock waves.

Voge, H. H. and Good, G. M. (Shell Development), THERMAL CRACKING OF HIGHER PARAFFINS. American Chemical Society. Journal, 71, 593-7 (1949). 1008

The thermal cracking of n-hexadecane was studied in a flow system at 500°C and one and 21 atm pressure. Detailed product analyses showed the data at 1 atm to be in good agreement with radical chain theory predictions. Rates of cracking for homologous normal paraffins are approximately represented by first order rate constants which fit the empirical equation $k(\mathrm{sec}^{-1}) = (n - 1)(1.57\,n - 3.9) \times 10^{-5}$ for 500°C.

1009

Voicu, O., Popescu, F. and Basarabescu, T., USE OF ISOOCTYLPHENOL AND DODECYLPHENOL AS OXIDATION INHIBITORS. Petrol si Gaze (Bucharest), 11, 130-4 (1960). (CA, 54, 25729d)

The use of long-chain alkylphenols, such as isoöctylphenol, isoöctylcresol, dodecylphenol, and dodecylcresol, is recommended as antioxidants in thermally cracked gasolines.

1010

Volf, M. B. and Kozik, B. L., STABILITY OF AIRCRAFT KEROSENES CONTAINING UNSATURATED HYDROCARBONS. Ufa. Bashkirskiy Nauchno-Issledovatel'skiy Institut po Pererabotke Nefti. Trudy, 1960, no. 3, 62-8. (CA, 56, abstr. 3724a, 1962).

The storage and chemical stability of aviation kerosines (fuel type T) containing cracked components is determined in the LSA-1 apparatus, with 125 ml glass flasks by heating 25 ml of fuel with a 50 square mm Cu plate as catalyst in the presence of air at 110° for 2-16 hours. A series of antioxidants was tested. Results were compared with 20-month storage tests at constant temperature in the presence of Cu and Fe plates. The amount of tar formed was determined periodically by GOST (U.S.S.R. Government Standard) method 1567-56. Comparison of the results shows good correlation of the accelerated oxidation test run >10 hours with actual storage tests, and great effectiveness of antioxidant FCh-16, which is the phenol obtained from the tar water from the semicoking of cherry wood charcoal.

1011

Volf, M. B., Kozik, B. L., and Morozova, G. P., THERMAL STABILITY OF HYDROCARBON FUELS. Ufa. Bashkirskiy Nauchno-Issledovatel'skiy Institut po Pererabotke Nefti. Trudy, 1960, no. 3, 51-61. (CA, 56, abstr. 9002i, 1962).

Thermal stability was investigated in a bomb (glass container) at constant temperature (100-250°C) with air plus N_2. After 4 hours, the amount of precipitate was measured. It was concluded that a reduction in the content of aromatic hydrocarbons (esp. bicyclics) increases thermal stability. Similarly, when paraffins are decreased and naphthenes increased, precipitation increases. Increased O_2 concentration also increases precipitation.

von Glahn, U. H., A CORRELATION OF FILM-BOILING HEAT-TRANSFER COEFFICIENTS OBTAINED WITH HYDROGEN, NITROGEN, AND FREON 113 IN FORCED FLOW. U. S. National Aeronautics and Space Administration, TN D-2294, May 1964. 42 pp. 1012

Limited film-boiling heat-transfer coefficients for hydrogen, nitrogen, and Freon 113 are correlated empirically for forced flow upward through electrically heated circular tubes. Correlation is obtained by means of a film-vaporization parameter and the ratio of the experimental vapor-phase Nusselt number modified by a two-phase correlation factor to a calculated turbulent vapor-phase Nusselt number. The film-vaporization parameter includes the local input per pound-mass of flowing fluid, the latent heat, and the fluid quality at the start of transition from nucleate to film boiling. The two-phase correlation factor consists of several dimensionless parameters that influence two-phase heat transfer.

von Glahn, U.H., ON THE EMPIRICAL CORRELATION OF CRITICAL BOILING HEAT FLUX FOR CHANNELS OF VARIOUS CROSS SECTIONS AND ORIENTATION. U. S. National Aeronautics and Space Administration, TN D-1656, June 1963. 21 pp. 1013

A correlation of boiling heat-transfer data associated with the maximum critical heat flux (burnout condition) in forced flow through uniformly heated circular tubes is extended to include data obtained with water flowing through rectangular channels and annular tubes with channel orientations varying from 0° to 90° upward from the horizontal. Correlation is achieved through the modification of an existing empirical relation by the use of an additional channel-shape factor.

Voronin, F. S. and Lelchuk, V. L., DEN WÄRMEÜBERGANG VON GAS ZU ROHRWAND BEI TURBULENTER STRÖMUNG MIT UBERSCHALLGESCHWINDIGKEIT. Teploenergetika 10, no. 4, 61-66 (1963). 1014

Heat transfer from gas to tube wall in turbulent flow at supersonic velocities was measured with air at 500°-540°K and 3 and 4 Mach and with diluted combustion products of petroleum at 990°-1340°K and 2, 3, and 4 Mach, both in counterflow with water. The composition of the diluted combustion products was varied from 76.4 to 77.6% by vol nitrogen, 10.9 to 14.9% oxygen, 3.9 to 7.1% carbon dioxide, and 3.6 to 6.6% water. An equation was derived for defining Stanton numbers in terms of Reynolds, Prandtl, and Mach numbers, the coefficient of resistance of the noncompressible medium, wall temperature, and braking temperature of the gas. For Mach = 0, the equation agreed well with published equations for subsonic velocities.

Votyakov, V. and Shumanatskiy, B., AERODYNAMIC HEATING. Sovetskaya Aviatsiya, 1959, April 14, 2. 1015

The authors review measures for the reduction of the aerodynamic heating of supersonic flying craft and of its consequences, state that these measured become effective in the case of ballistic rockets and briefly consider the following means for cooling the surface of a flying craft: 1) Heat insulating coatings. 2) Cooling by liquid fuel passing it through special channels along the covering. 3) Cooling by evaporation of water; the water gets on the surface of the covering through special pores or holes and evaporates. 4) Use of a strong magnetic field for pushing away the hot ionized air layers from the front edges of a flying craft.

Wachs, A. M., Bentur, S., Kott, Y., Babitz, M., and Stern, A. B. (Technion, Israel Institute of Technology), AVIATION GASOLINE CORROSIVENESS CAUSED BY SULFATE-REDUCING BACTERIA. Industrial and Engineering Chemistry Process Design and Development, 3, no. 1, 65-9 (1964). 1016

A sulfate-reducing bacteria, Desulfovibrio desulfuricans, has been found to be responsible for the corrosiveness occasionally occurring in aviation gasoline stored in tanks with small water bottoms, under the climatic conditions prevailing in Israel. In laboratory experiments, gasoline stored on culture media inoculated with D. desulfuricans became corrosive after 1 week of incubation. The diffusion of H_2S in gasoline stored on aqueous H_2S solutions and its consequent oxidation to free sulfur were determined experimentally. Of the numerous bacterial inhibitors tested initially on Desulfovibrio cultures, methyl violet, a mixture of chloramphenicol and streptomycin, and sodium azide were selected for experimental investigation of their capability of preventing corrosiveness in gasoline stored over inoculated culture media. Under the test conditions, the best results were obtained with methyl violet.

Wagner, H. Gg. (Universitat Gottingen), REACTION ZONE AND STABILITY OF GASEOUS DETONATIONS. pp. 454-60 in: "Symposium (International) in Combustion, 9th, Cornell University, August 27 - September 1, 1962." New York, Academic, 1963. 1017

The author reviews previous work both by others and in his own laboratory particularly with respect to detonations in the hydrogen-air system. He also reports new results on detonations of hydrocarbon oxygen mixtures as well.

Wakelin, R. J., Heron, R. and Baldwin, R. R. (G.K.N. Research Laboratories), STUDY OF THE FLAME STABILITY CHARACTERISTICS OF DIFFERENT VAPORIZED FUELS IN A SMALL SCALE COMBUSTION CHAMBER. Fuel, 30, no. 4, 82-91 (1951). 1018

The flame stability limits of a number of fuels have been studied with a view to determining the factors governing their performance in gas turbine combustion chambers. A small scale combustion chambers was designed to enable pure hydrocarbons to be used, and the fuels were injected in vapour form to eliminate complications consequent on differing particle size and volatility when a liquid atomizer is used. Under these specialized conditions, the combustion has been found to be of the flame propagation type, rather than the spontaneous ignition type that is responsible for knock in piston engines. Further, under certain conditions, a correlation has been found between flame stability and the static ignition limits of the fuel, and the interpretation of this is explained. The significance of the results in relation to the analysis of full scale chamber tests is discussed.

Walter, W. C. (Avro Aircraft, Canada), A QUANTITATIVE ANALYSIS OF THE CHARACTERISTICS AND LIMITATIONS OF AERODYNAMIC FLIGHT WITHIN THE ATMOSPHERE. PART II. LIMITATIONS. Aerospace Engineering, 18, no. 9, 63-6 (1959). 1019

Curves showing Mach number-altitude relations for efficient cruising flight are presented, and the limitation due to aerodynamic heating is shown for an allowable temperature of 2000°F.

Wang, T.-S. and Kino, H.-H., PREPARATION OF CATALYSTS FOR DEHYDROGENATION AND CYCLIC FORMATION. K'o Hsueh T'ung Pao, 1963, no. 1, 59-60. (C. A., 59, 1130 b, 1963). 1020

The effect of acidity of Pt-alumina and Mo-alumina catalysts on the dehydrogenation and cyclization of n-heptane was studied. The activity of the catalyst Pt-Al for dehydrogenation cyclization changed as the ratio of HF and K_2O in Al_2O_3 was changed. When the HF/K_2O ratio was 2-4, the catalytic activity of Pt-alumina and Mo-alumina was best. The catalytic activity was adversely affected when HF or K_2O existed alone with the Mo-alumina catalyst.

Ward, C.C., Schwartz, F.G. and Eccleston, B.H., FUNDAMENTALS OF FUEL STABILITY. STATISTICAL STUDY-MEASUREMENT OF GUM FORMING REACTIONS WITH RADIOACTIVE TRACER TECHNIQUES. U.S. Bureau of Mines, Technical Report No. 13, Department of the Army, Project 1021
1A024401A106, October 1963. 30 pp.

This is intended to be primarily a statistical study involving gum forming tendendcies of stored fuels, as measured by radio tracer techniques. Of special interest, however, is the use of binary mixtures of pure sulfur compounds with pure olefins or aromatic olefins in a n-heptane substrate. 1-Hexanethiol is shown to be orders of magnitude worse than n-butylsulfide.

Weatherford, W. D., Jr., Cuellar, J. P., Jr., and Johnston, R. K. (Southwest Research Institute), CHEMICAL KINETICS OF FUEL-DEPOSITION AND METAL-LOSS REACTIONS IN TURBULENT COMBUSTORS. American Chemical Society. Division of Petroleum Chemistry. Preprints 5, 1022
no. 4, C69-79 (September 1960).

Experimental studies of high-temperature hydrocarbon fuels were conducted with a small turbulent-vortex combustor to investigate carbon-deposition tendencies which can be detrimental to the performance and durability of aircraft gas-turbine engines. Kinetic analysis of deposition data, supported by combustor metal-loss data from another laboratory, suggests that both deposition and metal-loss involve chemisorption of fuel-derived intermediates on active metal sites. Depending on operating conditions, the chemisorbate may be converted either into carbon deposits or metal-containing volatile oxidation products. These results provide additional clues regarding the mechanisms of carbon formation and combustor metal loss.

Weber, R. J. and MacKay, J. S., AN ANALYSIS OF RAMJET ENGINES USING SUPERSONIC COMBUSTION. U. S. National Advisory Committee for Aeronautics, TN 4386, September 1958. 49 pp. 1023

Based on the premise that supersonic burning is possible, the performance of ram-jet cycles utilizing supersonic combustor velocities is calculated over a range of flight Mach numbers from 4 to 7. Depending on the inlet characteristics assumed, the supersonic combustion engine tends to become more efficient than a conventional ram jet as the flight speed is increased. The effects of parameters such as inlet design, combustor area, divergence, wall friction, and nozzle performance are considered. Estimates of engine weight and cooling loads are included.

Weber, R.J. (NASA Lewis Research Center), PROPULSION FOR HYPERSONIC TRANSPORT AIRCRAFT. International Council of the Aeronautical Sciences, Fourth Congress, Paris, Paper 64-558, August 24-28, 1964. 1024

The problem of achieving efficient, long-range hypersonic flight with turboramjet engines is examined. The performance of integrated engine-airframe configurations is studied in order to obtain meaningful results. After including appropriate off-design penalties and observing a 2 pound per square foot limit on sonic-boom over-pressure, the typical range of 2800 nautical miles is calculated for a Mach 6 cruise airplane (125 passengers and 500,000 lb gross weight) with JP fuel. To obtain longer ranges, improvements must be made in the assumed engine performance or an unconventional fuel such as hydrogen must be employed.

Wegener, P. P. and Cole, J. D., (Yale University), EXPERIMENTS ON PROPAGATION OF WEAK DISTURBANCES IN STATIONARY SUPERSONIC NOZZLE FLOW OF CHEMICALLY REACTING GAS MIXTURES. pp. 348-59 in: "Symposium (International) on Combustion, 8th, California Institute of Technology, August 28-September 3,1960." Baltimore, Williams and Wilkins, 1962. 1025

It was shown experimentally in a reacting gas mixture of nitrogen and nitrogen tetroxide in stationary supersonic nozzle flow in chemical equilibrium that weak disturbances propagate with a speed given by the frozen speed of sound. A solution of the linearized equations of motion for the supersonic flow of the mixture of reactants under discussion for the decay of wave strength of a frozen disturbance indicates that on the scale of the experiments no such decay should be observed. Because this prediction agreed with the experimental findings for a weak shock wave, a consistent picture of wave propagation in reacting mixtures emerged.

Weil, S. A., Ellington, R. T., Searight, E. F., and Hu, S., FUNDAMENTALS OF COMBUSTION OF GASEOUS FUELS - A CRITICAL LITERATURE REVIEW. Institute of Gas Technology, Research Bulletin 15, April 1957. 63 pp. 1026

This report gives a comprehensive survey of theoretical and fundamental treatments applicable to combustion processes in gaseous fuels. Flammability limits, ignition, and burning velocities in laminar and turbulent flow are treated. No attempt is made to include experimental results except as examples. The date of issue somewhat limits the current value of the report.

1027 Weiss, M. A., Lang, R. J., and Longwell, J. P. (Esso Research and Engineering), COMBUSTION RATES IN SPHERICAL REACTORS. EFFECTS OF INLET TEMPERATURE AND FUEL TYPE. Industrial and Engineering Chemistry, 50, no. 2, 257-64 (1958).

An experimental study in a spherical "well-mixed" reactor is described. This is a continuation of previous work designed to verify activation energy for iso-octane/air flames (by varying extent of preheat) and to extend the study to other fuels. In this equipment, differences in burning rates of hydrocarbons (not attributable to differences in flame temperature) were surprisingly small. This work was done under contract with the Bureau of Ordnance, Department of the Navy.

1028 Weisz, P. B. and Frilette, V. J. (Socony Mobil), INTRACRYSTALLINE AND MOLECULAR-SHAPE-SELECTIVE CATALYSIS BY ZEOLITE SALTS. Journal of Physical Chemistry, 64, 382 (1964).

Synthetic crystalline inorganic zeolite salts (i.e., "molecular sieves") were found to be more active for cracking of normal paraffins than conventional silica-alumina cracking catalysts. Product distribution varies with the cation introduced into the molecular sieve.

1029 Wellman, R. E. and Walters, W. D. (University of Rochester), THE THERMAL DECOMPOSITION OF ETHYLCYCLOBUTANE. American Chemical Society. Journal, 79, 1542-6 (1957).

Thermal decomposition of ethylcyclobutane was studied over the pressure range 7-400 mm. at 450° and at 420-460° for pressures of 10 to 200 mm. The products were found to be almost exclusively ethylene and 1-butene. The decomposition is a homogeneous, first-order reaction which is not inhibited by nitric oxide, propylene or toluene. The temperature dependence of the experiments with initial pressures of 10-200 mm. gave an activation energy of 62 ± 1 kcal./mole. The first-order rate constant can be expressed as $k = 3.6 \times 10^{15} e^{-62000/RT}$ sec.$^{-1}$.

Whitaker, A. C. and Kinmer, A. D. (Gulf Research and Development), EFFECT OF RESIDUAL COKE ON BEHAVIOR OF CRACKING CATALYST. Industrial and Engineering Chemistry, 47, no. 10, 2153-7 (1955). 1030

The effect of coke deposition on cracking catalyst behavior was studied in a bench scale apparatus. Log-log plots of conversion and carbon deposition were linear. Catalyst behavior characteristics were estimated at short residence times and low oil-catalyst ratios by extrapolating the linear log-log plots.

Whitney, L.M., DEVELOPMENT OF A LABORATORY METHOD FOR EVALUATION OF FUELS FOR GAS TURBINE ENGINES. Shell Development Co., S-13365, Final Technical Summary Report, U.S. Air Force Contract AF 33(038)-688, Supplemental Agreement No. 4, July 1, 1951 to June 30, 1952. 49 pp. 1031

A survey of the combustion efficiencies and rich and lean limits of several pure hydrocarbons and current and potential gas turbine fuels has been made for various air flows and chamber pressures in a small scale combustor. Exhaust gas analysis methods were used. On the basis of a survey of components of the exhaust a simplified equation was developed for the combustion efficiency based on an analysis for CO_2 from oxidation of the unburned and CO in the unburned. Results of the survey show very little difference between fuels but operational conditions were found to cause significant differences. In all cases increased chamber pressure and air-fuel ratio increased combustion efficiency. Preheating the fuel caused an increase in combustion efficiency for fuels of wide boiling range.

Whitney, L.M. and Bollo, F.G., DEVELOPMENT OF A LABORATORY METHOD FOR EVALUATION OF FUELS FOR GAS TURBINE ENGINES. Shell Development Co., S-13294, Final Technical Summary Report, U.S. Air Force Contract AF 33(038) 688, Supplemental Agreements 1 and 2, April 15, 1950 to June 30, 1951. 15 pp. plus figures and tables. 1032

Work under this contract on the development of laboratory methods for evaluation of gas turbine fuels has included two aspects of fuel performance--combustion efficiency and carbon deposition. During the present phase of the contract, a method of sampling the exhaust was developed and the composition of exhaust gases over a wide range of operating conditions and with a variety of fuel types were determined using the Analyzer and mass spectrograph. Only preliminary comparisons have been made between combustion efficiencies determined by exhaust gas analyses and thermocouple measurements.

Widawsky, A. (Marquardt Corp.), COMPUTER PROGRAM FOR THE DETERMINATION OF CHEMICALLY REACTING FLOW FIELDS BY THE METHOD OF CHARACTERISTICS. U. S. Air Force Propulsion Laboratory, RTD-TDR-63-4286, Contract AF 33(657)-10796, October 1963. 69 pp. (AD 437698). 1033

The report describes a computer program developed for the calculation of two-dimensional and axisymmetric flow fields by the method of characteristics, including the effects of finite rate chemical reactions. The program is applicable to hypersonic propulsion systems operating both below and above Mach 10. In the present form, the program is written for a reacting gas composed of the combustion products of hydrogen and air. Taken into account are 17 species and 27 chemical reactions. Modifications may be made to the program to enable it to handle any reacting gas.

Wiebe, W., PROPERTIES OF A STRESS-CARRYING INSULATING COMPOSITE OF VERMICULITE AND SODIUM SILICATE. Canada. National Aeronautical Establishment, Aeronautical report LR-332; National Research Council no. 6744, February 1962. 13 pp. (AD 275300). 1034

A study was made of the strength characteristics, density, and thermal properties of a lightweight refractory insulation material composed of vermiculite aggregate bonded with sodium silicate. The investigation indicated that the material, after exposure to temperatures between 500 and 800°F possesses dimensional stability, compressive strengths ranging from 100 to 150 lb/sq in. thermal conductivity values not in excess of 1.0 Btu-in./sq ft hr °F for mean specimen temperatures approaching 500°F, and densities ranging between 18 and 20 lb/cu ft.

Wienczyslaw, K., ALUMINOSILICATES AS CATALYSTS IN THE CRACKING PROCESS. Przemysl Chemiczny, 40, 548-53 (1961). (CA, 57, 110h). 1035

A review with 41 references.

Williams, F. A. and Cawley, F. A. (U. K. Energy Ministry), CONTAMINANTS IN FUELS. U. K. Central Electric Generating Board Flue Gas Corrosion International Meeting (Marchwood, May 20-25, 1963). Condensation in: Brenstoff-Warme-Kraft, 15, no. 8, 387-8 (1963). 1036

The review covers the origin of inorganic contaminants in coal and fuel oils, and analytical methods for their determination; techniques for their partial removal, e.g., centrifuging of heavy fuel oil or hydrogenation (which is not feasible economically); contamination of heating surfaces and corrosion due to inorganic fuel components; the strong effect of small amounts of sulfur in the fuel on the dew point of flue gases; and commercial tests on the scrubbing of flue gases to reduce air pollution.

Wilshire, J. F. K., THE PYROLYSIS OF 1-PHENYLTETRALIN. Australian Journal of Chemistry, 15, 538-47 (1962). 1037

The pyrolysis of 1-phenyltetralin at 700°C has been investigated, and mechanisms are advanced for the formation of the compounds found in the pyrolysate. For comparison, tetralin and hydrindene were pyrolysed at 700°C under the same conditions as the 1-phenyltetralin. The presence of polycyclic aromatic hydrocarbons in coal tar may be due to the thermal breakdown both of hydroaromatic and of aliphatic structures in the parent coal.

Winters, C. W. and Witte, W. G., A FLIGHT INVESTIGATION OF ABLATION ON A BLUNTED CYLINDER-FLARE CONFIGURATION TO A MACH NUMBER OF 8.48. U. S. National Aeronautics and Space Administration, TN D-2354, July 1964. 41 pp. 1038

A model was flown to a Mach number of 8.48 at an altitude of 25,000 feet. In-flight ablation measurements were made on the front face of a Teflon nose by using variable-capacitance sensors. A method of predicting the ablation rates is presented and thepredictions obtained are compared with the measured data. Temperature measurements were obtained under an unprotected inconel segment and a Teflon and inconel composite segment on a cylindrical test section and on the stabilizing flare. Ablation rates and inside wall temperatures obtained from a computer program agreed well with measured temperatures. Measured and theoretical heating rates are presented for the cylindrical and flare sections.

Winter, E.F., AN INVESTIGATION OF THE FUEL EFFECT IN THE FORMATION OF ATOMIZER SHROUD DEPOSITS IN AERO-GAS-TURBINE COMBUSTION CHAMBERS. Shell Thornton Research Centre, Report K.124, U.K. Ministry of Supply Contract No. 6/Engs/6603/CB.13(b). September 1954. 72 pp. 1039

The work was carried out to investigate the effects of fuel properties on the formation of carbonaceous deposits on the atomizer air shroud in spray-type combustion systems and to examine means of predicting the behaviour of fuels in this respect. The main part of the investigation was carried out on a modified Ghost II combustion charber operated to produce rapid rates of deposition. The deposits were assessed in terms of both weight and tendency to interfere with the fuel spray. Subsidiary work was done on an Avon R.A.3 chamber and on a Mamba chamber.

Winter, E.F., AN INVESTIGATION OF THE MECHANISM OF FORMATION OF CARBONACEOUS DEPOSITS IN AERO-GAS-TURBINE COMBUSTION CHAMBERS. Shell Thornton Research Centre, Report K.125, U.K. Ministry of Supply Contract No. 6/Engc./6603/CB.13(b), September 1954. 26 pp. 1040

The mechanism by which carbonaceous deposits are formed was studied by the observation of the behavior of various fuels in Ghost, Avon, and Mamba combustion chambers, by analytical examination of the deposits which formed in these chambers and by simple laboratory experiments on deposit formation.

Winter, E. F., Lewis, A., and Larson, R. G. (Shell Petroleum, Thornton Research Centre), FUEL-HANDLING PROBLEMS IN THE JET AGE. Advances in Petroleum Chemistry and Refining, 7, 137-238 (1963). 1041

Contains specifications for JP-type fuels, description of airfield fueling equipment, discussion of fuel cleanliness and contamination problems, description of equipment for removal and detection of water and solids in the fuel, discussion of hydraulic surge during fueling and devices for its prevention, and discussion of electrostatic phenomena in fuel handling.

1042 Winter, E.F. and Whyte, R.B., AN INVESTIGATION OF THE IMPORTANCE OF GUM IN DETERMINING THE DEPOSITION TENDENCY OF AVIATION GAS TURBINE FUELS. Shell Thornton Research Centre, Report K.126, U.K. Ministry of Supply Contract No. 6/Engs/6603/CB.13(b), September 1954. 22 pp.

The tendencies of various fuels to form carbonaceous deposits on the atomizer air shroud of a Ghost II combustion chamber, on flame-zone components of a Mamba pre-vaporising chamber and on the atomizer air shroud of a small scale combustion chamber were studied. The fuels comprised gasoline, kerosine and wide-cut types, alone or blended, and covered a wide range of gum contents and gum-forming characteristics. In the case of two wide-cut turbine fuels the content of gum and gum-forming components was varied by the addition of C_8-C_{18} olefines, aged or fresh as necessary. The addition of considerable amounts of gum and gum-forming components to two straight-run wide-cut turbine fuels had no worsening effect on the dirtiness of these fuels as manifested by deposits in the Ghost II combustion chamber.

1043 Wislicki, B., DEPENDENCE OF THE COMPLETENESS OF COMBUSTION OF TURBINE AND JET ENGINE FUELS ON CHEMICAL CONSTITUTION. Technika Lotnicza, 1961, no. 8, 171-8.

The effects of chemical constitution of hydrocarbon fuels on the combustion efficiency and tendency towards coking were investigated. Completeness of combustion, ø, is strongly affected by stability of the flame and the rate of combustion. Effects of the air/fuel ratio on ø have been investigated for kerosene, paraffin concentrate of boiling range 159-265°C, and for a mixture of aromatics (75.2%), cycloparaffins (11.4%) and paraffins (13.4%) boiling between 166 and 253°C. Values are given to show that the optimum air/fuel ratio is about 60, corresponding to ø = 98% for all the fuels considered. For different hydrocarbon types ø decreases in the order: paraffins > single-ring cycloparaffins > cycloolefins > double-ring cycloparaffins > single-ring aromatics with a side-chain > single-ring aromatics > double-ring aromatics. Coking increases with increased fuel density, boiling point, and in the order: paraffins < cycloolefins < aromatics. Within each group coking increases with decreased volatility and in general increases for the higher C/H ratios.

1044 Wislicki, B., ON POSSIBILITIES OF INCREASING THE HEAT OF HYDROCARBON FUEL COMBUSTION. Przemysl Chemiczny, 40, no. 5, 240-4, (1961) (Trans. FTD-TT-61-386; AD 272537).

The variation in heat of combustion for different hydrocarbon types is discussed, and the heats of combustion for various metals and their derivatives are presented and compared to values for petroleum fuels, on both a weight and volume basis. Problems of suspending solids in a petroleum fuel to increase the heat of combustion are considered, and difficulties associated with the presence of metal oxides in the combustion products are mentioned. The flight range as a function of fuel heating value is tabulated for a hypothetical aircraft.

Wolfhard, H. G., Glassman, I. and Green, L., eds., HETEROGENEOUS COMBUSTION. New York, Academic, 1964. 1045

This book consists of a selection of technical papers based mainly on the American Institute of Aeronautics and Astronautics Heterogeneous Combustion Conference held at Palm Beach, Florida, December 11-13, 1963. The contents consists of four sections. (1) Combustion and Ignition of Metals: this reports the results of studies on the combustion of a number of metals, including beryllium, aluminum, magnesium, boron, graphite, aluminum, tungsten, boron nitride, zirconium hydride, uranium. (2) High-energy Propellant Combustion: this includes the studies of the combustion of boron hydride, diborane, diethyl diborane, pentaborane, hydrazine, aluminum alkyls, and the inhibition of after-burning by metal compounds. (3) Effect of Air Dynamics on Heterogeneous Combustion: this section deals mainly with hybrid rocket combustion, examining in detail phenomena associated with boundary layers. (4) Condensation: this section is largely related to condensation phenomena occurring in nozzles and the effect of nucleation on condensation.

Wolfshagen, R., Braude, H., and Welge, W. (Thompson Ramo Wooldridge), RESEARCH AND DEVELOPMENT ON THERMAL STABILITY OF SPECIAL HYDROCARBON FUELS. U.S. Air Force, ASD TR 61-266, Contract AF 33(616)-7275, November 1961. 80 pp. (AD 267255). 1046

The thermal stabilities of various fuels for use in Mach 3 to 4 aircraft were evaluated in an aircraft fuel system-engine thermal simulator. Test conditions simulated heat flux and fuel temperature levels anticipated in high Mach aircraft. Included were simulation of heat input from aerodynamic fuel tank heating, hydraulic and lube oil heat exchangers and engine nozzle environment sources. Five JP-6 fuels were tested under simulated Mach 3 conditions, and 5 higher temperature fuels, including several nearly pure hydrocarbons, were tested under simulated Mach 4 conditions. Fuels were rated on the basis of relative change of heat exchanger performance in 50 operating hr. The fuels were rated in the ASTM-CFR Coker (JP-6 fuels) and the Erdco Research Coker (higher temperature fuels) to compare the test method with simulator results. A somewhat more detailed description of the data treatment is included in Progress Reports No. 1 (Sept., 1960) and No. 2 (Jan., 1961).

Wolfshagen, R., Edwards, H., Braude, H., and Welge, W. (Thompson Ramo Wooldridge), INVESTIGATION OF AUTOIGNITION AND OTHER PHENOMENA IN HIGH TEMPERATURE AIRCRAFT FUEL SYSTEMS. U.S. Air Force, ASD TR 61-480, Contract AF 33(616)-7137, September 1961. 43 pp. (AD 268499). 1047

The autoignition characteristics of JP fuels were investigated using a test rig incorporating a 1 cu ft reaction chamber simulating possible conditions in the vapor space of aircraft fuel tanks. The autoignition phenomena was governed primarily by time, mixture temperature, mixture pressure and mixture composition. Fuel vapor will react with any percentage of available O at any pressure level provided mixture temperature is sufficiently high and accumulated time at temperature is sufficiently long to promote autoignition. Combustion, with proper mixture composition and pressure level, will result in measurable pressure rise at autoignition temperatures above approximately 435°F. The pressure rise resulting from autoignition was related primarily to mixture composition and pressure level and is reasonably predictable from the 2 parameters. Variables producing little or no effect on the incidence or type of reaction obtained included presence of a small environmental hot spot in the chamber vapor space, chamber well temperature and material, type of diluent gas and chamber size.

1048 Wolfshagen, R.G., Welge, W.W. and Rothenberg, A.J., **RESEARCH AND DEVELOPMENT ON THERMAL STABILITY OF SPECIAL HYDROCARBON FUELS.** Tapco West Coast Engineering, Progress Report No. 1, September 1960, U.S. Air Force Contract AF 33(616)-7275. 49 pp.

Work was directed primarily toward design of a heat exchanger system capable of simulating the fuel heat fluxes and temperature rises anticipated in Mach 3 and Mach 4 aircraft. Basic engineering design of this system was completed during the reporting period. Determination of fuel physical properties at elevated temperatures necessary for heat exchanger design and later test data analysis was also carried out. Reference runs of test fuels were performed using the CFR Fuel Coker.

1049 Wolfshagen, R.G., Welge, W.W. and Rothenberg, A.J., **RESEARCH AND DEVELOPMENT ON THERMAL STABILITY OF SPECIAL HYDROCARBON FUELS.** Tapco West Coast Engineering, Progress Report No. 2, 11 Sept 1960 to 15 January 1961, U.S. Air Force Contract AF 33(616)-7275. 38 pp.

Fabrication and shakedown of a Mach 3 to Mach 4 engine heat exchanger and nozzle environment simulator was completed and a series of five JP-6 type fuels tested. The fuels were also catalogued using the CFR Fuel Coker. Results of this testing were as follows: (1) Relative thermal stability of the fuels as measured by percent decrease in tube to fuel heat transfer coefficient differed considerably between fuels, ranging from values of no measurable decrease to 72.5 percent decrease after fifty hours at test conditions. (2) The CFR Fuel Coker, operated at conditions of 450/500/6, for a duration of five hours, with a spacer inserted in place of the filter element, produced a good correlation with the heat exchanger tests. The fuel rating was based on the standard preheater deposit code.

1050 Wolfson, B. T. (U.S. Air Force Office of Scientific Research), **THE INFLUENCE OF INERT AND CHEMICALLY REACTIVE ADDITIVES ON THE MECHANISM OF DETONATION IN GASEOUS MIXTURES OVER WIDE RANGES OF INITIAL PRESSURE AND ADDITIVE CONCENTRATION.** Combustion Institute. Western States Section. 1964 Spring Meeting. Paper WSS/CI 64-16.

This study investigates the effect of helium, argon, and carbon dioxide additives on the mechanism of detonation in stoichiometric hydrogen-oxygen mixtures over wide ranges of initial pressures, and additive concentrations, and attempts to determine the validity of the Chapman-Jouguet thermohydrodynamic theory under these conditions. No quantitative conclusions were reached about whether complete equilibrium in the Chapman-Jouguet plane was established or whether the frozen or equilibrium product gas sound speed is most correct in the real gas situation. The detonation velocity was slightly dependent on initial pressure, but was critically dependent upon mixture composition. The experimental detonation static pressures followed the same general trend as the velocities.

Wurster, C. F., Smith, J. O., and Satterfield, C. N. (Monsanto Research), **FLAME LUMINOSITIES OF HYDROCARBONS AND HYDROCARBON MIXTURES BURNED IN THE GAS PHASE.** Journal of Chemical and Engineering Data, 6, 626-30 (1961). 1051

As part of an investigation of the feasibility of cooling very high speed aircraft by means of an endothermic reaction of the fuel prior to combustion, the burning characteristics of various fuels and their products of reaction have been studied. The goals of the work were to evaluate an instrument for comparing luminosities of fuels burned in the gase phase, to compare the luminosities of some potential endothermic fuels with the products that would be formed by reaction - e.g., cyclohexane vs a 3 to 1 molar mixture of hydrogen and benzene, and to develop a more basic understanding of the factors determining the luminosity of simple flames as measured in the Luminometer. The work was sponsored by the U.S. Air Force under Contract AF 33(616)-6608.

Wurster, C. F., Jr., Smith, J. O. and Satterfield, C. N. (Monsanto Chemical), **LUMINOSITIES OF HYDROCARBONS IN THE GAS PHASE.** American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, C49-58 (September 1960). 1052

The luminometer is an instrument designed to measure the tendency of a substance to form carbon particles in its combustion flame. During an evaluation of potential jet fuels in a study on endothermic fuels, the instrument was modified to permit the burning of substances in the gas phase as well as the liquid phase. To contribute to a more basic understanding of the luminometer, data have been obtained on many pure gases and gaseous mixtures. These studies also measured burning rates at a constant level of radiant energy release, and these have been correlated with luminosity. A number of conclusions regarding gas mixture luminosities have been drawn, and luminosity has also been correlated with molecular structure.

Wynnemer, D. J., (Humble Oil and Refining), **COKE FORMATION IN CATALYTIC CRACKING OF n-DECANE-2C^{14}.** American Chemical Society. Division of Petroleum Chemistry. Preprints 5, no. 4, B93-6 (September 1960). 1053

The relative radioactivity (radioactivity of residue divided by radioactivity of feed) of the coke residue when cracking n-decane-2C^{14} was found to be 0.12 at 850°F and 0.58 at 900° and 950°F. The fact that these values differ from 1 indicate that not all portions of the feed molecule enter equally into the formation of the coke. Consideration of the products obtained at low conversions and the possible mode of cracking of the n-paraffin indicates a possible mechanism for coke formation from this molecule.

Yamazaki, K. and Kato, Y., SHOCK-WAVE IGNITION OF PROPANE-OXYGEN MIXTURES. Kogyo Kagaku Zasshi, 63, 2124-30 (1960). (CA 57, 7944C, 1962). 1054

The shock-wave ignition limit of propane-O mixtures was determined at a pressure down to 6 mm. Hg in a shock-wave tube 26 mm. in diameter and 110 cm. long, with air as the driving gas. The width of the ignition limit becomes narrower as the pressure is lowered. The ignition mechanism is explained by assuming that the C—C bond in a hydrocarbon is destroyed between atm. pressure and 100 mm. Hg and the C—H bond below 100 mm. Hg.

Zabetakis, M. G., Furno, A. L. and Jones, G. W. (U. S. Bureau of Mines), MINIMUM SPONTANEOUS IGNITION TEMPERATURES OF COMBUSTIBLES IN AIR. Industrial and Engineering Chemistry, 46, no. 10, 2173-8 (1954). 1055

A new ignition temperature apparatus was developed which makes the determination of minimum spontaneous ignition temperatures-autogenous ignition temperatures-more rapid, accurate, and economical. This consists of a modification of ASTM Designation D286-30. S. I. T.'s and time lags before combustion measured in the apparatus are reported for a large variety of compounds including many hydrocarbons.

Zabetakis, M.G., Imhof, A.C. and Lang, F.W. (U.S. Bureau of Mines), RESEARCH ON THE FLAMMABILITY CHARACTERISTICS OF AIRCRAFT HYDRAULIC FLUIDS. U.S. Air Force, WADC TR 57-151, Supplement 1, Contract AF 18(600)-151 May 1958. 29 pp. (AD 155510.) 1056

Spontaneous ignition temperature tests were conducted on JP-4 and 7 hydraulic fluids in air while in contact with 7 surfaces found in aircraft. Tests were conducted at reduced and elevated pressures by using both low and high velocity injection techniques. The flash and fire points of these fluids were determined in a standard ASTM apparatus. The minimum spontaneous ignition temperatures of the 7 hydraulic fluids increased with decrease in pressure. The rates of increase varied for each of these fluids so that the fluid with the highest minimum spontaneous ignition temperature value at atmospheric and elevated pressures had the lowest value at reduced pressures. The minimum spontaneous ignition temperature of the fluids at 1000 and 2000 psig injection pressures were independent of the injection nozzle-to-heated surface distance between 3 5/16 and 11 11/16 inches.

1057 Zabetakis, M. G., Jones, G. W., Scott, G. S., and Furno, A. L. (U.S. Bureau of Mines), RESEARCH ON THE FLAMMABILITY CHARACTERISTICS OF AIRCRAFT FUELS. U.S. Air Force, WADC TR 52-35, suppl. 4, Contract AF 18(600)-151, January 1956, 85 pp. (AD 91875).

A summary of the theory of combustion, explosion and ignition is presented as well as the results of limit-of-flammability, limit-of-ignitibility, limit-of-propagation, ignition energy and ignition temperature tests on various Air Force fuels, fuel components and hydraulic fluids. These data were obtained in air, and carbon dioxide and nitrogen-enriched air at various simulated altitudes by the Bureau of Mines and other laboratories. The combustibles investigated include the paraffins, aromatics, blends of these, JP-1, JP-3, and JP-4 jet fuels, 100/130 and 115/145 aviation gasolines, MIL-O-5606 hydraulic fluid and several experimental hydraulic fluids. The data are presented in graphic and tabular form.

1058 Zabor, R. C. and Emmett, P. H. (University of Pittsburgh), THE ADSORPTION OF NORMAL PARAFFINS ON CRACKING CATALYSTS. American Chemical Society. Journal, 73, 5639-43 (1951).

Adsorption measurements have been made for n-butane, n-heptane and n-octane on a Houdry S-46 cracking catalyst in the temperature range from room temperature up to and above the lowest temperature at which decomposition occurs. The adsorption appears to be physical in nature up to about 150°. Above this temperature, and even at cracking temperatures, the adsorption is very small, being equal to or less than 0.005 millimole (approx 0.1 cc) per gram of catalyst.

1059 Zakkay, V. and Krause, E. (Brooklyn Polytechnic Institute), MIXING PROBLEMS WITH CHEMICAL REACTIONS. U. S. Air Force, ARL 63-109, Contract AF 33(616)-7661, June 1963. 55 pp. (AD 411760).

An investigation of turbulent mixing with chemical reaction for Air-Hydrogen mixtures is presented. First an analysis is given whereby the reaction products for finite reaction rates may be determined along streamlines, provided the quantities in the flow field of mixing under frozen conditions are known. Then measurements of concentrations, pressures, velocities, and stagnation temperatures along the centerline of two coaxial jets with and without chemical reaction are presented. These measurements are used in order to determine the flow parameters ahead of the flame, and also in calculating flame shapes under equilibrium conditions. Finally, detailed flame shapes are included for various boundary conditions and compared with the theoretical predictions.

Zengel, A. E., Lander, H. R., Scribner, W. G. and Warren, J. H., AN EXAMINATION OF METHODS FOR CALCULATING VAPOR PRESSURE OF PETROLEUM HYDROCARBONS. U. S. Air Force, APL TDR 64-37, March 1964. 21 pp. 1060

At high temperatures, the vapor pressure of kerosene-type hydrocarbons is difficult to measure accurately with laboratory apparatus. Because of the inherent difficulties in direct measurement of vapor pressure-temperature relationships at high temperatures, the vapor pressure is being determined through calculation techniques. The purposes of this report are to compare the difficulty and accuracy of five techniques, of which three were basic calculation techniques and two were experimental techniques. In an effort to compare the techniques and to determine the precision of a calculation technique, four independent workers calculated the vapor pressure-temperature relationship for one high-quality jet fuel and for one synthetic blend of seven pure hydrocarbons. The results demonstrate that the method of assuming segments of the true boiling point curve to be pure compounds and finding the total vapor pressure as the sum of the component partial pressures is precise to ±5 percent. The empirical technique developed by Edmister is less accurate (based on the comparison with experimental results) and less precise than the more laborious true boiling point curve technique.

Zhorov, Yu. M. and Panchenkov, G. M., RELATIONS BETWEEN THE ACTIVATION ENERGY AND FREQUENCY FACTOR OF THE EXPONENTIAL TERM FOR CUMENE CRACKING PROCESSES CATALYZED BY ALUMINOSILICATES. Moskovskii Institut Neftekhimicheskoi i Gasovoi Promyshlennosti im I. M. Gubkina. Trudy, 1962, no. 37, 19-23 (CA, 58, 2307d, 1963). 1061

The cracking of cumene was used as a model reaction for investigating the kinetics of the general cracking reaction on an aluminosilicate catalyst. For evaluation of the exptl. data, the formula $n_0x = -n_0\ln(1 - x) - KS$ can be used, n_0 being the flow rate, x the conversion of the reactant, K the apparent reaction rate const., and S the surface area of the catalyst. This equation is valid in the temp interval 360-410° with the reaction kinetically controlled. Rapid activation energy changes occur when the temp is raised so that kinetic control goes into diffusion control. For the 1st case, a linear relation between K_0 and the activation energy E was found with a standard deviation of 5%. If an aluminosilicate catalyst with grain size approx. 4.5 mm is used, then $\ln K = -9.33 + E(0.88 \times 10^{-3} - 1/RT)$. This equation permits calcn. of the activation energy from one expt. and the evaluation of the activity of the aluminosilicate catalyst.

Zhovinskiy, N. Ye., HEAT BARRIER IN SUPERSONIC FLIGHT, Moscow, Voyenizdat, 1959. 127 pp. 1062

This book discusses the problems of aeronautics occurring because of aerodynamic heating of aircraft and missiles in flight at high supersonic speeds. It describes the origin of the problem and the various steps which are taken to reduce the effects of aerodynamic heating. It considers problems of heating of air due to friction and the changes of air temperature in the boundary layer. The conditions of heating of surfaces of aircraft and other aerodynamic bodies, such as rockets, at supersonic speeds are dealt with. The book also briefly discusses, in somewhat general terms, the methods which can be applied to permit successful reentry of satellites into the earth's atmosphere. The book is illustrated by a large number of figures and diagrams.

Ziebland, H. and Dupree, K. T. (Explosives Research and Development Establishment), THERMAL CONDUCTIVITY OF KEROSINE D.ENG. R.D. 2495 BETWEEN 15 AND 325°C AT PRESSURES UP TO 200 ATM. ARS Journal, 31, 845-8 (1961). 1063

The thermal conductivity of an aviation kerosine, Spec. No. D.Eng. R.D. 2495, was measured with a vertical, coaxial cylinder apparatus in the temperature range 15 to 325°C at pressures between 1 and 200 atm. The trend of these results, demonstrated by the influence of temperature and pressure on the thermal conductivity, is characteristic of normal, nonassociating liquids. Smoothed graphs showing the variation of thermal conductivity with pressure and temperature were prepared. At temperatures in excess of 280°C noticeable thermal decomposition of kerosine took place, believed to be due to the catalytic effect of the material of the receiving cylinder, a 97%/3% copper/nickel alloy. About 4% of toluene was detected after the kerosine had been exposed for approximately 7 days to temperatures between 280 and 320°C. No such decomposition took place in the same temperature interval after the receiving cylinder had been replaced by an all silver one.

Zimmerschied, W. J., Mickel, B. L., Hunt, R. A. and DerHerder, M. J. (Standard Oil), HIGH-PERFORMANCE JET FUELS FROM PETROLEUM. American Chemical Society. Division of Petroleum Chemistry. Preprints 4, no. 2, B 47-50 (April 1959). 1064

High-performance military jet aircraft will require specially tailored fuels. These fuels must have good burning quality, high gravimetric and volumetric heating value, thermal stability to temperatures above 800°F, low volatility, and low freezing point. Alkyl bicyclic naphthenes containing 11 to 14 carbon atoms seem best for use as high-performance jet fuels. Alkyl bicyclic naphthenes were prepared in the laboratory by hydrogenating reformer bottoms, an extract of catalytic cycle oil, and fractions of catalytic cycle oil over a platinum catalyst. These products were evaluated critically as high performance jet fuels.

Zrelov, V. N., THE DEVELOPMENT OF JET FUELS ABROAD. Khimiya i Tekhnologiya Topliv i Masel, 1959, no. 12, 54-9. (U.S. Air Force. MCL 594/1; AD 256127). 1065

This paper surveys jet fuel developments outside Russia. In addition to discussing kerosene and wide-fraction hydrocarbon fuels, mention is made of the possible use of metal-hydrocarbon suspension, boron hydrides, free radicals, and nuclear fuels. Studies of thermal stability and the use of additives for stability improvement, and works on improvement of the energy characteristics of fuels (heats of combustion, and combustion efficiency) are discussed. The relative merits of paraffins, naphthenes, and aromatics as fuel components are considered.

1066 Zrelov, V. N., METHODS OF ASSESSING THE QUALITY OF JET FUELS. Khimiya i Tekhnologiya Topliv i Masel, 1961, no. 2, 66-70.

This is a general review article of Soviet and foreign practice. At present particular attention is being directed to methods of assessing the quality of new high boiling jet fuels. Increasing the boiling range of jet fuels results in an increase in the content of aromatic hydrocarbons to as much as 28% which can result in increased deposit formation. To assess deposit formation small laboratory apparatus has been devised in which the fuel is burned and the amount of deposit measured. This gives a better assessment of deposit forming tendencies than the earlier instruments. For research purposes deposit forming tendencies of jet fuels are assessed in rigs with small scale jet turbine combustion chambers, rigs of this kind have been developed in the USSR by Tereshchenko and abroad by C. G. Williams and others. Tereshchenko's equipment is widely used to study other properties of jet fuel.

1067 Zrelov, V. N., Marinchenko, N. I., and Shchagin, V. M., SEDIMENT FORMATION IN JET ENGINE FUELS. Khimiya i Tekhnologiya Topliva i Masel, 1957, no. 7, 57-67.

Elevated temperature is the main factor in sediment formation. These are formed by oxidation and polymerization of nitrogen-sulfur and oxygen-containing (heteroatomic) compounds. Hydrocarbons have a limited capacity to retain such high-molecular compounds either in solution or in colloidal dispersion.

1068 Zrelov, V. N. and Melekhin, V. M., ...EFFECT OF ORGANIC NITROGEN COMPOUNDS...[IN]... FUELS FROM SULFUR-CONTAINING PETROLEUMS. pp. 236-44: in Sbornik Khimiya Seraorganicheskikh Soedinenii, Soderzhashchikhsya v Neftyakh i Nefteproduktakh, v. 4, Moscow, Gostoptekhizdat, 1961. (Referativnyi Zhurnal, Khimiya, 1962, no. 3, 489, abstr. 3M193).

The full title of this article is INVESTIGATION OF THE EFFECT OF ORGANIC NITROGEN COMPOUNDS ON THE CORROSIVE ACTIVITY AND ON THE THERMAL STABILITY OF THE FUELS FROM SULFUR-CONTAINING PETROLEUMS.

Corrosion activity of fuels and anti-corrosive action of additives were observed. Thermal stability in fuels was increased most effectively by aliphatic monoamines (dioctadecylamine, paraffinic methylamines), aromatic tertiary monoamines, and also some secondary aromatic monoamines (i.e., monoethylaniline and phenyl-α-naphthylamine).

Zrelov, V. N. and Melekhin, V. M., EFFECTS OF PHENOLS AND AMINES ON SEDIMENT FORMATION IN FUELS CONTAINING CRACKING COMPONENTS. Journal of Applied Chemistry (U.S.S.R.), 34, 2400-6 (1961). 1069

Reduction of sediment formation in fuels, containing cracking components, for aviation gas-turbine engines is a difficult problem. At temperatures above 80° these fuels are found to form insoluble solid precipitates (sediments) and produce abundant dark deposits on the bronze surfaces of the engine. Studies of the influence of certain chemical compounds, which can be used as antisediment additives, on these effects are of considerable interest. This paper gives the results obtained in an investigation of phenols, amines, hydroxy amines, and other nitrogen-containing compounds as additives for prevention of deposits. For assessment of their effectiveness, the substances were added to two fuels; one was obtained from low-sulfur Groznyi oil, and the other from Tatar oils containing 0.38% of sulfur. The fuels contained 30% of cracking components. Amines and oxyamines appear to be more efficient antioxidants for sulfurous fuel, while phenols are better in low sulfur fuel. A high antisediment forming capacity of the amide of stearic acid, which prevents any deposition of sediment in hot fuel, was observed.

Zuber, N. (University of California, Los Angeles), HYDRODYNAMIC ASPECTS OF BOILING HEAT TRANSFER. U. S. Atomic Energy Commission, AECU - 4439, 1959. 196 pp. (CA, 54, 11596f). 1070

A theoretical analysis is given for five aspects of boiling. The analytical model of Bosnjakovic for a bubble growing in a uniformly superheated liquid is extended to include a non-uniform field, and the growth is shown to be a function of the heat flux as well as the superheat. A theory for the diameter and emission frequency for bubbles at a cavity shows both factors to be functions of the cavity diameter. A relation is derived showing the superheat and heat flux at which a cavity of stated diameter will nucleate. The maximum heat flux is shown to be caused by the same hydrodynamic factors that cause flooding in perforated-plate absorber towers. The minimum flux in film boiling is derived from considerations of Taylor instability. Soviet literature is reviewed extensively. 114 references.

Zuber, N. (University of California, Los Angeles), THE STABILITY OF BOILING HEAT TRANSFER. American Society of Mechanical Engineers. Transactions, 80, 711-20 (1958). (CA, 52, 8641e). 1071

Boiling heat transfer in the nucleate region is reviewed. The transition film-boiling region is analyzed by considering the stability of a plane vortex sheet separating two inviscid fluids. By using the classical results of Helmholtz, Kelvin, and Rayleigh, expressions have been derived that predict the maximum and minimum heat-transfer rates in the nucleate and the film-boiling regimes, respectively. The model exhibits the essential features of the phenomenon and shows good agreement with experimental data.

Zukoski, E.E. and Spaid, F.W., SECONDARY INJECTION OF GASES INTO A SUPERSONIC FLOW. California Institute of Technology. Jet Propulsion Center, October <u>1963</u>. 62 pp. 1072

The flow field around the injection part for secondary injection of a gas into a supersonic stream has been studied experimentally. New information concerning pressure fields, concentration fields, and shock shapes is presented. Results are of interest concerning fundamental processes in the region of fuel injection into a supersonic burner.

BRITAIN'S MACH-3 RESEARCH AIRCRAFT-THE BRISTOL 188 ANALYSED. Aeroplane and Astronautics, <u>100</u>, no. 2586, 517-21 (<u>1961</u>). 1073

The paper gives a fairly detailed description of the airplane, particularly novel features of the airframe. Steel construction is used in this two-engined aircraft designed for sustained Mach 3 flight. Thermal problems are discussed, and use of the fuel as a heat sink for cooling hydraulic fluid, gear box oil, electrical machinery, and instrumentation is described. Controlled recycle of fuel through the heat exchangers is used to accommodate the cooling load at varying fuel use rates.

FINDING FUSELAGE CONDITIONS AT MACH 4. Engineering, <u>194</u>, 625 (Nov. 9, <u>1962</u>). 1074

A brief description of a laboratory operting at the Royal Aircraft Establishment, Farnborough, is given. The function of the laboratory is to test the efficiency of various designs of cooling systems and wall insulation for aircraft under conditions up to Mach 4 and 80,000 ft. The test chamber can accommodate sections of a full size fuselage.

A LUBRICANT. Chemical Week, 93, no. 12, 54 (September 21, 1963). 1075

A lubricant, Shell VRT Fluid "E", offered by Shell Oil Co. is a polyphenyl ether with good temperature stability which has performed well in high-speed antifriction bearings exposed to oxidation and radiation. Possible applications include supersonic aircraft and rockets.

NEW CONCEPTS STEM FROM FREE RADICAL WORK AT ESSO RESEARCH AND ENGINEERING CO. Chemical and Engineering News, 41, no. 43, 40-2, 141 (1963). 1076

A survey of work by A. A. Oswald et al since 1957 on free radical reactions of diolefins and acetylene with thiols (undertaken to explain the formation of black pyrrole sludges in stored hydrocarbon fuels and the inhibiting action of alkylamine stabilizers) covers studies of the Kharasch hydroperoxide cooxidation mechanism; the reactions of hydroperoxides with alkylamines; the chemistry and stereochemistry of allylic radical intermediates; the cooxidation of thiols and phenylacetylene to phenylglyoxal hemithioacetals, which involves the selective oxidation of an acetylene bond by molecular oxygen; and the selective free-radical addition to allene by a terminal attack mechanism.

NEW FUELS HAVE HIGH HEAT SINK VALUES. Aviation Week, 73, no. 14, 90-2 (1960). 1077

The article summarizes a paper given by R. R. Hibbard at a recent A.C.S. meeting. In the paper Hibbard compared the light hydrocarbons (methane, ethylene, propane) to conventional jet fuels (JP-4, JP-2) as endothermic fuels. The article tabulates vapor pressure data, heat sink capacities, heats of combustion, flammability limits, spontaneous ignition temperatures, and densities for these fuels.

RAMJETS, STATE OF THE ART, 1959. Astronautics, 4, no. 11, 46, 171 (1959).

1078 The paper presents a general summary of the prospects of ramjet engines. A list of references is given.

SST BY '70? Machine Design, 35, 154-8 (April 11, 1963).

1079 A popular exposition of some of the design problems of the present commercial Mach 3 SST program. Cooling problems are discussed among other aspects.

SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, 3d, University of Wisconsin, September 7-11, 1948. Baltimore, Williams & Wilkins, 1949.

1080 Among the more pertinent papers published in this volume are: B. P. Millins, "The Spontaneous Combustion of Fuels Injected into a Hot Gas Stream". W. Jost, "Reactions of Adiabatically Compressed Hydrocarbon-Air Mixtures". R. F. Strickland-Constable, "The Burning Velocity of Gases in Relation to the Ignition Delay Period". R. J. Dery, "Development of a Combustion Wave in a Flowing Gas". Other papers on kinetics and detonations are also of interest.

SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, 4th, Massachusetts Institute of Technology, September 1-5, 1952. Baltimore, Williams and Wilkins, 1953. 1081

Among the more pertinent papers published in this volume are: J. Friedman, et al, "The Engineering Application of Combustion Research to Ramjet Engines". R. Siestrunck, et al, "Some Properties of Stationary Detonation Waves". G. L. Dugger, et al, "Flame Velocities of Hydrocarbon-Oxygen-Nitrogen Mixtures". Other papers on kinetics and fundamental processes in flames and detonations are also of interest.

SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, 5th, University of Pittsburgh, August 30-September 3, 1954. New York, Reinhold, 1955. 1082

Among the more pertinent papers published in this volume are: P. Lloyd, "Problems of Turbo-Jet Combustion". J. P. Longwell, "Combustion Problems in Ramjets". R. S. Brokaw, et al, "Effect of Temperature, Pressure, and Composition on Ignition Delays for Propane Flames". Other papers on kinetics and fundamental processes in flames and detonations are also of interest.

SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, 6th, Yale University, August 19-24, 1956. New York, Reinhold, 1957. 1083

Among the more pertinent papers published in this volume are: L. N. Khitrin, et al, "Thermal Theory of Ignition of Gas Mixtures: Limiting Conditions". H. C. Hottel, et al, "Combustion Studies in a Stirred Reactor". W J. Wohlenberg, "A Discussion of the Relations Existing Between Limiting Energy Release Rates and Blowout for Hydrocarbon Fuels". E. D. Brown, et al, "Flame Stabiliziation in Fast Streams" (a panel discussion). Other papers on kinetics and fundamental processes in flames and detonations are also of interest.

SYMPOSIUM (INTERNATIONAL) ON COMBUSTION, 7th, London and Oxford, August 28-September 3, 1958. London, Butterworth, 1959. 1084

Among the more pertinent papers published in this volume are: R E Miller, "Some Factors Governing the Ignition Delay of a Gaseous Fuel". P. Gray et al, "The Thermal Theory of Induction Periods and Ignition Delays". C. J. Chang, et al, "Ignition Delay of Propane in Air Between 725-880°C Under Isothermal Conditions". J A. Sage, et al, "An Attempt at Measuring Homogeneous Ignition Temperatures". L. N. Khitrin, "On Some Consequences of the Thermal Theory of Ignition in a Fast Flow". J. A. Nicholls, et al, "Studies in Connection with Stabilized Detonation Waves". Other papers on kinetics and fundamental processes in flames and detonations are also of interest.

Symposium (International) on Combustion, 8th, California Institute of Technology, August 28-September 3, 1960. Baltimore, Williams and Wilkins, 1962. 1085

Among the more pertinent papers published in this volume are: S. G. Saytzev, et al, "Study of Combustion of an Adiabatically Heated Gas Mixture". J. A. Nicholls et al, "Recent Results on Standing Detonation Waves". R. Kling et al, "Detonation in Shock-Wave Ignited Kerosene-Air Mixtures". Y. Tanasawa, "A Study on the Internal Vaporizing Combustor". P. A Tesner et al, "The Formation of Dispersed Carbon in Hydrocarbon Diffusion Flames". Other papers on kinetics and fundamental processes in flames and detonations are also of interest.

Symposium (International) on Combustion, 9th, Cornell University, August 27-September 1, 1962. New York, Academic, 1963. 1086

Among the more pertinent papers published in this volume are: J. A. Nicholls, "Standing Detonation Waves". I. N. Momtchiloff et al, "Calculation of Ignition Delays for Hypersonic Ramjets". T. Asaba et al, "A Shock Tube Study of Ignition of Methane-Oxygen Mixtures". C. R. Orr, "Combustion of Hydrocarbons Behind a Shock Wave". Other papers on fundamental kinetics and other processes in flames and detonations are also of interest.