NBS SPECIAL PUBLICATION 718

U.S. DEPARTMENT OF COMMERCE/National Bureau of Standards

Bibliographies of Industrial Interest:

Thermodynamic Measurements on the Systems CO_2-H_2O, $CuCl_2$-H_2O, H_2SO_4-H_2O, NH_3-H_2O, H_2S-H_2O, $ZnCl_2$-H_2O, and H_3PO_4-H_2O

B.R. Staples, D. Garvin, D. Smith-Magowan, T.L. Jobe, Jr., J. Crenca, C.R. Jackson, T.F. Wobbeking, R. Joseph, A. Brier, R.H. Schumm, and R.N. Goldberg

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[3] Laboratories at Boulder, CO; some programs at Gaithersburg, MD.

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Thermodynamic Measurements on the Systems CO_2-H_2O, $CuCl_2$-H_2O, H_2SO_4-H_2O, NH_3-H_2O, H_2S-H_2O, $ZnCl_2$-H_2O, and H_3PO_4-H_2O

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ABSTRACT

Contained herein are bibliographies of sources of experimental and correlated thermodynamic data for seven binary aqueous mixtures of industrial importance, namely, mixtures of CO_2, H_2S, NH_3, H_2SO_4, H_3PO_4, $CuCl_2$, and $ZnCl_2$ with water. The categories of equilibrium data included in the bibliographies are activity and osmotic coefficients, equilibria in solution, enthalpies and heat capacity data, vapor-liquid equilbria, and phase equilbrium data.

KEY WORDS: ammonia; bibliography; carbon dioxide; copper chloride; enthalpy; equilibrium constants; heat capacity; hydrogen sulfide; phosphoric acid; sulfuric acid; thermodynamics; water; zinc chloride.

INTRODUCTION

This report is comprised of bibliographies on seven binary aqueous mixtures of great industrial importance, mixtures of CO_2, NH_3, H_2SO_4, H_3PO_4, H_2S, $CuCl_2$, and $ZnCl_2$ with water. The bibliographies identify sources of measurements or treatments of the equilibria that exist in these systems and the effects of temperature and pressure upon these equilibria. Treatments concerning more complex admixtures were not explicitly sought but those that were found that also addressed a fundamental aspect, such as the effect of ionic strength, were retained in the list. Three of the systems, CO_2, NH_3, and H_2S involve both vapor/liquid equilibria and acid/base dissociations under most typical conditions. Concerns regarding mixtures of H_2SO_4 and H_3PO_4 are limited for the most part to acid/base dissociation. The two salt systems, $CuCl_2$ and $ZnCl_2$ involve multiple association equilibria between cation and anion as well as hydrolysis of the cation. Annotations have been provided to describe the type of data reported in a particular publication and the environmental conditions under which measurements were made or for which the treatment is valid.

This report has been prepared for the Design Institute for Physical Property Data (DIPPR) of the American Institute of Chemical Engineers as part of the Project 811. Their support is gratefully acknowledged.

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*prepared for publication by D. Smith-Magowan

CO_2-H_2O

Bert R. Staples, Jacqueline Crenca, Cynthia R. Jackson, and David Garvin

INTRODUCTION

Listed in this bibliography are publications that contain information on the vapor-liquid equilibrium between CO_2 gas and its solutions in water or data on the ionization equilibria among $CO_2(aq)$, $H_2CO_3(aq)$, $HCO_3^-(aq)$ and $CO_3^{2-}(aq)$. To a lesser extent are publications on equilibria of CO_2 with and in mixture of water and organic compounds, on the enthalpies of solution, dilution and ionization, on activity coefficients and on the thermochemistry of the species listed above. References reporting measurements or presenting correlations or evaluations of data are included. Publications that consider only applications of existing data to specific systems but provide no new data have been avoided.

A subset of the papers is about the neutral molecule H_2CO_3, carbonic acid, as distinguished from dissolved CO_2. The study of the formation and ionization is a problem in both kinetics and thermodynamics. See [75KER] for a good introduction to this topic. Papers that refer to the "true" ionization constant of carbonic acid are about $H_2CO_3 = H^+ + HCO_3^-$. Papers about the "apparent" ionization constant of carbonic acid or of carbon dioxide consider the overall process $CO_2(aq) + H_2O = H^+ HCO_3^-$. There is confusion in the nomenclature but not the numbers, the "true" K is approximately 10^{-4} and the apparent K is about 10^{-7} (because of the appreciable solubility of CO_2).

The references are listed alphabetically by first author. Each citation is preceeded by a brief identification code composed of the year of publication and three letters from the last names of the first two authors. The citations list the names of authors; the title of the article, chapter or report as appropriate, and the source information, i.e. journal or book title, volume, year of publication . The structure of these citations does not conform to the specifications established by the American National Standards Institute but is the information necessary to direct the reader to a particular reference. In a few instances only an abstract or secondary reference was available. In these cases either the citation to Chemical Abstracts or source of the secondary citation is given.

Some titles have been translated, e.g. those in Russian. These translations come, by preference, from abstracts in the papers themselves or from Chemical Abstracts (The titles from the latter may be condesations of the original).

Each paper has been annotated to show the class of data, the temperature range and, if appropriate, pressure, solution composition and pH. The data class designations are taken from the Bulletin of Chemical Thermodynamics. They are two letter codes with some mnemonic or physical chemical associations. A list is appended. No attempt has been made to assess the quality of the data, however, an annotation of "Ze" indicates that a particular reference constitutes or includes an evaluation of experimental data from several sources.

The bibliography has been prepared by searching the files of the NBS Chemical Thermodynamics Data Center, the Bulletin of Chemical Thermodynamics and references in the papers retrieved from those sources. It covers a time period from the 19th century to 1982. Additions and corrections will be welcomed.

22ADO/HEN:	Adolph, E.F.; Henderson, L.J.; "The heat of reaction of oxygen with hemoglobin"; J. Biol. Chem.; 50, 463-490 (1922); [CA 16-1254]	Hm, Hr, 22°C, p?, solution and reaction with NaOH and KOH(aq).
77AND:	Anderson, G.R.; "The Raman spectra of carbon dioxide in liquid H_2O and D_2O"; J. Phys. Chem.; 81, 273-276 (1977) (negative results).	Md, 10°C, 45 atm, H_2CO_3, Raman spec.
16ANT:	Anthony; Bonfort's Wine and Spirit Circular; (1916)	Pv, see 58LIN for table of data.
21APP:	Appell, P.; "Resultats experimentaux sur l'absorption de l'anhydride carbonique par l'eau pure et salle"; Chaleur et Industrie; 2, 345-347, (1921)	Pv, t = ?, in H_2O and NaCl(aq), cited in passing in 58LIN.
11AUE/PIC:	Auerbach, F.; Pick, H.; Arb. Kaiser Gesundh.; 38, 1243, (1911).#	Kk, 18°C, 2d ioniz. (from 64SIL/MAR)
63AUS/LAC:	Austin, W.H.; LaCombe, E.; Rand, P.W.; Chatterjee, M.; "Solubility of carbon dioxide in serum from 15 to 38°"; J. Appl. Physiol.; 18, 301-304, (1963); [CA 59:7969f]	Pv, 15-38°C, in H_2O and blood serum.
56BAR/FRI:	Bartholome, E.; Friz, H.; "Loslichkeit von Kohlendioxyd in Wasser bei hoheren Drucken"; Chemie - Ing. Tech.; 28, 706-708, (1956)	Pv, 10-30°C, 1-20 atm.
83BAR/HEP:	Barbero, J.A.; Hepler, L.G.; McCurdy, K.G.; Tremaine, P.; "Thermodynamics of aqueous carbon dioxide and sulfur dioxide: heat capacities, volumes, and the temperature dependence of ionization"; Can. J. Chem.; 61, 2509-2519, (1983)	Dx, t = 25°C, $m(CO_2)$ = 0.01 - 0.1 mol/kg
66BAT/CLE:	Battino, R.; Clever, H.L.; "The solubility of gases in liquids"; Chem. Rev.; 66, 395-463, (1966)	Zr, Ze, Pv, methods, thermodynamic formulae, bibliography, data quality but no data.
06BAU:	Bauer, E.; "Uber die Dissociationskonstanten schwacher Sauren"; Z. Phys. Chem.; 56, 212-222, (1906)	Pv, 25°C, 730 mmHg.

74BAU/GAS:	Bauer, K.; Gaspar, M.; "Solubility of Nagylengyel reservoir rock in carbon dioxide-saturated formation water"; Koolaj Foldgaz; 7, 140-144, (1974)	Pv, 120°C, 10-70 kPa, in $MgCO_3$ and $CaCO_3$ sat. sol.
41BEL/SHP:	Belopolsky; Shpunt; Palkina; Ref. Zh. Khim.; 4(6), 82-83, (1941)	Pv, in aq. NH_4Cl-$(NH_4)_2SO_4$.
53BER/PAT:	Berg, D.; Patterson, A., Jr.; "The high field conductance of aqueous solutions of carbon dioxide at 25°C. The true ionization constant of carbonic acid"; J. Am. Chem. Soc.; 75, 5197-5200, (1953)	Kk, 25°C, H_2CO_3.
78BER/VAN:	Berg, R.L.; Vanderzee, C.E.; "Thermodynamics of carbon dioxide and carbonic acid- (a) the standard enthalpies of solution of Na_2CO_3(s), $NaHCO_3$(s), and CO_2(g) in in water 298.15 K, (b) the standard enthalpies of formation standard gibbs energies of formation, and standard entropies of CO_2(aq), HCO_3^-(aq), CO_3^{2-}(aq) $NaHCO_3$(s), Na_2CO_3(s), $Na_2CO_3.H_2O$(s), and $Na_2CO_3.10H_2O$(s)"; J. Chem. Thermodyn.; 10, 1113-1136, (1978)	Hm, 25°C, CO_2, $NaHCO_3$, Na_2CO_3 in NaOH(dilute).
78BER/VAN2:	Berg, R.L.; Vanderzee, C.E.; "Enthalpies of dilution of sodium carbonate and sodium hydrogen carbonate solutions, and the standard enthalpies of ionization of aqueous carbonic acid, at 298.15K"; J. Chem. Thermodyn.; 10, 1049-1075, (1978)	Hm, Kk, 25°C, in carbonate sol.
29BHA/DHA:	Bhagwat, W.V.; Dhar, N.R.; "Dissociation constants of some inorganic acids from solubility measurements"; J. Indian Chem. Soc.; 6, 807-822, (1929)	Pv, 20-30°C in aq. sol. KF and salts of oxyacids, of P, Cr, Mo, V, Ti, B, Sb, and I.
23BJE:	Bjerrum, N.; "Dissoziationskonstanten von mehrbasischen Sauren und ihre Anwendung zur Berechnung molekularer Dimensionen"; Z. Phys. Chem.; 106, 219-242, (1923)	Zr, Kk, 18°C, citing earlier data.
1899BOH:	Bohr, C.; "Definition und Methode zur Bestimmung der Invasions- und Evasionscoefficenten bei der Auflosung von Gasen in Flussigkeiten. Werthe der Genannten Constanten sowie der Absorptionscoefficienten der Kohlensaure bei Auflosung in Wasser und in Chlornatriumlosungen"; Ann. Phys.; 68, 500-525, (1899)	Pv, 0-60°C, 1 atm.?, in H_2O and NaCl(aq).

76BOU:	Bourrie, G.; "Relations between pH, alkalinity, buffer intensity, and carbon dioxide equilibrium in natural waters"; Bull. Assoc. Fr. Etude Sol; No. 3, 141-159, (1976)	Pv, t ca.ambient, CO_2 in natural water. analysis of speciation.
69BOX/EMI:	Boxkes, W.; Emig, G.; "Bestimmung von CO_2-Loslichkeiten in Wasser"; Chem.- Ing.- Tech.; 41, 1273-1276, (1969)	Pv, 15-80°C, pH 3.9-6, $[CO_2]$ vs. pH (at 21°C)
33BRI/MAR:	Brinkman, R.; Margaria, R.; Roughton, F.J.W.; "III. The kinetics of the carbon dioxide-carbonic acid reaction"; Phil Trans; A232, 65-97, (1933)	Kk, 15-18°C?, pH = 1-13, H_2CO_3 (kinetics).
76BRU/BRU:	Bruice, P.Y.; Bruice, T.C.; Yagi, H.; Jerina, D.M.; "Nucleophilic displacement on the arene oxides of phenanthrene"; J. Am. Chem. Soc.; 98(10), 2973-2981, (1976)	Kk, 30°C, 2d ioniz., new data?
61BRU/NEL:	Bruckenstein, S.; Nelson, D.C.; "Acid-base dissociation constants in 1.0M sodium chloride"; J. Chem. Eng. Data; 6(4), 605-606, (1961)	Kk, 25°C, in NaCl(aq).
38BUC:	Buch, K.; "New determination of the second dissociation constant of carbonic acid in sea water"; Acta Acad. Aboensis Math Physica; 11(5), 5-16, (1938)	Kk, Za, 20°C, 1 atm., 2d ioniz.
39BUC:	Buch, K.; "Kohlensaure in Atmosphare und Meer an der Grenze Zum Arktikum"; Acta Acad. Aboensis Math Physica; 11(12), 5-31, (1939)	Pv, ca.20°C, ca.10^{-4} atm, in seawater.
45BUC:	Buch, K.; "Kolsyrejamuikten i Baltiksa Havet"; Fennia; 68(5), (1945)	Pv, in sea water, cited in 77OST
1855BUN:	Bunsen, R.; "Memoires sur la loi de l'absorption des gaz par les liquides"; Ann. Chim. Phys.; 43, 496-508, (1855)	Pv, 0-20°C, 1 atm.
1855BUN2:	Bunsen, R.; Justus Liebigs Ann. Chem.; 93, 1, (1855)	Pv, 0-20°C, 1 atm, same data as 1855BUN.
1855BUN3:	Bunsen, M.R.; Phil. Mag. (4th series); "On the absorption of gases"; 9, 116-130; 181-201, (1855)	Pv, 0-20°C, 1 atm, same data as 1855BUN.

27BUY/BRI:	Buytendyk, F.J.J.; Brinkman, R.; Mook, H.W.; "A study of the system carbonic acid, carbon dioxide and water I. Determination of the true dissociation constant of carbonic acid"; Biochem. J.; 21, 576-584, (1927)	Kk, 14-18°C, dil. sol., H_2CO_2(kinetics).
05CHR:	Christoff, A.; "Untersuchungen uber die Absorption des CO_2 in wasserigen Salzlosungen und binaren Flussigkeitsgemengen"; Z. Phys. Chem.; 53, 321-340, (1905)	Pv, 15°C, in dil. aq. salt and acid sol.
06CHR:	Christoff, A.; "Uber die Abhangigkeit der Absorption von der Oberflachenspannung"; Z. Phys. Chem.; 55, 622-634, (1906)	Pv, 20°C, in conc. H_2SO_4.
71COA/KIN:	Coan, C.R.; King, A.D., Jr.; "Solubility of water in compressed carbon dioxide, nitrous oxide, and ethane. Evidene for hydration of carbon dioxide and nitrous oxide in the Gas Phase"; J. Am. Chem. Soc.; 93, 1857-1862, (1971)	Pv, t = 25 - 100°C, p = 1 - 60 atm.
82COB/MUR:	Cobble, J.W.; Murray, R.C., Jr.; Turner, P.J.; Chen, K.; 'High-temperature thermodynamic data for species in aqueous solution'; EPRI NP-2400, Electric Power Research Institute, Palo Alto, CA (1982)	Ze, Kk, Pv, 0-300°C, thermal functions, 2d ioniz.
79COL:	Collins, P.L.F.; "Gas hydrates in CO_2-bearing fluid inclusions and the use of freezing data for estimation of salinity"; Economic Geology; 74, 1435-1444 (1979)	Px, -30 to 30°C.
17COS:	Coste, J.H.; "The absorption of atmospheric gases by water"; J. Soc. Chem. Ind.; 36, 846-853, (1917)	Pv, Zr, review of early meas.
62COX/HEA:	Cox, J.D.; Head, A.J.; "Solubility of carbon dixoide in hydrofluoric acid solutions"; Trans. Faraday Soc.; 58, 1839-1845, (1962)	Pv, Hm, 20-30°C, 1 atm., in H_2O and HF(aq).
67CUL/KES:	Culberson, C.; Kester, D.R.; Pytkowicz, R.M.; "High-pressure dissociation of carbonic and boric acids in seawater"; Science; 157, 59-61, (1967)	Kk, 22°C, 1-654 atm., 1st and 2d ioniz. in seawater.
68CUL/PYT:	Culberson, C.; Pytkowicz, R.M.; "Effect of pressure on carbonic acid, boric acid, and the pH in seawater"; Limnol. Oceanog. 13(3), 403-417, (1968)	Kk, 2-22°C, 1-1000 atm, 1st and 2d ioniz. in seawater.

38CUR/HAZ:	Curry, J.; Hazelton, C.L.; "The solubility of carbon dioxide in deuterium oxide at 25°"; J. Am. Chem. Soc.; 60, 2771-2773, (1938)	Pv, 25°C, in D_2O.
38CUR/HAZ2:	Curry, J.; Hazelton, C.J.; "The first thermodynamic ionization constant of deuterio-carbonic acid at 25°"; J. Am. Chem. Soc.; 60, 2773-2776, (1938)	Kk, 25°C, 1 atm, 1st ioniz.
54CUT/STR:	Cuta, F.; Strafelda, F.; "The second dissociation constant of carbonic acid between 60 and 90°C"; Chem. Listy; 48, 1308-1313, (1954)	Kk, 60-90°C, 2d ioniz. in dil. $NaHCO_3/Na_2CO_3$ sol.
65DIS/DIS:	Disteche, A.; Disteche, S.; "The effect of pressure on pH and dissociation constants from measurements with buffered and unbuffered glass electrode cells"; J. Electrochem. Soc.; 112, 350-354, (1965)	Kk, Dm, 22°C p = 1000 kg cm^{-2}?, 1st and 2d ioniz., in KCl(aq).
67DIS/DIS:	Disteche, A.; Disteche, S.; "The effect of pressure on the dissociation of carbonic acid from measurements with buffered glass electrode cells"; J. Electrochem. Soc.; 114, 330-340, (1967)	Kk, Dm, 22°C, 1-1000 bar pH 5.1-9.6 I=0-1.0 1st and 2d ioniz.
56DOD/STU:	Dodds, W.S.; Stutzman, L.F.; Sollami, B.J.; "Carbon dioxide solubility in water"; Ind. Eng. Chem.; 92-95, (1956)	Zc, Pv, 0-120°C, 1-700 atm.
73DYR/HAN:	Dyrssen, D.; Hansson, I.; "Ionic medium effects in sea water. Comparison of acidity constants of carbonic acid in sodium chloride and synthetic sea water"; Marine Chem.; 1(2), 137-149, (1973); [CA 79:70056c]	Zr, Kk, 1st. and 2d ioniz., in seawater.
70EDM/GIE:	Edmond, J.M.; Gieskes, J.M.T.M.; "On the calculation of the degree of saturation of sea water with respect to calcium carbonate under in situ conditions"; Geochim. Cosmochim. Acta; 34, 1261-1291, (1970)	Kk, Za, 5-35°C, 1-1000 atm. in seawater.
78EDW/MAU:	Edwards, T.J.; Maurer, G.; Newman, J.; Prausnitz, J.M.; "Vapor-liquid equilibria in multicomponent aqueous solutions of volatile weak electrolytes"; AIChE J.; 24(6), 966, (1978)	Zc, Pv, Kk, 0-170°C, I to 6m, 1st ioniz.

75EDW/NEW:	Edwards, T.J.; Newman, J.; Prausnitz, J.M.; "Thermodynamics of aqueous solutions containing volatile weak Electrolytes"; AIChE J.; 21(2), 248-259, (1975)	Zc, Pv, Kk, 0-100°C, m(salt) to 2, 1st ioniz.
59ELL:	Ellis, A.J.; "The effect of pressure on the first dissociation constant of 'carbonic acid'"; J. Chem. Soc.; 3689-3699, (1959)	Kk, 25-65°C, P(total) to 3000 atm, 1st ioniz.
59ELL2:	Ellis, A.J.; "The system Na_2CO_3-$NaHCO_3$-CO_2 H_2O at temperatures up to 200°"; Am. J. Sci.; 257, 287-296, (1959)	Pv, 120-200°C, $Na_2CO_3/NaHCO_3$ sol.
59ELL3:	Ellis, A.J.; "The solubility of carbon dioxide in water at high temperatures"; Am. J. Sci.; 257, 217-234, (1959)	Pv, 115-350°C, $P(CO_2)$ < 5 atm.
59ELL4:	Ellis, A.J.; "The solubility of calcite in carbon dioxide solutions"; Am. J. Sci.; 257, 354-365, (1959)	Pv, 100-300°C, $P(CO_2)$ = 1-4 atm., sat. $CaCO_3$(aq).
57ELL/FYF:	Ellis, A.J.; Fyfe, W.S.; "Hydrothermal chemistry"; Rev. Pure Appl. Chem.; 7, 261-316, (1957)	Zr, Pv, 25-370°C, Kk, 0-300°, (graph)
63ELL/GOL:	Ellis, A. J.; Golding, R. M.; "The solubility of carbon dioxide above 100°C in water and in sodium chloride solutions"; Amer. J. Sci.; 261, 47-60, (1963)	Pv, 150-300°C, m(NaCl) = 0-2.
56END/KLE:	Enders, C.; Kleber, W.; Paukner, E.; "The solubility of carbon dioxide, oxygen, and nitrogen in beer and water"; Brauwissenschaft; 2-8, 50-59, (1956)	Pv, t=?, in H_2O, 4% EtOH and beer.
57ERE:	Eremenko, V.Ya.; "The value of the ionization constants of carbonic acid"; Gidrokhim. Materialy; 27, 122-134, (1957); [CA 52:13379c]	Zr, Kk, literature review.
59ERE:	Eremenko, V.Ya.; Gidrokhim. Materialy; 28, 233, (1959)	Zr, Kk, 0-38°C, 2d ioniz. (from 64SIL/MAR).
75ESP:	Espinoza Gala, O.; "Diagram for calculation of molar heats of solution of carbon dioxide in water"; Bol. Soc. Quim. Peru; 41, No. 2, 91-93, (1975)	Hm, Zc, -20 to +20°C, graphical correlation, data source not given.

75ESP2:	Espinoza Gala, O.; "Generalized nomogram for calculation of equilibrium data in the carbon dioxide-water system"; Bol. Soc. Quim. Peru; 41, No. 2, 94-100, (1975)	Zc, Pv, graphical correlation, data source not given.
52ESS/GAN:	Essery, R.E.; Gane, R.; "Effect of storage on beers concentrated by freezing, and on beers kept in the frozen state- solubility of carbon dioxide in ice"; J. Inst. Brewing; 58, 129-133, (1952); [CA 46:9775a]	Pv, -20 and -5°C, in ice.
76EVE/MOO:	Evelein, K.A.; Moore, R.G.; Heidemann, R.A.; "Correlation of the phase behavior in the systems hydrogen sulfide-water and carbon dioxide-water"; Ind. Eng. Chem.; 15(3), 423-428 (1976)	Zc, Pv, Px, t = 290-520°C, p to 2000 atm, 2 and 3 phase equilibrium.
24FAU:	Faurholt, C.; "Etudes sur les solutions aqueuses d'anyhydride carbonique et d'acide carbonique"; J. Chim. Phys.; 21, 400-455, (1924)	Kk, 0-18°C, H_2CO_3.
21FAU:	Fauholt, C.; "Uber die Prozesse "$NH_2COOH_4 + H_2O = (NH_4)_2CO_3$" und "$CO_2 + H_2O = H_2CO_3$"; Z. Anorg. Allgem. Chem.; 120, 85-102, (1921)	Kk, 0°C, H_2CO_3 (kinetics and thermo).
08FIN:	Findlay, A.; "Einfluss von Kolloiden auf die Absorption von gasen, insbesondere von Kohlendioxyd, in Wasser"; Kolloid Z.; 3, 169-170, (1908)	Pv, 25°C, in H_2O and with added colloids.
10FIN/CRE:	Findlay, A.; Creighton, H.J.M.; "The influence of colloids and fine suspensions on the solubility of gases in water. Part I. Solubility of carbon dioxide and nitrous oxide"; J. Chem. Soc.; 97, 536-561, (1910)	Pv, 25°C, in H_2O and aq. suspensions of $Fe(OH)_3$, dextrin, As_2S_3, and nat. macro-molecules.
15FIN/HOW:	Findlay, A.; Howell, O.R.; "The solubility of carbon dioxide in water in the presence of starch"; J. Chem. Soc.; 107, 282-284, (1915)	Pv, 25°C, in aq. starch sol.
11FIN/SHE:	Findlay, A.; Shen, B.; "The solubility of carbon dioxide in beer"; J. Chem. Soc.; 1313-1320, (1911)	Pv, 25°C, in H_2O, alcohol-water sol., and in beer.

12FIN/SHE:	Findlay, A.; Shen, B.; "The influence of colloids and fine suspensions on the solubility of gases in water. Part II. solubility of carbon dioxide and of hydrogen"; J. Chem. Soc.; 101, 1459-1468, (1912)	Pv, 25°C, 760-1350mmHg, also salt sol. and colloids.
13FIN/WIL:	Findlay, A.; Williams, T.; "The influence of colloids and fine suspensions on the solubility of gases in water. Part III. Solubility of carbon dioxide at pressures lower than atmospheric"; J. Chem. Soc.; 103, 636-645, (1913)	Pv, 25°C, in H_2O, and aq. suspensions of $Fe(OH)_3$, dextrin, starch, etc.
59FOK:	Fokeev, V.M.; "Determination of the saturation pressure of carbon dioxide in water"; Izvst. Vysshikh Ucheb. Zavedenii, Geol. i Razvedka; (6), 87-92, (1959); [CA 54:6280i]	Pv, t = ?, $x(CO_2)$ = 0.5-0.95.
29FRE/JOH:	Frear, G.L.; Johnston, J.; "The solubility of calcium carbonate (calcite) in certain aqueous solutions at 25°"; J. Am. Chem. Soc.; 51, 2082-2093, (1929)	Pv, 25°C, 0.003-1 atm., in sat. $CaCO_3$(aq).
58FRY/NIL:	Frydman, M.; Nilsson, G.; Rengemo, T.; Sillen, L.G.; "Some solution equilibria involving calcium sulfite and carbonate III. The acidity constants of H_2CO_3 and H_2SO_3, and $CaCO_3$ $CaSO_3$ equilibria in $NaClO_4$ Medium at 25°C"; Acta Chem. Scand.; 12, 378-884, (1958)	Kk, 25°C, 1st and 2d ioniz., in $NaHCO_3/NaCO_3/NaClO_4$ sol.
26GAT:	Gatterer, A.; "The absorption of gases by colloidal solutions"; J. Chem. Soc.; 299-316, (1926)	Pv, 5-25°C, in colloidal sol.
04GEF:	Geffcken, G.; "Beitrage zur Kenntnis der Loslichkeitsbeeinflussung"; Z. Phys. Chem.; 49, 257-302, (1904)	Pv, 15 and 25°C, in aq. sol. of acids and of alkali metal salts.
79GEH/LEN:	Gehrig, M.; Lentz, H.; Franck, E.U.; "Thermodynamic properties of water-carbon dioxide-sodium chloride mixtures at high temperatures and pressures"; High-Pressure Sci. Technol., AIRAPT Conf., 6th; 1, 539-542 (1979)	Pv, Px, t<500°C, p<3kbar.
71GER/BIT:	Gerecke, J.; Bittrich, H.J.; Wiss. Tech. Rochsch. Chem. Carl Schorlemmer Leuna - Mersebur; 13, 115, (1971)	Pv, 25°C, (from 77WIL/BAT)

80GIG:	Giggenbach, W.F.; "Geothermal gas equilibria"; Geochim. Cosmochim. Acta; 44, 2021-2032, (1980)	Pv, 100-300°C, application of previously published data to geochemical equilibria.
82GIL/WIL:	Gillespie, P.C.; Wilson, G.M.; 'Vapor-liquid and liquid-liquid equilibria: water-methane, water-carbon dioxide, water-hydrogen sulfide, water-npentane, water-methane-npentane'; Research Report 48, Gas Processors Association; Tulsa, Okla., (1982)	Pv, t = 60 - 600°F, p = 17 - 3000 psi
53GJA:	Gjaldbaek, J. Chr.; "The solubility of carbon dioxide in perfluoro-n-heptane, normal heptane, cyclo-hexane, carbon tetrachloride, benzene, carbon disulphide and aqueous solution of aerosol"; Acta Chem. Scand.; 7, 537-544, (1953)	Pv, 25°C, in H_2O, CS_2, CCl_4, C_6H_6, C_7F_{16}, C_7H_{16}.
60GLA/LON:	Glasoe, P.K.; Long, F.A.; "Use of glass electrodes to measure acidities in deuterium oxide"; J. Phys. Chem.; 64, 188-190, (1960)	Kk, 25°C, 1st ioniz., in D_2O and H_2O.
58GOL/MAL:	Golutvin, Yu., M.; Malysheva, T.V.; Skorobogatova, V.I.; "Solubility of hydrogen sulfide and carbon dioxide in water and aqueous solutions of ammonia and phenol"; Izvest. Sibir. Otdel. Akad. Nauk SSSR; (8), 83-87, (1958); [CA 53:9787i]	Pv, 20°C.
74GOR/BAS:	Gordienko, V.I.; Bashirova, L.Kh.; Leibert, B.M.; "Hydrolysis constants for carbonate and bicarbonate ions in highly concentrated sodium chloride aqueous solutions"; Izv. Vyssh. Ucheb. Zaved. Khim. Khim. Tekhnol.; 17, 1127-1131, (1974); [CA 82-22381]	Kk, 25°C? 2d ioniz., $NaOH/NaHCO_3/NaCl(aq)$.
73GRE:	Greenwood, H.J.; "Thermodynamic properties of gaseous mixtures of H_2O and CO_2 between 450° and 800°C and 0 to 500 bars"; Am. J. Sci.; 273, 561-571 (1973)	Da, 450-800°C, in gaseous CO_2 + H_2O mixtures.
20HAE:	Haenel, O.; "The strength of carbonic acid at higher pressures"; Centr. Min. Geol.; 25-32, (1920); [CA 15:620]	Pv, Kk, 0°C, 1-50 atm.

1885HAM:	Hamberg, A.; "Beitrage zur Chemie des Meerwassers II. Ein Apparat zur Bestimmung des Stickstoffgases und der Kohlensaure im Meerwasser"; J. Prakt. Chem.; [2] 33, 433-463, (1885)	Pv, 0-20°C, in full-strength and diluted seawater.
73HAN:	Hansson, I.; "The determination of dissociation constants of carbonic acid in synthetic sea water in the salinity range of 20-40 ppt. and temperature range of 5-30°C"; Acta Chem. Scand.; 27, 931-944, (1973)	Kk, Za, 5-30°C, 1 atm, 1st and 2d ioniz. in seawater.
73HAN2:	Hansson, I.; "A new set of acidity constants for carbonic acid and boric acid in sea water"; Deep-Sea Research; 20, 461-478, (1973)	Kk, Zc, 10-35°C, 1 atm, in seawater.
58HAN/BER:	Han, S.T.; Bernardin, L.J.; "Ionic activity coefficients of sodium bicarbonate"; Tappi; 41, 540-544, (1958)	Kk, Dm, Da, Zc, 20-65°C, 1 atm, I to 1.1
01HAN/VAG:	Hantzsch, A.; Vagt, A.; "Uber den Zustand Geloster Stoffe auf Grund von Verteilungsversuchen"; Z. Phys. Chem.; 38, 705-42, (1901)	Pv, 0-90°C, $P(CO_2)$ = 0.3-0.7 atm.
45HAR/BON:	Harned, H.S.; Bonner, F.T.; "The first ionization of carbonic acid in aqueous solutions of sodium chloride"; J. Am. Chem. Soc.; 67, 1026-1031, (1945)	Kk, 0-50°C, 1st ioniz., m(NaCl) = 0-1.
43HAR/DAV:	Harned, H.S.; Davis, R. Jr.; "The ionization constant of carbonic acid in water and the solubility of carbon dioxide and in water and aqueous salt solutions from 0 to 50°"; J. Am Chem. Soc.; 65, 2030-2037, (1943)	Pv, Kk, 0-50°C, 1st ioniz., in H_2O and Na_2CO_3(aq).
41HAR/SCH:	Harned, H.S.; Scholes, S.R., Jr.; "The ionization constant of HCO_3^- from 0 to 50°"; J. Am. Chem. Soc.; 63, 1706-1709, (1941)	Kk, Hr, Ql, 2d ioniz., 0-50°C, in Na_2CO_3(aq).
16HAS:	Hasselbalch, K.A.; "Die Berechnung der Wasserstoffzahl des Blutes aus der freien und gebundenen Kohlensaure desselben, und die Sauerstoffbindung des Blutes als Funktion der Wasserstoffzahl"; Biochem. Z.; 78, 112-144, (1916)	Kk, 18 and 38°C, in $NaHCO_3$(aq) and blood.

25HAS/SEN:	Hastings, A.B.; Sendroy, J., Jr.; "The effect of variation in ionic strength on the apparent first and second dissociation constants of carbonic acid"; J. Biol. Chem.; 65, 445-455, (1925)	Kk, 38°C, 1st and 2d ioniz., in $NaHCO_3/Na_2CO_3/NaCl/NaOH$ sol.
73HAW/PYT:	Hawley, J.E.; Pytkowicz, R.M.; "Interpretation of pH measurements in concentrated electrolyte solutions"; Marine Chemistry; 1, 245-250, (1973)	Kk, 25°C, 1 atm, in NaCl.
71HAY/MAL:	Hayduk, W.; Malik, V.K.; "Density, Viscosity, and carbon dioxide solubility and diffusivity in aqueous ethylene glycol solutions"; J. Chem. Eng. Data; 16, 143-146, (1971)	Pv, 25°C, 1 atm., in H_2O-glycol mixt, x=0 to 1
15HEA:	Heath, W.P.; Privately Printed, Atlanta, GA.; (1915)	Pv, see 58LIN for data.
67HEL:	Helgeson, H.C.; "Thermodynamics of complex dissociation in aqueous solution at elevated temperatures"; J. Phys. Chem.; 71(10), 3121-3126, (1967)	Ze, Kk, Pv, 0-200°C
76HEL/KIR:	Helgeson, H.C.; Kirkham, D.H.; "Theoretical prediction of the thermodynamic properties of aqueous electrolytes at high pressures and temperatures. III. Equation of state for aqueous species at infinite dilution"; Am. J. Sci.; 276, 97-240, (1976)	Kk, Zc, Ze, 25-3000°C, 1-1000 atm.
81HEL/KIR:	Helgeson, H.C.; Kirkham, D.H.; Flowers, G.C.; "Theoretical prediction of the thermodynamic behavior of aqueous electrolytes at high pressures and temperatures: IV. Calculation of activity coefficients, osmotic coefficients, and apparent molal and standard and relative partial molal properties to 600°C and 5kB"; Am. J. Sci.; 281, 1249-1516, (1981)	Ze, Kk, Da, Dm, 0-600°C, 0-5kB
70HER/GOD:	Hertz, M.B.; Godbold, T.M.; "Sodium carbonate equilibrium with monoethanolamine additive"; Roth, J.A.; 15(1), 137-139, (1970)	Pv, Kk, 30°C, in $NaHCO_3/Na_2CO_3$ sol. and with added monoethanolamine.
75HOR:	Horrath, A.L.; "Reference literature to the critical properties of aqueous electrolyte solutions"; J. Chem. Infor. Comp. Sci.; 15, 245-247 (1975)	Zr, Vc

57HOU/MCL:	Houghton, G.; McLean, A. M.; Ritchie, P. D.; "Compressibility, fugacity, and water-solubility of carbon dioxide in the region 0-36 Atm. and 0-100°C"; Chem. Eng. Sci.; No. 6, pg. 132, (1957)	Pv, Vg, 0-100°C, p = 0-36 atm., x(CO_2) = 0.6 to 10, reanalysis, new eq. of state.
72HU/SIN:	Hu, A.T.; Sinke, G.C.; Mansson, M.; Ringner, B.; "Test Substances for Bomb Combustion Calorimetry. p-chlorobenzoic acid"; J. Chem. Thermodyn.; 4, 283-299, (1972)	Ze, Pv, Hm, 25°C.
78JHO/NEA:	Jho, C.; Nealon, D.; Shogbola, S.; King, A. D., Jr.; "Effect of pressure on the surface tension of water adsorption of hydrocarbon gases and carbon dioxide on water at temperatures between 0 and 50°C"; J. Colloid Interface Sci.; 65, 141-154, (1978)	Hs, 25°C, effect of CO_2 on surface tension of H_2O.
01JUS:	Just, G.; "Loslichkeit von gasen in Organischen Losungsmitteln"; Z. Phys. Chem.; 37, 342-367, (1901)	25°C, 1 atm.?, also in 43 organic liq. at 15, 20, and 25°C.
73KAL/DUB:	Kalinin, Yu. Ya.; Dubinin, A. B.; "Specific heats of a boiling liquid and dry saturated water vapor, Freon 21, carbon dioxide along the left and right branches of a boundary curve"; Izv. Vyssh. Ucheb. Zaved., Energ.; 16, No. 6, 142-147, (1973)	Ql, Qh, Qg, 0-320°C, and sat. process.
34KAU:	Kauko, Y.; "The first dissociation constant of the carbonic acid equilibrium"; Ann. Acad. Sci. Fennicae; A39(3), 88, (1934); [CA 29:3218 7]	Zr, Kk, 1st ioniz., 0-25°C.
35KAU:	Kauko, Y.; "The value of the first dissociation constant of carbonic acid"; Ann. Acad. Sci. Fennicae; No. 9, 8 pp. (1935); [CA 30-2828 4]	Ze, 18°C, 1st ioniz.
37KAU/AIR:	Kauko, Y.; Airola, A.; "Die Zweite Dissoziationskonstante der Kohlensaure"; Z. Phys. Chem.; A179, 307-313, (1937)	Zr, Kk, 0-38°C, dilute $Na_2CO_3/NaHCO_3$ sol.
35KAU/CAR:	Kauko, Y.; Carlberg, J.; "Zur Kenntnis der Ersten Dissoziationskonstante der Kohlensaure"; Z. Phys. Chem.; A173, 141-149, (1935)	Kk, 18°C, 1st ioniz., $NaHCO_3$ sol.
39KAU/ELO:	Kauko, Y.; Elo, H.; "Die erste Dissoziation der Kohlensaure"; Z. Phys. Chem.; A184, 211-230, (1939)	Ze, Kk, 1st ioniz., 0-25°C.

16KEN:	Kendall, J.; "The specific conductivity of pure water in equilibrium with atmospheric carbon dioxide"; J. Am. Chem. Soc.; 38, 1480-1497, (1916)	Pv, Kk, 1st ioniz., 0-25°C.
60KER:	Kern, D.M.; "The hydration of carbon dioxide"; J. Chem. Education; 37, 14-23, (1960)	Zr, Kk, 25°C, H_2CO_3 (kinetics and thermo).
73KHI/KAD:	Khitarov, N. I.; Kadik, A. A.; "Water and carbon dioxide in magmatic melts and peculiarities of the melting process"; Contrib. Mineral. Petrology; 41, 205-215, (1973)	Pv, above 1000°C, p = 10kb.
37KIS/LAJ:	Kiss, A.V.; Lajtai, I.; Thury, G.; "Uber die Loslichkeit von gasen in Wasser-Nichtelektroltgemischen"; Z. Anorg. Allgem. Chem.; 233, 346-352, (1937)	Pv, 0-25°C, in H_2O and its mixtures with org. compounds.
26KLE/HER:	Klemenc, A.; Herzog, M.; "Zur Kenntnis der Dissoziationskonstante der Kohlensaure"; Montsh.; 47, 405-413, (1926)	Kk, 0, 12.5°C, 1st ioniz., very dil. solutions.
35KOB/WIL:	Kobe, K.A.; Williams, J.S.; "Confining liquids for gas analysis"; Ind. Eng. Chem.; 7(1), 37-38, (1935)	Pv, 25°C, 1 atm., in H_2O, acid and salt sol.
61KOE/ENG:	Koefoed, J.; Engel, K.; "Kinetics of the carbon dioxide hydration under conditions of enforced stationarity"; Acta Chem. Scand.; 15, 1319-1326, (1961)	Kk, 0°C, H_2CO_3 (kinetics).
28KOL/BOS:	Kolthoff, I.M.; Bosch, W.; "The influence of neutral saltson acid-salt equilibria III. The second dissociation constant of carbonic acid and the influence of salts on the activity of the hydrogen ions in a bicarbonate carbonate mixture"; Rec. Trav. Chim.; 47, 819-825, (1928)	Kk, 25°C, 2d ioniz., in H_2O and alkali metal salt sol.
80KOR/KAR:	Korbutova, Z. V.; Karpova, Yu. G.; Leites, I. L.; "Solubility of carbon dioxide in aqueous solutions of potassium carbonate"; Khim. Prom-st.; No. 12, 721-725, (1980); Tr. The Soviet Chemical Industry, 1401-1404, (1980)	Pv, 40-70°C?, 20-40 wt%. K_2CO_3

70KRA/SOB:	Kratochvil, J.; Sobr, J.; Matous, J.; Pick, J.; "Solubility of carbon dioxide in heavy water at pressures up to 40 Atm."; Collect. Czech. Chem. Commun.; 35, 3761-3764, (1970)	Pv, 25°C, p to 40 atm., sol. in D_2O.
35KRI/SHA:	Kritschewsky, I.R.; Shaworonkoff, N.M.; Aepelbaum, V.A.; "Gemeinsame Loslichkeit der gase in Flussigkeiten unter Druck. I. Loslichkeit des Kohlendioxyds in Wasser aus seinen Gemischen mit Wasserstoff bei 20 und 30°C und Gesamtdruck bis 30 kg/cm^2"; Z. Phys. Chem.; A175, 232-238, (1935)	Pv, 20-30°C, 5-30 bar.
82KRU/FRA:	Kruse, R.; Franck, E.U.; "Raman spectra of hydrothermal solutions of CO_2 and $KHCO_3$ at high temperatures and pressures"; Ber. Bunsenges. Phys. Chem.; 86, 1036-1038 (1982)	Kk, 22-300°C, 1st ioniz., p to 2000 bar.
71KRY/STA:	Kryukov, P.A.; Starostina, L.I.; Tarasenko, S.Ya.; Pavlyuk, L.A.; Smolyakov, B.S.; "Ionization constants of carbonic acid, hydrogen sulfide, boric acid, and sulfuric acid at high temperatures"; Larionov, E.G.; Mezhdunar. Geokhim. Kongr., [Dokl.], 2, 186-198, (1971); [CA 81-69193]	Kk, 25-100°C, 1st and 2d ioniz.
22KUN:	Kunerth, W.; "Solubility of CO_2 and N_2O in certain solvents"; Phys. Rev.; 19, 512-524 (1922)	Pv, 18-34°C, approx. 1 atm. and 2d ioniz.
69LAR/HEP:	Larson, J.W. ; Hepler, L.G. ; "Heats and entropies of 0f ionization"; 'Solute-Solvent Interactions', Coetzee, J.F. and Ritchie, C.D.(eds); Marcel Dekker, NY and London, (1969)	Zr,Kk, Hr, 25°C, 1st and 2d ioniz.
71LI/TSU:	Li, Y.-H.; Tsui, T.-F.; "Solubility of carbon dioxide in water and sea water"; J. Geophys. Res. ; 76,4203-4207, (1971)	Pv, t = 0-30°C, [salt] = 0-2.9%, Cl^- and 0.64m NaCl.
58LIN:	Linke, W.F. ; 'Solubilities' , 4th ed.; D. Van Nostrand, Princeton, (1958) [originated by A. Seidel]	Ze, Pv, 0-1000ψ, compiled solubility data for CO_2 in water salt solutions and mixed solvents.

75LIN/BOR:	Lindberg, A.; Borno, C.; "Calculation of calcium carbonate-carbon dioxide equilibrium in water and mixtures of water"; Verh.-Int. Ver. Theor. Angew. Limnol.; No. 19, Pt. 2, 1511-1517, (1975)	Za, Kk, 0-100°C, selected ionization constants (from Schmitt(1955)).
58LJU/LAM:	Ljunggren, S.; Lamm, O.; "A relaxation method for the determination of moderately rapid reaction rates near chemical equilibrium"; Acta Chem. Scand.; 12, 1834-1850, (1958)	Kk, 4°C, H_2CO_3 (kinetics and thermo).
57LOP:	Loprest, F.I.; "A method for the rapid determination of the solubility of gases in liquids at various temperatures"; J. Phys. Chem.; 61, 1128-1130 (1957)	Pv, Px, 2--60°C.
33MAC/BEL:	MacInnes, D.A.; Belcher, D.; "The thermodynamic ionization constants of carbonic acid"; J. Am. Chem. Soc.; 55, 2630-2646, (1933)	Kk, 25°C, 1st and 2d ioniz.
35MAC/BEL:	MacInnes, D.A.; Belcher, D.; "The thermodynamic ionization constants of carbonic acid at 38° from electromotive force measurements"; J. Am. Chem. Soc.; 57, 1683-1685, (1935)	Kk, 38°C, 1st and 2d ioniz.
1877MAC:	Mackenzie, J.J.; "Uber die Absorption der gase durch Salzlosungen"; Ann. Phys.; 237, 438, (1877)	Pv 8-30°C, 1 atm?, aq NaCl, KCl, NH_4Cl, $CaCl_2$, $SrCl_2$, and $BaCl_2$
55MAI/BAB:	Mai, K.L.; Babb, A.L.; "Vapor-liquid equilibria by radioactive tracer techniques. System carbon dioxide hydrogen sulfide-sodium carbonate-sodium bicarbonate sodium sulfide-water"; Ind. Eng. Chem.; 47, 1749-1757, (1955)	Pv, 20-65°C, in $Na_2CO_3/NaHCO_3$ sol.
74MAK/KAP:	Makarov, A. V.; Kapyrina, Yu. D.; Fokeev, V. M.; "Solubility of carbon dioxide in aqueous-saline solutions under pressure"; Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; 17, No. 4, 90-92, (1974)	Pv, 290-370 K, in 0.1M NaCl.
59MAL:	Malinin, S.D.; "The system H_2O-CO_2 at high temperatures pressures"; Geokhimiya; No. 3, 235-245, (1959); [CA 53:18612f] Tr. Geochemistry No. 3 292, (1959)	and Pv, t = 200-330°C, p = 100-500kg/cm^2, [salt] = 0, 10% $CaCl_2$.

74MAL:	Malinin, S.D.; "Questions concerning the thermodynamics of the H_2O - CO_2 system"; Geokhimiya; No. 10, 1523-1549, (1974)	Zr, V, 100-600°C.
78MAL:	Malinin, S.D.; "CO_2 solubility in aqueous solutions of electrolytes"; Geokhimiya; No. 10, 1452-1465, (1978)	Zc, Pv, 25-300°C, in NaCl and $CaCl_2$ sol.
75MAL/KUR:	Malinin, S. D.; Kurovskaya, N. A.; "Solubility of carbon dioxide in chloride solutions at elevated temperatures and carbon dioxide pressures"; Geochem. Intern.; 12, 199-201, (1975)	Pv, t = 25-100°C, p to 50kg/cm^{-2}, [salt] = 0 to 7 molal, solubility in NaCl and $CaCl_2$ solutions.
72MAL/SAV:	Malinin, S.D.; Savelyeva, N.I.; "The solubility of CO_2 in NaCl and $CaCl_2$ solutions at 25, 50 and 75° under elevated CO_2 pressures"; Geochem. Int.; 9, 410-418 (1972)	Pv, 25-75°, in NaCl and $CaCl_2$ solutions
41MAR/KOB:	Markham, A.E.; Kobe, K.A.; "The solubility of gases in liquids"; Chem. Rev.; 41, 519-588, (1941)	Zr, Pv, methods, thermodynamic formulae, bibliography, data quality but no values for solubilities.
41MAR/KOB2:	Markham, A.E.; Kobe, K.A.; "The solubility of carbon dioxide in aqueous solutions of sulfuric and perchloric acids at 25°"; J. Am. Chem. Soc.; 63, 1165-1166, (1941)	Pv, 25°C, in H_2SO_4(aq) and in $HClO_4$(aq), 0-100%.
41MAR/KOB3:	Markham, A.E.; Kobe, K.A.; "The solubility of carbon dioxide and nitrous oxide in aqueous salt solutions"; J. Am. Chem. Soc.; 63, 449-454 (1941)	Pv, 0.2-40°C, in various salt solutions.
58MAR/LOP:	Marshall, W.L.; Loprest, F.J.; Secoy, C.H.; "The equilibrium $Li_2CO_3(s) + CO_2 + H_2O = 2\ Li_+ + 2HCO_3^-$ temperature and pressure"; J. Am. Chem. Soc.; 80, 5646-5651, (1958)	Pv, 200-290°C, P to 200 atm., at high in sat. Li_2CO_3 sol.
74MAS/KIN:	Massoudi, R.; King, A. D., Jr.; "Effect of pressure on the surface tension of water. Adsorption of low molecular weight gases on water at 25°C"; J. Phys. Chem.; 78 , 2262-2266, (1974)	Ps, 25°C.

69MAT/SOB: Matous, J.; Sobr, J.; Novak, J. P.; Pick, J.; "Solubility of carbon dioxide in water at pressures up to 40 atm"; Collect. Czech. Chem. Commun.; 34, 3982-3985, (1969)

Pv, 30-80°C, $P(CO_2)$ = 10.38 atm.

03MCC: McCoy, H.N.; "Equilibrium in the system composed of sodium carbonate, sodium bicarbonate, carbon dioxide, and water"; Amer. Chem. J.; 29, 437-462, (1903)

Kk, near 25°C, 2d ioniz., in $NaHCO_3/Na_2CO_3$ sol.

73MEH/CUL: Mehrbach, C.; Culberson, C.H.; Hawley, J.E.; Pytkowicz, R.M.; "Measurement of the apparent dissociation constants of carbonic acid in sea water at atmospheric pressure"; Limnol. Oceanogr.; 18(6), 897-907, (1973); [CA 80:112427c]

Kk, 2-35°C, 1 atm., in seawater.

57MEI/SCH: Meier, J.; Schwarzenbach, G.; "Eine mit Glaselecktroden ausgerustete Stromungsapparatur (Uber die H_2CO_3 aciditatskonstante der wahren Kohlensaure und deren Dehydratationsgeschwindigkeit"; Helv. Chem. Acta; 40, 907-917, (1957)

Kk, 20°C, formation of (kinetics and thermo).

73MEI/PEP: Meissner, H.P.; Peppas, N.A.; "Activity coefficients. aqueous solutions of polybasic acids and their salts"; AIChE J.; 19, 806-809, (1973)

Zc, Da, Pv, 25°C, generalized activity coefficient correlation (to high ionic strengths).

22MEN: Menzel, H.; "Uber Dissoziations- und Hydrolysengleichgewichte in Losungen kohlensaurer und borsaurer Salze"; Z. Phys. Chem.; 100, 276-315, (1922)

Kk, 18°C, 1st ioniz., in dil. $NaHCO_3$(aq).

24MET: Metschl, J.; "The supersaturation of gases in water and certain organic liquids"; J. Phys. Chem.; 28, 417-437, (1924)

Pv, 25°C?, supersaturation.

25MIC/MIZ: Michaelis, L.; Mizutani, M.; "Die Dissoziation der Schwachen Elektrolyte in Wasserig-alkoholischen Losungen"; Z. Phys. Chem.; 116, 135-139, (1925)

Kk, 20°C, 2d ioniz. in H_2O and mixt. with EtOH

14MIC/RON: Michaelis, L.; Rona, P.; "Die Dissoziationskonstante der Kohlensaure"; Biochem. Z.; 67, 182-192, (1914)

Kk, 16-37°C, 1st and 2d ioniz., in $NaHCO_3/Na_2CO_3$/NaCl sol.

72MIL/BER:	Millero, F.J.; Berner, R.A.; "Effect of pressure on carbonate equilibria in seawater"; Geochim. Cosmochim. Acta; 36, 92-98, (1972)	Kk, Dm, 25°C, 1000 atm. calc. of partial molar volume from pressure dependence.
40MIL/URE:	Mills, G.A.; Urey, H.C.; "The kinetics of isotopic exchange between carbon dioxide, bicarbonate ion, carbonate ion and water"; J. Am. Chem. Soc.; 62, 1019-1026, (1940)	Kk, 0 and 25°C, H_2CO_3?, ^{18}O exchange.
31MOR/MAA:	Morgan, O.M.; Maass, O.; "An investigation of the equilibria existing in gas-water systems forming electrolytes"; Can. J. Res.; 5, 162-199, (1931)	Pv, Kk, 0-25°C, 5-80 mmHg, 1st ioniz.
30MOR/PYN:	Morgan, J.L.R.; Pyne, H.R.; "Solubility relations in gas-liquid systems. I. A new apparatus for determining gas solubilities"; J. Phys. Chem.; 34, 1578-1582, (1930)	Pv, 25°C, 1 atm?.
52MOR/BIL:	Morrison, T.J.; Billett, F.; "The salting-out of non-electrolytes. Part II. The effect of variation in non-electrolyte"; J. Chem. Soc.; 3819-3822, (1952)	Pv, 13-75°C, 1 atm.
67MUN:	Munjal, P. K.; "Solubility of carbon dioxide in sea water and its concentrates"; Diss. Abstr. B; 27, 3952-3953, (1967) sea water	Pv, 5-25°C, p = 10-45 atm., p = 10-45 atm and concentrates.
71MUN/STE:	Munjal, P.; Stewart, P.B.; "Correlation equation for solubility of carbon dioxide in water, seawater, and seawater concentrates"; J. Chem. Eng. Data; 16(2), 170-172, (1971)	Zc, Pv, -5 to 25°C, 1-45 atm., in H_2O, seawater and its concentrates.
71MUR/RIL:	Murray, C. N.; Riley, J. P.; "Solubility of gases in distilled water and sea water. IV. carbon dioxide"; Deep-Sea Res.; 18, 533-541, (1971)	Pv, 1-35°C, in H_2O and acidified seawater, and brines to 3.8% Cl^-.
71MUX:	Muxart, T.S.; "Solubility of calcite in water in the presence of carbon dioxide"; Mezhdunar. Geokhim. Kongr. [Dokl] 1st; 4(Part 1), 326-337 (1971); [CA 80-100687]	Kk, 20 and 30°C, 2d ioniz., in sat. $CaCO_3$(aq).
77MYS:	Mysen, B.O.; "The solubility of water and carbon dioxide under predicted magma genesis conditions and some petrological and geophysical implications"; Rev. Geophys. Space Phys.; 15, 351-361, (1977)	Zr, Pv, t to 1600°C, p to 40 kbar, solubility in silicate melts.

70NAK:	Nakayama, F.S.; "Sodium bicarbonate and carbonate ion pairs and their relation to the estimation of the first and second dissociation constants of carbonic acid"; J. Phys. Chem.; 74(13), 2726-2728, (1970)	Zc, Kk, 25°C, CO_2 and ion pairs in $NaHCO_3$(aq) and Na_2CO_3(aq).
71NAK:	Nakayama F.S.; "Thermodynamic functions for the dissociation of $NaHCO_3^\circ$, $NaCO_3^-$, HCO_3^-"; H_2CO_3 and HCO_3^-"; J. Inorg. Nucl. Chem.; 33, 1287-1291, (1971)	Kk, 0-50°C, ion pairing in Na_2CO_3(aq) and $NaHCO_3$(aq).
46NAS:	Nasanen, R.; "Die zweite Dissoziationskonstante der Kohlensaure in NaCl- und KCl-Losungen"; Suomen Kemistilehti; 19B, 90-93, (1946)	Kk, 25°C, I<2m, 2d ioniz., in NaCl(aq).
47NAS:	Nasanen, R.; "Potentiometric study on the first ionization of carbonic acid in aqueous solutions of sodium chloride"; Acta Chem. Scand.; 1, 204-209, (1947)	Kk, 5-45°C, 1st ioniz. m(NaCl) = 0-3.
61NAS/MER:	Nasanen, R.; Merilainen, P.; Leppanen, K.; "Potentiometric Determination of the solubility product of lead carbonate"; Acta Chem. Scand.; 15, 913-918, (1961)	Kk, 25°C, 2d ioniz., in 2m KNO_3.
74NAU/KHA:	Naumov, V. B.; Khakimov, A. Kh.; Khodakovsky, I.L.; "On the solubility of carbon dioxide in concentrated chloride solutions at high temperatures and pressures"; Geokhimiya; No. 1, 45-55, (1974)	Zr, Pv, Kk, 100-500°C, 600-2500 bar.
68NEZ:	Nezdoiminoga, N. A.; "On the question of the solubility of carbon dioxide in water"; Izv. Akad. Nauk Arm. SSR; Ser. Tekh. Nauk., 21, No. 3, 11-17, (1968)	Pv, 24°C, 0.1-5 atm., sol. in H_2O and carbonate solutions.
58NIL/REN:	Nilsson, G.; Rengemo, T.; Sillen, L.G.; "Some solution equilibria involving calcium sulfite and carbonate I. Simple solublity equilibria of CO_2, SO_2, $CaCO_3$, and $CaSO_4$"; Acta Chem. Scand.; 12, 868-872, (1958)	Pv, 25, 35 and 75°C, in $NaClO_4$(aq).
61NOV/FRI:	Novak, J.; Fried, V.; Pick, J.; "Loslichkeit des Kohlendioxyds in Wasser bei verschiedenen Drucken und temperaturen"; Collection Czech. Chem. Communs.; 26, 2266-2270, (1961)	Pv, 10-80°C, 100-760 mmHg.

70OND/SAD:	Onda, K.; Sada, E.; Kobayashi, T.; Kito, S.; Ito, K.; "Salting-out parameters of gas solubility in aqueous salt solutions"; J. Chem. Jap.; 3(1), 18-24, (1970); [CA 73:39198c]	Pv, 25°C, 1 atm., in aq salt sol.
36ORC/SEE:	Orcutt, F.S.; Seevers, M.H.; "A method for determining the solubility of gases in pure liquids or solutions by the Van Slyke-Neill Manometric Apparatus"; J. Biol. Chem.; 117, 501-507, (1936)	Pv, 25°C, 1 atm., in H_2O and org. solv.
77OST:	Ostrom, B.; "Solubility of carbon dioxide total carbon dioxide content and primary production is sea water. Relations and formulas for calculations"; Botanica Marina; 20(2), 69-74, (1977)	Pv, -2 to 30°C, reanalysis of data of 45BUC for solubility of CO_2 in seawater.
68OSU/SAT:	Osugi, J.; Sato, M.; Fujii, T.; "Pressure-jump study on the kinetics of reactions in ionic solutions"; Nippon Kagaku Zasshi; 89(6), 562-565, (1968)	Kk, 25°C, H_2CO_3
69PAR/NEV:	Parkinson, W.J.; deNevers, N.; "Partial molal volume of carbon dioxide in water solutions"; Ind. Eng. Chem. Fund.; 8, 709-713, (1969)	V, 0-40, $P(CO_2)$ = 15-500 psia.
31PAS:	Passauer, H.; "Neue gasanalytische Sperrflussigkeiten"; Feuerungsteck; 19, 142, (1931)	Pv, 20°C, in water and sat. salt sol.
82PAT/SLO:	Patterson, C.S.; Slocum, G.H.; Busey, R.H.; Mesmer, R.E.; "Carbonate equilibria in hydrothermal systems: first ionization of carbonic acid in NaCl media to 300°C"; Geochim. Cosmochim. Acta 46, 1653-1663, (1982)	Kk, t = 50 - 300°C, p = psat to psat + 70 bar
74PER/SAN:	Perez, J. F.; Sandall, O. C.; "Carbon dioxide solubility in aqueous carbopol solutions at 24°, 30°, and 35°C"; J. Chem. Eng. Data; 19(1), 51-53, (1974)	Pv,24-350C, in H_2O and carboxy polymethylene
56PIN/PEA:	Pinsent, B.R.W.; Pearson, L.; Roughton, F.J.W.; "The Kinetics of combination of carbon dioxide with hydroxide ions"; Trans. Faraday Soc.; 52, 1512-1520, (1956)	Kk, 0-40°C, H_2CO_3 (kinetics).

49PIN/ROU:	Pinsent, B.R.W.; Roughton, F.J.W.; Abs. 1st Internal Congr. Biochem., Cambridge, England; (1949).#	Kk, 0-38°C, 2d ioniz. (from 64SIL/MAR).
37PIT:	Pitzer, K.S.; "The heats of ionization of water, ammonium hydroxide, carbonic, phosphoric, and sulfuric acids. The variation of ionization constants with temperature and the entropy change with ionization"; J. Am. Chem. Soc.; 59, 2365-2371, (1937)	Zc, Kk, Hr, 1st ioniz., 0-60°C.
82PLU/BUS:	Plummer, L.N.; Busenberg, E.; "The solubilities of calcite, aragonite, and vaterite in CO_2-H_2O solutions between 0 and 90°C, and an evaluation of the aqueous model for the system $CaCO_3$-CO_2-H_2O"; Geochim. Cosmochim. Acta; 46, 1011-1040, (1982)	Zr, Pv, Kk, 0-250°C, 1st and 2d ioniz., 1 atm. to 100°C, p(H_2O, sat) above 100°C, evaluation of data.
77POC/BJO:	Pocker, Y.; Bjorkquist, D.W.; "Stoped-flow studies of carbon dioxide hydration and bicarbonate dehydration in H_2O and D_2O. Acid-base and metal ion catalysis"; J. Am. Chem. Soc.; 99(20), 6537-6543, (1977)	Kk, 25°C, 1st ioniz. in H_2O and D_2O, from kinetic data.
67PON:	Ponnamperuma, F. N.; "A theoretical study of aqueous carbonate equilibria"; Soil Sci.; 103, 90-110, (1967)	Zc, Px, 25 C, influence of p(CO_2) on pH and solubilities of carbonates and hydroxides.
78POS/PED:	Postigo, M. A.; Pedrosa, G.; Katz, M.; "New experimental method for determining gas solubility in liquids"; Ann. Asoc. Quim. Argent.; 66, No. 1, 25-30, (1978)	Pv, Hm, 15-55°C, 25°C, Bunsen coefficients in 10 to 60 wt% sucrose.
45PRU/SAV:	Prutton, C.F.; Savage, R.L.; "The solubility of carbon dioxide in calcium chloride-water solutions at 75, 100, 120° and high pressures"; J. Am. Chem. Soc.; 67, 1550-1554, (1945)	Pv, 75-120°C, 16-694 atm, in H_2O and conc., $CaCl_2$ sol.
1895PRY/HOL:	Prytz, K.; Holst, H.; "Die Absorptionscoefficienten der Kohlensaure und des Schwefelwasserstoffs in Wasser bei dessen Gefrierpunkt"; Ann. der Phys.; 290, 130-138, (1895)	Pv, 0°C, 1 atm.
16PUS:	Pusch, L.; "Uber die Zeitreaktion bei der Neutralisation der Kohlensaure und die wahre Dissoziationskonstante der Kohlensaure"; Zeit. Elektrochemie; 22, 206-212, (1916)	Kk, t = ?, H_2CO_3 (kinetics and thermo).

16PUS2: Pusch, L.; "Nachtrag zu meiner Arbeit: Uber die Zeitreaktion bei der Neutralisation der Kohlensaure und die wahre Dissoziationskonstante de Kohlensaure"; Zeit. Elektrochemie; 22, 293, (1916)

Kk, t = ?, erratum, H_2CO_3.

74PYT/HAW: Pytkowicz, R.M.; Hawley, J.E.; "Bicarbonate and carbonate ion-pairs and a model of seawater at 25°C"; Limnol. Oceanog.; 19(2), 223-234, (1974)

Kk, 25°C, 1 atm. in seawater.

75REA: Read, A.J.; "The first ionization constant of carbonic acid from 25 to 250°C and to 2000 bar"; J. Solution Chem.; 4(1), 53-70, (1975)

V, Kk, 25-250°C, 1st ioniz., H_2CO_3, 1-2000 bar.

11RIL: Riley, O.; J. Inst. Brewing; 17, 124, (1911).#

Pv, see 58LIN for table of data.

59ROB/STO: Robinson, R.A.; Stokes, R.H.; Butterworths, London; 'Electrolyte solutions'; second edition (1959)

Ze, Kk, Da, summary of useful data.

68ROB/ZIM: Robb, R.A.; Zimmer, M.F.; "Solubility and heat of solution of carbon dioxide in aqueous solutions of arsenous oxide, arsenic pentoxide, and hydrochloric acid. Standard state correction for the combustion calorimetry of organochlorine compounds"; J. Chem. Eng. Data; 13, 200-203, (1968)

Pv, 20-30°C, 1 atm., in water, HCl(aq), arsenite and arsenate solutions.

41ROU: Roughton, F.J.W.; "The kinetics and rapid thermochemistry of carbonic acid"; J. Am. Chem. Soc.; 63, 2930-2934, (1941)

Hr, 0-37°C, H_2CO_3.

63RYZ: Ryzhenko, B.N.; "Determination of dissociation constants of carbonic acid and calculation of degree of hydrolysis of the CO_3^{2-} and HCO_3^- ions in solutions of carbonate and bicarbonate at elevated temperatures"; Geokhimiya; 137-148, (1963); [CA 58:10785g]

Kk, 100-300°C, 1st and 2d ioniz.

28SAA: Saal, R.N.J.; "The velocity of ionic reactions"; Rec. Trav. Chim. Pays Bas.; 47, 264-285, (1928)

Kk, 14°C, H_2CO_3 (kinetics and thermo).

74SAD/KIT: Sada, E.; Kito, S.; Ito, Y.; "Solubilities of gases in aqueous solutions of weak acids"; J. Chem. Eng. Jap.; 7, No. 1, 57-59, (1974)

Pv, 25°C, [acid] to 5 molar, solubility in phosphoric and five organic acids.

69SAL/HAK: Salomaa, P.; Hakala, R.; Vesala, S.; Aalto, T.; "Solvent deuterium isotope effects on acid-base reactions III. Relative acidity constants of inorganic oxyacids in light and heavy water. Kinetic applications"; Acta Chem. Scand.; 23, 2116-2126, (1969)

Kk, 25°C, 2d ioniz., in H_2O and D_2O.

69SAL/VES: Salomaa, P.; Vesala, A.; Vesala, S.; "Solvent deuterium isotope effects on acid-base reactions. Part II. Variation of the first and second acidity constants of carbonic and sulfurous acids in mixtures of light and heavy water"; Acta Chem. Scand.; 23, 2107-2115, (1969)

Pv, Kk, 25°C, 1st and 2d ioniz., in H_2O D_2O mixt.

58SCH/BRO: Scheurer, P.G.; Brownell, R.M.; DuValle, J.E.; "An apparatus for the investigation of rapid reactions. The kinetics of the carbonic acid dehydration"; J.Phys. Chem. 62, 809-812, (1958)

Kk, 17-37°C, H_2CO_3 (kinetics and thermo).

55SCH: Schmitt, C.; "Contribution a l'etude du system chaux-carbonate et de calcium bicarbonate de calcium-acid carbonic-eau'; These Renne; Ser. B; 12 (1955)

Kk, 0-100°C, literature review (from75LIN/BOR)

73SCH: Schroder, W.; "Untersuchungen uber die temperaturabhangigkeit der Gasloslichkeit in Wasser"; Chemie- Ing. Tech.; 45, 603-608, (1973)

Zc, Pv, 50-300°C, 120-2000 atm.

28SCH/BER: Schwab, G.-M.; Berninger, E.; "Invasion und Solvatation von gasen in Wasser"; Z. Phys. Chem.; A138, 55-74, (1928)

Pv, 20-80°C?.

62SEG/HOL: Segnit, E.R.; Holland, H.D.; Biscardi, C.J.; "The solubility of calcite in aqueous solutions - I The solubility of calcite in water between 75 and 200 at CO_2 pressures up to 60 atm"; Geochim. Cosmochim. Acta; 26, 1301-1331, (1962)

Pv, 75-200°C, 2-60 atm., in sat. $CaCO_3$(aq).

17SEY/LLO: Seyler, C.A.; Lloyd, P.V.; "Studies of the carbonates. Part II. Hydrolysis of sodium carbonate and bicarbonate and the ionisation constants of carbonic acid"; J. Chem. Soc.; 111, 138-158, (1917)

Kk, 25°C, 1st and 2d ioniz., $Na_2CO_3/NaHCO_3$ sol.

17SEY/LLO2: Seyler, C.A.; Lloyd, P.V.; "Studies of the carbonates. Part III. Lithium, calcium, and magnesium carbonates"; J. Chem. Soc.; 111, 994-1001, (1917)

Pv, 25°C, in $LiHCO_3$ sol.

57SHC/DEV:	Shchennikova, M.K.; Devyatykh, G.G.; Korshunov, I.A.; "Determination of the solubility of carbon dioxide in aqueous solutions of sulfuric acid by the isotopic dilution method"; J. Appl. Chem. USSR; 30, 881-886, (1957); Tr. of Zh. Prikl. Khim., 30, 833-838, (1957)	Pv, 20-75°C, in H_2SO_4(aq).
35SHE/MAC:	Shedlovsky, T.; MacInnes, D.A.; "The first ionization constant of carbonic acid, 0 to 38, from conductance measurements"; J. Am. Chem. Soc.; 57, 1705-1710, (1935)	Kk, Hr, 0-38°C, 1st ioniz.
36SHO/FER:	Showalter, H.A.; Ferguson, J.B.; "The solubility of carbon dioxide in aqueous solutions containing alcohols and sugars"; Can. J. Res.; B14, 120-126, (1936)	Pv, 15°C., P < 1 atm.
62SIE:	Siesjo, B.K.; "Solubility of carbon dioxide in cerebral cortical tissues of cats. With a note on the solubility of carbon dioxide in water, 0.16M NaCl, and cerebrospinal fluid"; Acta Physiol. Scand.; 55, 325-341, (1962) [CA 58:11750f]	Pv, 38°C, in H_2O, salt solutions, acid, spinal fluid, tissue.
64SIL/MAR:	Sillen, L.G.; Martell, A.E.; 'Stability constants of metal-ion complexes. Section I. Inorganic ligands', The Chemical Society (London); 215-216, (1964); Special Publication No. 17#	Ze, Kk, 0-200°C, 1st and 2d ioniz. compiled data, see for early references.
71SIL/MAR:	Sillen, L.G.; Martell, A.E.; 'Stability constants of metal-ion complexes. Supplement No 1', The Chemical Society (London); (1971); Special Publication No. 25#	Kk, 20-350°C, compiled data.
58SIR:	Sirs, J.A.; "Electrometric stopped flow measurements of rapid reactions in solution Part 2. Glass electrode pH Measurements"; Trans. Faraday Soc.; 54, 207-212, (1958)	Kk, 0-30°C, H_2CO_3 (kinetics).
76SMI/MAR:	Smith, R.M.; Martell, A.E.; 'Critical stability constants'; 4, 37, (1976)	Ze, Kk, $\Delta_r H$, $\Delta_r S$ 25°C, I=0, 0.5 and 1.0, 2d ioniz., evaluated data.
84SON/KOB:	Song, K.Y.; Kobayashi, R.; Marsh, W.; "The water content of CO_2-rich fluids in equilibrium with liquid water or hydrate"; 'Research Report RR-80'; Gas Producers Assoc., Tulsa, OK, (1984)	Pv, Px, 0-77°F, p to 2000 psia.

28STA/HAW:	Stadie, W.C.; Hawes, E.R.; "Studies on the oxygen-, acid-, and base-combining properties of blood III. The validity of hydrogen ion activity determinations by the hydrogen electrode in systems containing carbonic acid, carbonates, hemoglobin, carbon monoxide hemoglobin, and methemoglobin"; J. Biol. Chem.; 77, 241-301, (1928)	Kk, 38°C, 1st ioniz., very dil. solutions.
70STE/MUN:	Stewart, P. B.; Munjal, P.; "solubility of carbon dioxide in pure water, synthetic sea water, and synthetic sea water concentrates at -5° to 25°C. and 10- to 45-atm. pressure"; J. Chem. Eng. Data; 15(1), 67-71, (1970)	Pv, -5 to 25°C, 10-45 atm, in H_2O, sea water and its concentrates
16STR:	Strohecker, E.R.; "Contributions to the knowledge of aqueous solutions of carbon dioxide"; Z. Nahr.-Genussm.; 31, 121-160, (1916); [CA 10:1826]	Kk, 4°C (and 18 C?), H_2CO_3.
75SZE/ADA:	Sze, Y.K.; Adams, W.A.; Davis, A.R.; "A laser Raman study of clathrate and aqueous solutions of carbon dioxide"; 'Chemistry and Physics of Aqueous Gas Solutions', Adams, W.A. (editor); The Electrochemical Society, Princeton, (1975)	Kk, hydrate formation from Raman spectra, 12-18°C, 0.04-1.76 kbar.
64TAK/KEN:	Takesonchi, S.; Kennedy, G.C.; "The binary system H_2O-CO_2 at high temperatures and pressures"; Am. J. Sci.; 262, 1055-1074 (1964)	Pv, Px, 110-350°C, p to 3000 bars.
62TAN:	Tans, A.M.P.; "Solubility of carbon dioxide in water"; Ind. Chemist; 38, 411 (1962); [CA -14485 d]	Pv, t=?, nomogram
55TAY:	Taylor, C.E.; "Thermodynamics of sodium carbonate in solution"; J. Phys. Chem.; 59, 653-657, (1955)	Kk, Pv, Da, 15-95°C, 0.1-2.5m in Na_2CO_3
14THI/STR:	Thiel, A.; Strohecker, E.R.; "Dynamics of the time reactions between carbonic acid and bases"; Ber.; 47, 1061-1068, (1914); [CA 8:2293]	Kk, 4°C, H_2CO_3 (kinetics).
82TOD:	Todheide, K.; "Hydrothermal solutions"; Ber. Bunsenges. Phys. Chem.; 86, 1005-1016 (1982)	Zr: Pv, Px, Kk, Da, 0-1000°C, p to 800 bar, in water and in NaCl solutions. solutions.

63TOD/FRA:	Todheide, K.; Franck, E. V.; "Das Zweiphasengebiet und die kritische Kurve in system Kohlendioxid-wasser bis zu Drucken von 3500 bar"; Z. Phys. Chem.; 37, 387-401, (1963)	Pv, Px, 50-350°C, p to 3500 bar, critical phenomena.
75TOK:	Tokunaga, J.; "Solubilities of oxygen, nitrogen, and carbon dioxide in aqueous alcohol solutions"; J. Chem. Eng. Data; 20(1), 41-46, (1975)	Pv, 10 and 20°C, in H_2O and aq. EtOH.
10USH:	Usher, F.L.; "The influence of non-electrolytes on the solubility of carbon dioxide in water"; J. Chem. Soc.; 97, 66-78, (1910)	Pv, 20°C, in H_2O and aq. sol. of sugars, amides and acids.
81VAN/HAA:	Vanderzee, C.E.; Haas, N.C.; "Second cross virial coefficients B_{12} for the gas mixture (carbon dioxide + water) from 300 to 1000 K"; J. Chem. Thermodyn.; 13, 203-211 ,(1981)	Ze, Da, t = 300 - 1000 K p < 30MPa.
28VAN/SEN:	Van Slyke, D.D.; Sendroy, J. Jr.; Hastings, A.B.; Neill, J.M.; "Studies of gas and electrolyte equilibria in blood. X. Solubility of carbon dioxide at 38° in water, salt solution, serum, and blood cells"; J. Biol. Chem.; 78, 765-799, (1928)	Pv, 38°C, approx. 2 atm., in H_2O, various salts and acids and in blood.
77VES/SAL:	Vesala, A.; Saloma, E.; "Determination of basicity constants by potentiostatic titration"; Finn. Chem. Lett.; (6), 160-163, (1977)	Kk, 25°C, 2d ioniz., in K_2CO_3(aq).
82WAG/EVA:	Wagman, D.D.; Evans, W.H.; Parker, V.B.; Schumm, R.H.; Halow, I.; Bailey, S.M.; Churney, K.L.; Nuttall, R.L.; "The NBS Tables of chemical thermodynamic properties"; J. Phys. Chem. Ref. Data; 11, Supplement No 2 (1982)	Pv, Kk, 25°C. $\Delta_f H$, $\Delta_f G$, S, compiled thermochemical data.
27WAL/BRA:	Walker, A.C.; Bray, U.B.; Johnston, J.; "Equilibrium in solutions of alkali carbonates"; J. Am. Chem. Soc.; 49, 1235-1256, (1927)	Pv, Da, Kk, 25 and 37°C, 1st ioniz., in bicarbonate and chloride sol.
00WAL/COR:	Walker, J.; Cormack, W.; "The dissociation constants of very weak acids"; J. Chem. Soc.; 77, 5-21, (1900)	Kk, 18°C, 1st. ioniz. const.
22WAR:	Warburg, E.J.; "Studies on carbonic acid compounds and hydrogen ion activities in blood and salt solutions"; Biochem. J.; 16, 153, (1922)	Kk, 16-20°C, in NaCl sol.

80WAS/BUL:	Wasmund, R.; Bultmann, H.; "Carbon dioxide adsorption in pure water and its dependence on pressure and temperature"; Monatsschr. Brau.; 33, pgs. 356, 358-360, (1980)	Pv, 0-60°C, 1-9 bar.
35WEI:	Weider, O.; "Determination of the second dissociation constant of carbonic acid"; Ber.; 68B, 1423-1430, (1935);	Kk, 0, 18°C, 0.01-0.1m, 2d ioniz. in $NaCl/NaHCO_3/Na_2CO_3$ sol.
74WEI:	Weiss, R. F.; "Carbon dioxide in water and sea water-solubility of a nonideal gas"; Mar. Chem.; 2, 203-215, (1974)	Pv, Zc, 6 to 20°C, -1 to 40 °C, [salt] = 0, 4%.
78WEN/RUP:	Wenzel, H.; Rupp, W.; "Calculation of phase equilibria in systems containing water and supercritical components"; Chem. Eng. Sci.; 33, 683-687, (1978)	Zc, Pv, Px, 298-573K, p to 500 bar.
41WIE:	Wiebe, R.; "The Binary system carbon dioxide-water under pressure"; Chem. Rev.; 29, 475-481, (1941)	Pv, 12-100°C, 1-700 atm.
39WIE/GAD:	Wiebe, R.; Gaddy, V.L.; "The solubility in water of carbon dioxide at 50, 75, and 100°, at pressures to 700 atmospheres"; J. Am. Chem. Soc.; 61, 313-318 (1939)	Pv, 50-100°C, 25-700 atm.
40WIE/GAD:	Wiebe, R.; Gaddy, V. L.; "The solubility of CO_2 in water at various temperatures from 12 to 40° and at pressures to 500 atmospheres"; J. Am. Chem. Soc.; 62, 815-817, (1940)	Pv, 12-40°C, 25-500 atm
41WIK/GAD:	Wikbe, R.; Gaddy, V.L.; "Vapor phase composition of carbon dioxide-water mixtures at various temperatures and at pressures to 700 atmospheres"; J. Am. Chem. Soc.; 63, 475-477 (1940)	Pv, 25-75°C, 1 to 700 atm.
21WIL:	Wilke, E.; "Zur Kenntnis wassriger Kohlensaurelosungen"; Z. Anorg. Chem.; 119, 365-379, (1921)	Kk, 18-40°C, 1st ioniz., in water and alkali metal chloride sol.
77WIL/BAT:	Wilhelm, E.; Battino, R.; Wilcock, R.J.; "Low-pressure solubility of gases in liquid water"; Chem. Rev.; 77, 219-262, (1977)	Ze, Pv, 0-100°C, P=1 atm, methods, tables, thermodynamic properties, correlations and theory.

83WIL/BRA: Wilson, G.M.; Brady, C.J.; "Heats of mixing of steam with N_2, CO_2, H_2, CH_4, and CO at high temperatures and pressures using a new high temperature calorimeter"; 'Research Report RR-73'; Gas Producers Assoc., Tulsa, OK, (1983)

Hm, 780-1180°F, 500-2500 psia, $CO_2(g) + H_2O(g)$.

06WIN: Winkler, L.W.; "Gesetzmassigkeit bei der Absorption der Gase in Flussigkeiten"; Z. Phys. Chem.; 55, 344, (1906)

Zr, Pv, 0-60°C, analysis # of early meas. Data in 58LIN p. 1153.

54WIS/FRE: Wissbrun, K.F.; French, D.M.; Patterson, A. Jr.; "The true ionization constant of carbonic acid in aqueous solution from 5 to 45°C"; J. Phys. Chem.; 58, 693-695, (1954)

Kk, Hr, 5-45°C, H_2CO_3.

27WOL/KRA: Wolf, O.; Krause; "Sperrflussigkeiten fur technisch gasuntersuchen"; Arch. Warmewirt; 8, 216-218, (1927)

Pv, 20, 30°C, in H_2O, aq. acids and salts, (data in 58LIN)

81WON/CHU: Won, Y.S.; Chung, D.K.; Mills, A.F.; "Density, viscosity, surface tension, and carbon dioxide solubility and diffusivity of methanol, ethanol, aqueous propanol, and aqueous ethylene glycol at 25°C"; J. Chem. Eng. Data; 26, 140-141, (1981)

Pv, 25°C, in H_2O, EtOH and PrOH aq. sol.

1882WRO: Wroblewksi, S.; "Sur les lois de solubilite de l'acide carbonique dans l'eau sous de hautes pressions"; Compt. Rend.; 94, 1355-1357, (1882)

Pv, 0-12°C, 1-30 atm.

79YAS/TSU: Yasunishi, A.; Tsuji, M.; Sada, E.; "Solubility of carbon dioxide in aqueous mixed-salt solutions"; Adv. Chem. Ser.; 177, 189-203, (1979)

Pv, 25°C, $p(CO_2)$ = 1 atm., [salt] = 0.3 to 4 molar, solubility in aqueous mixtures (binary and ternary) containing halides and sulfates.

79YAS/YOS: Yasunishi, A.; Yoshida, F.; "Solubility of carbon dioxide in aqueous electrolyte solutions"; J. Chem. Eng. Data; 24(1), 11-14, (1979)

Pv, 15-35°C, 1 atm, sol. as fn. of salt conc. in aq. chlorides, nitrates and sulfates.

64YEH/PET: Yeh, S.-Y.; Peterson, R.E.; "Solubility of carbon dioxide, krypton, and xenon in aqueous solution"; J. Pharm. Sci.; 53, 822-824, (1964)

Pv, 25-45°C, 1 atm., in water, NaCl(aq) and phosphate buffer.

40ZAA:	Zaalishvili,; "Solubility of CO_2 in mixtures with other gases at 20, 30, 35 and 50°C"; Zhur. Fiz. Khim.; 14, 413-417 (1940)	qPv, 20-50°C, in mixt. with H_2 and other gases.
81ZAW/MAL:	Zawisza, A.; Malesinska, B.; "Solubility of carbon dioxide in liquid water and of water in gaseous carbon dioxide in the range 0.2-5 MPa and at temperatures up to 473K"; J. Chem. Eng. Data; 26, 388-391, (1981)	Pv, 50-200°C, 0.2-5MPa.
39ZEL:	Zelvenskii; Zh. Prikl. Khim.; 12, 1311-1329, (1939)	Pv, 0-100°C, p<100 atm, (data in 58LIN).
39ZHA:	Zhavoronkov, N.M.; "The partial pressure of ammonia, carbon dioxide and water over copper ammonium solutions"; J. Chem. Ind.; 16(10), 36-37, (1939); [CA 34:2233 9]	Pv, 20-80°C, in copper-ammonia(aq) and formate solutions.

$CuCl_2$-H_2O

Bert R. Staples, Thomas L. Jobe, Jr., and David Garvin

INTRODUCTION

Listed in this bibliography are publications that contain information on the equilibria that exist in aqueous solutions of cupric chloride. The species present are $Cu^{2+}(aq)$, $CuCl^{+}(aq)$, $CuCl_2(aq)$ and $CuCl_3^{-}(aq)$.

The position of the equilibrium is dependent upon the Cl^- concentration and to a lesser extent the acidity and total salt concentration.

The references listed here treat the stability constants, solubilities, activity coefficients, enthalpies of solution and dilution, heat capacities and thermochemistry of the solids. The only vapor species of any importance above the solutions is water; the measurement of its pressure is considered in papers treating activity coefficients. Publications reporting measurements or presenting correlations/evaluations are included but publications that consider only applications of existing data to specific problems without providing new data have been avoided.

The references are listed alphabetically by first author. Each citation is preceeded by a brief identification code composed of the year of publication and three letters from the last names of the first two authors. The citations list the names of authors; the title of the article,chapter or report as appropriate, and the source information, i.e. journal or book title,volume, and year of publication. The structure of these citations does not conform to the specifications established by the American National Standards Institute but is the information necessary to direct the reader to a particular reference. In a few instances only an abstract or secondary reference was available. In these cases either the citation to Chemical Abstracts or source of the secondary citation is given.

Some titles have been translated, e.g. those in Russian. These translations come, by preference, from abstracts in the papers themselves or from Chemical Abstracts. (The titles from the latter may be condensations of the original)

Each paper has been annotated to show the class of data, the temperature range and, if appropriate, pressure, solution composition and pH. The data class designations are taken from the Bulletin of Chemical Thermodynamics. They are two letter codes with some mnemonic or physical chemical associations. A list is appended. No attempt has been made to assess the quality of the data, however, an annotation of "Ze" indicates that a particular reference constitutes or includes an evaluation of experimental data from several sources.

The bibliography has been prepared by searching the files of the NBS Chemical Thermodynamics Data Center, the Bulletin of Chemical Thermodynamics and references in the papers retrieved from those sources. It covers a time period from the 19th century to 1982. Additions and corrections will be welcomed.

75ADE/NWA:	Adeosun, S.O.; Nwanze, V.O.; "Thermochemistry of dialkylamine complexes of Cu(II) halides"; J. Inorg. Nucl. Chem.; 37, 2091-2093 (1975)	Q1, dialkyamine complexes of $CuCl_2$ and other halides.
28AGO:	Agostini, P.; "Heats of formation of the double chlorides of copper and potassium"; Atti. Acad. Lincei.; 7, 1030-1032 (1928)	Hm, temp. given, 600 H_2O.
71AND/CHA:	Andreev, S.N.; Chaiko, A.I.; "Effect of the dielectric constant of the solvent on the stability of complexes"; Zh. Neorg. Khim.; 16, 1965-1967 (1971)	Kk, alcohol complexes, me thru n-butyl.
71AST/KRA:	Astakhova, R.K.; Krasikov, B.S.; "Electrochemical behavior of copper in chloride electrolytes"; Zh. Prikl. Khim.; 44, 363-371 (1971); [CA 74:150198]	Kk.
60BAR/BET:	Barton, P.B., Jr.; Bethke, P.M.; "Thermodynamic properties of some synthetic zinc and copper minerals"; Am. J. Sci.; 258A, 21-34 (1960)	Px, Kk, 25 to 75°C, $Cu(OH)_2Cl_2$ in KCl and HCl.
73BAR/PAN:	Barvinok, M.S.; Panin, A.V.; Obozova, L.A.; "Compounds of pyridine with cobalt (II), copper (II), and zinc (II) chlorides"; Zh. Neorg. Khim.; 18, 1572-1575 (1973)	Kd, Hm, 25°C, pyridine complexes.
73BEL/KON:	Belousov, E.A.; Konstantinova, K.K.; Bocharov, V.V.; Alovyainikov, A.A.; Mironov, V.E.; "The composition and stability of copper(II) and cobalt(II) chloride complexes in hydrochloric acid solutions in tributyl phosphate"; Zh. Fiz. Khim.; 47, 1869-1871 (1973)	Kk, 25°C in tributyl phosphate - HCl mixt.
1873BER:	Berthelot, M.; "Recherches sur les sels metalliques et sur les ferriques en particulier"; Ann. Chim. Phys.; [4], 30, 145-204 (1873)	Hm, 18°C, 100-300 H_2O.
1879BER:	Berthelot, M.; "Sur le protochlorure de cuivre"; Compt. rend.; 89, 967-971 (1879)	Hr, 16.5°C, react. $BaO_2 + CuCl + HCl(aq) = BaCl_2 + CuCl_2(aq)$.
1880BER:	Berthelot, M.; "Recherches sur les sels basiques et sur l'atakamite"; Compt. rend.; 91, 450-453 (1880)	Hr, 15°C, with KOH.

77BJE/SKI:	Bjerrum, J.; Skibsted, L.H.; "A contribution to our knowledge of weak chloro complex formation by copper(II) in aqueous chloride solutions"; Acta Chem. Scand.; 31, 673-677 (1977)	Kk, 25°C, meas., discussion of earlier work.
74BLO/RAZ:	Blokhin, V.V.; Razmyslova, L.I.; Shalaevskaya, M.I.; Makashev, Yu.A.; Mironov, V.E.; "Thermodynamics of copper(II) monochloride complexes in aqueous alcoholic solutions"; Zh. Fiz. Khim.; 48, 469-471 (1974)	Hr, Kk, 25°C, 0-80% ethanol or methanol, I = 3 $NaClO_4$.
50BOB/LAR:	Bobtelsky, M.; Larisch, R.D.; "The heat of solution of halides, sulphuric acid, oxalic acid, sodium hydroxide, and urea in ethyl alcohol-water mixtures"; J. Chem. Soc.; 3612-3615 (1950)	Hm, 22.5°C, 307 H_2O, dihydrate.
76CAR/WET:	Carlsson, B.; Wettermark, G.; "Determination of the equilibrium constants and uv-absorption spectra for Cu^{2+}-Cl^-complexes in 1 M $HClO_4$"; J. Inorg. Nucl. Chem.; 38, 1525-1527 (1976)	Kk, 25°C, 1 M perchloric acid, Cl complexes.
76CAR/WOO:	Cartwright, M; Woolf, A.A.; "Heats of formation of tin and titanium iodides"; J. Chem. Soc., Dalton Trans.; 829-833 (1976)	Hr, 25°C.
62D'A/CAL:	D'Amore, G.; Calabro, G.; Curro, P.; "A study of solution complexity by ion exchangers. I. Copper(II)-chloride system"; Atti Soc. Peloritana Sci. Fis. Mat. Nat.; 8, 265-281 (1962)	Kk, 30°C, fctn of molality, Cu(II) complexes.
16DER/YNG:	Derby, I.H.; Yngve, V.; "The dissociation tensions of certain hydrated chlorides and the vapor pressures of their saturated solutions"; J. Am. Chem. Soc.; 38, 1439-1451 (1916)	Pv, 26.6-64.5°C and 17.9-64.2°C.
1892DEV/STA:	van Deventer, C.M.; van de Stadt, H.J.; "Over the relation between solubility and heats of solution of salts"; Maandblad Natuurwetenschappen; 17, 1-9 (1892)	Hm, 18°C, 8 - 40 H_2O.
76DOW/PIT:	Downes, C.J.; Pitzer, K.S.; "Thermodynamics of electrolytes. Binary mixtures formed from aqueous NaCl, Na_2SO_4, $CuCl_2$ and $CuSO_4$ at 25°C"; J. Solution Chem.; 5, 389-398 (1976)	Da, 25°C, osmotic coefs. and activ. coefs.

62FAU/CRE:	Faucherre, J.; Crego, A.; "Determination cryoscopique de constantes de dissociation de complexes peu stables"; Bull. Soc. Chim. Fr.; 1820-1824 (1962)	Kd, Kd for $CuCl^+$ in KNO_3 eutectic.
1853FAV/SIL:	Favre, P.-A.; Silbermann, J.-T.; "Recherches sur les quantites de chaleur degagees dans les actions chimiques et moleculaires"; Ann. Chim. Phys.; [3], 37, 406-508 (1853)	Hm, t = 11-13°C?, sol. in acid.
37FED/SIL:	Fedorov, A.S.; Sil'chenko, G.F.; "Heats of formation and solution of saturated aqueous solutions of some salts"; Ukr. Khem. Zh.; 12, 53-60 (1937)	Hm, 17°C, 300 H_2O.
52FRI:	Friedberg, S.A.; "The specific heat of $CuCl_2.2H_2O$ between 1.5 and 20°K"; Physica (Utrecht); 18, 714-722 (1952)	Ql, 1.5 - 20°K, Cp.
70GED/PEA:	Gedansky, L.M.; Pearce, P.J.; Hepler, L.G.; "Thermochemistry of copper compounds: $Cu(OH)_2$, $CuCl_2$, $Cu(IO_3)_2.H_2O$ and $Cu(IO_2)_2$"; Can. J. Chem.; 48, 1770-1773 (1970)	Hm, 25°C, 5 m.
79GOL:	Goldberg, R.N.; "Evaluated activity and osmotic coefficients for aqueous solutions: Bi-univalent compounds of lead, copper, manganese, and uranium"; J. Phys. Chem. Ref. Data; 8, 1005-1050 (1979)	Ze, Da, 25°C.
72GRI/PHI:	Gritzner, G.; Phillips, R.F.; "Densities, viscosities, and vapor pressures of copper(II) chloride solutions in hydrochloric acid"; J. Chem. Eng. Data.; 17, 425-428 (1972)	Xd, Xv, 30-90°C, 4-7M HCl.
58GUG/STO:	Guggenheim, E.A.; Stokes, R.H.; "Activity coefficients of 2:1 and 1:2 electrolytes in aqueous solution from isopiestic data"; Trans. Faraday Soc.; 54, 1646-1649 (1958)	Da, 25°C, revision of activ. coeffics.
49GUI:	Guiter, H.; "The hydrolysis of the chloride nitrate, and sulfate of copper"; Compt. rend.; 228, 569-570 (1949)	Kk, t = ??, $CuCl_3OH^{2-}$(aq).
64HAM/GRE:	Hammer, R.R.; Gregory, N.W.; "Vaporization reactions in the copper chloride-chlorine system"; J. Phys. Chem.; 68, 3229-3233 (1964)	Pp, 285 and 440°C, H and S calculated, at 298°K.

46HER:	Herrera, C.G.; "Fisico-quimica de las soluciones de cloruro cuprico"; An. Fis. Quim.; 42, 165 (1946)	Ke, Kk, Xr, conductivity, room temp.
38HIE/FED:	Hieber, W.; Feder, E.E.; "Heats of formation of cupric and mercuric halogen compounds with amines"; Z. Elektrochem.; 44, 881-887 (1938)	Hm, Kr, 20°C, sol in HCl(aq).
66HUA/PAN:	Huang, J.-T.; Pan, K.; "Osmotic and activity coefficients of copper(II) chloride and cadmium chloride from freezing point measurements"; J. Chin. Chem. Soc. (Taipei); 13, 64 (1966)	Da, Px, 0°C, m < 0.1.
1891ISA:	Isaachsen, D.; "Die Farbenanderung von Salzlosungen"; Z. Phys. Chem.; 8, 145 (1891)	Px, Pv, 0 and 100°C, freezing and boiling points, m < 0.4.
75KAK/GIE:	Kakolowicz, W.; Giera, E.; "Heat of formation of chelate complexes of some d-electron elements and metal-oxygen bond energy"; Conf. Intern. Thermodyn. Chim. Quat.; 1, 73-79 (1975)	Hm, 25°C, 4.36M HCl, sol.
66KEN/LIS:	Kennedy, M.B.; Lister, M.W.; "Heats of association of aqueous copper, nickel, and cobalt ions with halide ions"; Can. J. Chem.; 44, 1709-1716 (1966)	Hr, 25 and 40°C, I = 2m $CuClO_4$(aq) + NaCl(aq).
59KEN:	Kenttamaa, J.; "A cryoscopic study of the dissociation of some bivalent metal chlorides in aqueous solutions saturated with electrolyte"; Suom. Kemistil. B.; 32B, 68-70 (1959)	Px, Kk, 0°C, complexation.
76KHA/SCH:	Khan, M.A.; Schwing-Weill, M.J.; "Stability and electronic spectra of the copper(II) chloro complexes in aqueous solutions"; Inorg. Chem.; 15, 2202-2205 (1976)	Kk, Md, t=?, I=5M, Cl complexes.
72KIR/TRU:	Kirintsev, A.N.; Trushnikova, L.N.; Lavrent'eva, V.Q.; 'Handbook of phase diagrams of inorganic substances in water'; Khimiya, Leningrad; (1972)	Px, -40 to 120°C, x=0 to .60, pg. 23.

71KLY/GLE:	Klygin, A.E.; Glebov, V.A.; Lekae, V.A.; Kolyada, N.S.; Smirnova, I.D.; Nikol'skaya, N.A.; Zavrazhnova, D.M.; "Complex formation by the ions of metals of the first transition series in hydrochloric acid solutions"; Zh. Neorg. Khim.; 16, 1590-1595 (1971)	Kk, 25°C?, complexes in M(HCl) = 0-10 solns.
69KOL:	Kolonin, G.R.; "Chloride complexes of ore-forming metals at high temperatures (calculated data)"; Eksp. Issled. Mineral.; 105-117 (1969-1970); [CA 77:118904]	Kk, 25 and 200°C, complexation.
76KON/FED:	Koneva, T.N.; Fedorov, V.A.; "Influence of the ionic strength of the solution on the stability of $CuCl^+$(aq)"; Zh. Neorg. Khim.; 21, 1132 -1135 (1976)	Kk, 25°C, in 0.05 - 8M ClO_4^-(aq).
72LEB/NIK:	Lebedeva, A.P.; Nikolaev, V.P.; Frolov, Yu.G.; Vlasenko, K.K.; Karapet'yants, M.Kh.; "Change in excess thermodynamic functions during mixing of the isopiestic solutions sodium chloride-water + cobalt(II) chloride-water, rubidium chloride-water + cobalt(II) chloride-water, and lithium chloride-water + copper(II) chloride-water"; Tr. Mosk. Khim.-Tekhnol. Inst.; 71, 105-106 (1972); [CA 80:100769]	Hm, Dx, mixing of $CuCl_2$(aq) with LiCl(aq).
73LIB:	Libus, Z.; "Nature and stability of the $CuCl^+$ complex in aqueous solution"; Inorg. Chem.; 12, 2972-2977 (1973)	Kk, 25°C, Cl complexes in perchlorate media.
58LIN:	Linke, W.F.; 'Solubilities'; D. Van Nostrand, N.Y.; 1, Fourth Edition (1958)	Px, 0-360°C, in H_2O, sol. of acids and aq. salts.
60LIS/ROS:	Lister, M.W.; Rosenblum, P.; "Some equilibrium constants of transition metal halides"; Can. J. Chem.; 38, 1827-1836 (1960)	Kk, 12,25,40°C, I = 2.0m $NaClO_4$, K1 and K2.
71MAK/KUL:	Makashev, Yu.A.; Kul'ba, F.Ya.; Agaf, M.I.; Volokhov, Yu.A.; Mironov, V.E.; "Effect of ionic strength and solution temperature on the formation of inner-sphere and outer-sphere copper(II) complexes"; Zh. Fiz. Khim.; 45, 734-735 (1971)	Kk, 15-50°C, $NaClO_4$ media.

65MAN/IWA:	Manahan, S.E.; Iwamoto, R.T.; "Chloro complexes of copper(II) and copper(I) in acetonitrile"; Inorg. Chem.; 4, 1409-1413 (1965)	Kk, 25°C, complexation.
1876MAR:	Marignac, C.; "Sur les chaleurs specifiques des solutions salines"; Ann. Chim. Phys.; 8, 410-430 (1876)	Ql, 19-51°C, 10-200 H_2O, specific heats.
69MAV/MIR:	Mavrina, I.V.; Mironov, V.E.; Makashev, Yu.A.; "Inner sphere and outer sphere complexes of copper(II)"; Uch. Zap., Leningrad Gos. Pedagog. Inst. im. A. I. Gertsena; 385, 153-157 (1969); [CA 75:122861]	Kk, 25°C, aq solns. of LiX mixtures.
50MCC/DAV:	McConnell, H.; Davidson, N.; "Optical interaction between the chloro-complexes of copper(I) and copper(II) in solutions of unit ionic strength"; J. Am. Chem. Soc.; 72, 3168-3173 (1950)	Kk, 25 and 47°C, complexation K's.
74MIH:	Mihailov, M.H.; "A correlation between the overall stability constants of metal complexes.- I. Calculation of the stability constants using the formation function n"; J. Inorg. Nucl. Chem.; 36, 107-113 (1974)	Kk, theory, stepwise complex formation.
68MIR/MAK:	Mironov, V.E.; Makashev, Yu.A.; Mavrina, I.Ya.; Markhaeva, D.M.; "Determination of stability constants of inner-sphere and outer-sphere complex compounds"; Zh. Fiz. Khim.; 42, 2987-2989 (1968)	Kk, 25°C, in 3.0M $LiClO_4$ and LiCl.
69MIR/MAK:	Mironov, V.E.; Makashev, Yu.A.; Mavrina, I.Ya.; "Inner-sphere and outer-sphere complexes of copper(II)"; Zh. Nerog. Khim.; 14, 1424-1425 (1969)	Kk, 25°C, in 3.0M $LiClO_4$ and LiCl.
70MIR/MAK:	Mironov, V.E.; Makashev, Yu.A.; Mavrina, I.Ya.; Kryzhanovskii, M.M.; "Outer-sphere and inner-sphere complexes of cobalt(II), and nickel(II), and copper(II)"; Zh. Neorg. Khim.; 15, 1301-1304 (1970)	Kk, 25°C, I = 3m, complexation.
51MON:	Monk, C.B.; "Electrolytes in solutions of amino acids. Part II. The cupric complexes of glycine, alanine, and glycyl-glycine"; Trans. Faraday Soc.; 47, 285-291 (1951)	Kk, 25°C, $CuCl^+$.

62MOR/SHO:	Morris, D.F.C.; Short, E.L.; "Stability Constants of Copper(II) Complexes"; J. Chem. Soc.; 2672-2675 (1962)	Kk, 20°C, I = 0.691m $HClO_4$, stability constants of Cl complexes.
50NAS:	Näsänen, R.; "Complex formation in dilute aqueous solutions of cupric chloride, spectrophotometric determination of equilibrium involving slight complex for formation in electrolytic solution"; Acta Chem. Scand.; 4, 140-145 (1950)	Kk, 25°C, in HCl(aq).
51NAS/LUM:	Näsänen, R.; Lumme, P.; "Potentiometric studies on the equilibria of some copper(II)-hydroxysalts in aqueous salt solutions, and involved complex formation"; Acta Chem. Scand.; 5, 13-22 (1951)	Kk, 25°C, $NaClO_4$ and NaCl solns.
49NAS/TAM:	Näsänen, R.; Tamminen, V.; "The equilibria of cupric hydroxysalts in mixed aqueous solutions of cupric alkali salts at 25°C"; J. Am. Chem. Soc.; 71, 1994-1998 (1949)	Px, Kk, 25°C, $Cu(OH)_3Cl$ in KCl.
77OIK/GEO:	Oikova, T.; Georgiev, G.; "The $CuCl_2$-$MnCl_2$-H_2O system at 25°C"; Zh. Neorg. Khim.; 22, 3147-3151 (1977)	Dx, mixtures with $MnCl_2$ (c/aq).
29PAR/SOP:	Partington, J.R.; Soper, W.E.; "The heats of solution of some salts in water and ethyl alcohol solutions"; Philos. Mag.; 7, 209-247 (1929)	Hm, 25°C, 0-10.049m, H soln and diln.
1890REI/DEV:	Reicher, L. T.; Van Deventer, C. M.; "Uber einige eigentumlichkeiten von kupferchloridlosungen in thermischer hinsicht"; Z. phys. Chem. (Leipzig); 5, 559-565 (1890)	Hm, 11°C, heat of soln etc.
74RIC/BRO:	Richardson, D.W.; Brown, R.R.; "Enthalpy of formation of malachite [$Cu_2(CO_3)(OH)_2$]"; U.S. Bur. Mines. Rept. Invest.; 7851, 5pp. (1974)	Hm, 25°C, formation and soln for malachite $(Cu_2(CO_3)(OH)_2$.
40ROB/STO:	Robinson, R.A.; Stokes, R.H.; "Part VI. The activity coefficients of manganese, cobalt, nickel and copper chloride in aqueous solution at 25°"; Trans. Faraday Soc.; 36, 1137-1138 (1940)	Da, Pv, 25°C, 0.1 to 2.769m, isopiestic meas.
59ROB/STO:	Robinson, R.A.; Stokes, R.H.; 'Electrolyte Solutions'; Butterworths, London; Second Edition, (1959)	Ze, Pv, Da, 25°C, 0.1-6.0m.

34ROT/BUC:	Roth, W.A.; Büchner, A.; "The heats of ionization of some metals"; Z. Elektrochem.; 40, 87-89 (1934)	Hm, 20°C, 999-3640 H_2O.
76RUD/YAG:	Rud'ko, P.K.; Yaglova, V.N.; Novikova, G.I.; "Thermal dehydration of copper(II) chloride dihydrate"; Zh. Fiz. Khim.; 50, 2988 (1976)	Hr, 20-300°C, vap press. measured also.
1889SAB:	Sabatier, P.; "Sur les chlorures metalliques hydrates"; Bull. Soc. Chim. Fr.; [3], 1, 88-91 (1889)	Hm, 20°C, sol. in 300-600 H_2O.
73SCH:	Schwing-Weill, M.J.; "Copper(II) chloride complexes in aqueous solutions"; Bull. Soc. Chim. Fr.; [3], 1, 823-830 (1973); [CA 79:58291]	Kk, 25°C, Cl = .005 - 4.9 M, I = 5m $NaClO_4$ and NaCl, pH = 2, succesive form. of mononucl. complexes.
54SHC/ORA:	Shchukarev, S.A.; Oranskaya, M.A.; "Thermal stability of copper halides"; Zh. Obshch. Khim.; 24, 1926-1935 (1954)	Kd, 219-495°C, meas. pressure $Cl_2(g)$, mp +436°C.
27SIE/GOT:	Sieverts, A.; Gotta, A.; "Heat of formation of copper hydride"; Justus Liebigs Ann. Chem.; 453, 289-297 (1927)	Hr, 23.5°C, reduction of cupric to cuprous.
64SIL/MAR:	Sillen, L.G.; Martell, A.E.; 'Stability constants of metal-ion complexes'; Chemical Soc., London; Special Publ. No. 17, (1964)	Kk, -3 to 75°C, compiled data.
76SMI/MAR:	Smith, R.M.; Martell, A.E.; 'Critical Stability Constants. Vol. 4: Inorganic complexes'; Plenum Press, N.Y.; (1976)	Kk, 25°C, I = 0-1 m, crit. evaluation.
56SMI/TIK:	Smirnov, V.I.; Tikhonov, A.I.; "Concerning the equilibrium reactions of chlorides of cobalt, nickel and copper with oxygen"; Izvest. Akad. Nauk SSSR, Otdel. Tekh. Nauk; 9, 48-54 (1956)	Kk, 300-450°C, $CuCl_2/CuO$, Cu_2Cl_2/CuO.
48STO:	Stokes, R.H.; "A thermodynamic study of bivalent metal halides in aqueous solution. Part XVII - Revision of data for all 2:1 and 1:2 electrolytes at 25°, and discussion of results"; Trans. Faraday Soc.; 44, 295-307 (1948)	Da, 0.1 - 6m, activ. coeff.

70SZA/PAL:	Szabo, Z.G.; Palfalvi-Rozsahegyl, M.; Burger, K.; "Hydration of metal ions"; Proc. Symp. Coord. Chem. 3rd.; 1, 99-110 (1970)	Hm, t=?, $CuCl_2$(aq) + (HCl + $LiCl_2$(aq)).
74VAS/KAR:	Vasilev, V.A.; Karapet'yants, M.Kh.; Sanaev, E.S.; Novikov, S.N.; "Heat capacities of copper(II) chloride solutions at 25°C"; Zh. Fiz. Khim.; 48, 2360-2362 (1974)	Ql, 25°C, Cp solns.
76VAS/SAN:	Vasilev, V.A.; Sanaev, E.S.; Karapet'yants, M.Kh.; "The heat capacities of mixed aqueous solutions containing chlorides of d transition metals in the fourth period"; Zh. Fiz. Khim.; 50, 1128-1131 (1976)	Ql, 25°C, mixtures of $CuCl_2$ with LiCl or $NiCL_2$.
66VDO/KOL:	Vdovenko, V.M.; Kolokol'tsov, V.B.; Stebunov, O.B.; "Resonance processes in complex formation"; Radiokhimiya; 8, 286-290 (1966)	Kk, 25°C?, complexation.
76VIL/DEM:	Vilcu, R.; De Madrinan, E.C.; Ionei, F.; "Thermodynamic properties of electrolyte solutions. V. Differential cryoscopy in sodium chloride + copper(II) chloride + water and potassium chloride + copper(II) chloride + water ternary systems and in associated binaries"; Rev. Roum. Chim.; 21, 333-341 (1976); [CA 85:131441]	Da, activ. coeff. in mixtures with NaCl or KCl.
71VLA/KAR:	Vlasenko, K.K.; Karapet'yants, M.Kh.; "Thermodynamic properties of mixed electrolyte solutions. IX. Temperature variation of the heats of mixing of aqueous lithium, sodium, and cesium chlorides with copper(II) chloride solutions"; Zh. Fiz. Khim.; 45, 2460-2463 (1971)	Hm, 0, 25, 40°C, heat of mixing with isomolal Cs, Li or Na chloride solns.
30WAR/WER:	von Wartenberg, H.; Werth, H.; "The heats of formation of cuprous and cupric chloride"; Z. Physik. Chem.; 151A; 109-112 (1930)	Hr, temp. not given, formation of $CuCL_2$ from elements.
53YAT/KHA:	Yatsimirskii, K.B.; Kharitonov, V.V.; "On the thermochemistry of anthranylates"; Zh. Fiz. Khim.; 27, 799-804 (1953)	Hm, 25°C, in 6.24m HCl.

H_2SO_4-H_2O

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INTRODUCTION

Listed in this bibliography are publications that report data on equlibria in mixtures of sulfuric acid and water and on the associated vapor-liquid equilibria and solubilities (at low temperature) as shown in phase diagrams. To a lesser extent there are data on enthalpies of mixing, on activity coefficients and on the thermochemistry of the system.

Sulfuric acid is a dibasic acid in solutions below 0.01 m, dissociating into $2H^+$ and SO_4^{2-}. Above 1 molal it is a monobasic strong acid, forming H^+ and HSO_4^-. At the sulfuric acid rich side of the phase diagram, molecular species predominate. Several crystaline hydrates have been studied at low temperatures.

References reporting measurements or presenting the results of correlations and evaluations have been included. Publications that consider only applications of existing data to specific problems without providing new data have been avoided. References concerning mixtures with organic substances have also been excluded.

The citations are listed alphabetically according to first author. Each is prceeded by a brief identification code composed of the year of publication and three letters from the last names of the first two authors. The citations list,in order, the names of authors; the title of the article, chapter or report as appropriate; and the source information, i.e. journal or book title,volume, and year of publication. The structure of these citations does not conform to the specifications established by the American National Standards Institute but the information given is that necessary to direct the reader to a particular reference. In a few instances only an abstract or secondary reference was available. In these cases either the citation to Chemical Abstracts or to the secondary reference is given.

Some titles have been translated, e.g. those in Russian. These translations come, by preference, from abstracts in the papers themselves or from Chemical Abstracts.(The titles from the latter may be condensations of the originals.)

Each publication has been annotated to show the class of data, the temperature range and, if appropriate, pressure, solution composition and pH. The data class designations are taken from the Bulletin of Chemical Thermodynamics. They are two letter codes with some mnemonic or physical chemical associations. A list is appended. No attempt has been made to assess the quality of the data, however, an annotation of "Ze" indicates that a particular reference constitutes or includes an evaluation of experimental data from several sources.

The bibliography has been prepared by searching the files of the NBS Chemical Thermodynamics Data Center, the Bulletin of Chemical Thermodynamics, and references in the papers retrieved from those sources. It covers a time period from the 19th century to 1982. Additions and corrections will be welcomed.

46ABE:	Abel, E.; "The Vapor Phase Above the System Sulfuric Acid-Water"; J. Phys. Chem.; 50, 260 (1946)	Zr, Pv, vapor pressures, m = 2.5 to 90.
26AGD/HOL:	Agde, G.; Holtmann, H.; "Die Spezifischen Warmen der Systeme Schwefelsaure-Wasser, Eisenvitrol-Wasser, Schwefelsaure-Eisenvitrol-Wasser"; Z. Anorg. Allgem. Chem.; 158, 317 (1926)	Ql, 25-45°C.
69ADH/GAN:	Adhikari, M.; Ganguli, D.; Biswas, G.; Ghosh, D.; "Determination of the Second Dissocation Constant of H_2SO_4 from Measurements of E.M.F. Across Cation Exchange Membrane"; J. Ind. Chem. Soc.; 46, 1131 (1969)	Ke, 25 and 30°C, m = .001-.005, clay membranes.
26AKE:	Akerlof, G.; "Investigations of Sulfate Solutions. Experimental Methods and Results on Cells Without Liquid Junction"; J. Am. Chem. Soc.; 48, 1160 (1926)	Ke, t = ?, m = .01-3.6.
62AUS/MAI:	Austin, J.M.; Mair, R.D.; "The Standard Enthalpy of Formation of Complex Sulfate Ions in Water. I. HSO_4^-, $LiSO_4^-$, $NaSO_4^-$"; J. Phys. Chem.; 66, 519 (1962)	Hm, m = .007.
60BAS/GIL:	Bass, S.J.; Gillespie, R.J.; Oubridge, J.V.; "Solutions in Sulphuric Acid. Part XXVIII. Osmotic Coefficients of Some Electrolyte Solutions"; J. Chem. Soc.; 837 (1960)	Da, Pt, t = 0, $MHSO_4$ and org. bases.
60BEC/DOB:	Beck, W.H.; Dobson, J.V.; Wynne-Jones, W.F.K.; "The Potentials of the Mercurous Sulphate/Mercury Electrode"; Trans Faraday Soc.; 56, 1172 (1960)	Ke, 5-55°C, m = 0.1-8.
59BEC/SIN:	Beck, W.H.; Singh, K.P.; Wynne-Jones, W.F.K.; "The Behaviour of the Lead Dioxide Electrode. Part 6. The Potentials of the Lead Dioxide/Lead Sulphate Electrode"; Trans Faraday Soc.; 55, 331 (1959)	Ke, 5-55°C, m = 0.1-8.
34BEC/ROT:	Becker, G.; Roth, W.A.; "Zur Bestimming der Verbrennungswarme von Organischen Schwefelverbundungen"; Z. Phys. Chem.; A169, 287 (1934)	Zr, Hm, 20°C, 10000 H_2O.
09BED:	Bedford, T.G.; "The Depression of Freezing Point in very Dilute Aqueous Solutions"; Proc. Roy. Soc. London; 83A, 454 (1909)	Pt, t = 0, m = 0.0005-001.

19BER/HAR:	Berkeley, R. [8th earl]; Hartley, E.G.J.; Burton, C.V.; "On Osmotic Pressures Derived from Vapour-Pressure Measurements: Aqueous Solutions of Cane Sugar and and Methyl Glucoside"; Philos. Trans. Royal Soc. London; 218, 295 (1919)	Po, Pv, 0 and 30°C.
1873BER:	Berthelot, M.; "Parallels between the Formation of Solid Salts [of] Picric, Hydrochloric, Nitric, Sulfuric, Acetic and Benzoic Acids"; Ann. Chim. Phys.; *(4)29, 328 (1873)	Hr, 18°C?, neutralization.
1873BER2:	Berthelot, M.; "On Anhydrous Potassium Bisulfate and on the Heat of Solution of Anhydrous Sulfuric Acid"; Ann. Chim. Phys.; *(4)30, 433 (1873)	Hm, 18°C?
1874BER:	Berthelot, M.; "On the Crystalline Hydrates of Sulfuric Acid"; Compt. Rend.; 78, 716 (1874)	Hm, 12°C, sol of hydrates.
1875BER:	Berthelot, M.; "Refrigeration Mixtures"; Ann. Chim. Phys.; *(5)4, 47 (1875)	Hm, $t < 0$°C, H_2O(cr) and hydrates of H_2SO_4.
1875BER2:	Berthelot, M.; "On the Heat of Combination as Carried to the Solid State. New Expressions of the Reactions"; Ann. Chim. Phys.; *(5)4, 74-104 (1875)	Hm, 10-15°C, in 50 to 100 H_2O, also metal sulfates.
1875BER3:	Berthelot, M.; "On the Crystalline Hydrates of Sulfuric Acid"; Ann. Chim. Phys.; *(5)4, 154 (1875)	Hm, 12°C, sol of hydrates, same as 1874BER.
1875BER4:	Berthelot, M.; "Solution of Acids and Bases"; Ann. Chim. Phys.; *(5)4, 445 (1875)	Hm, 18°C?, dilution.
1878BER:	Berthelot, M.; "Some of the Fundamental Laws of Thermochemistry"; Ann. Chim. Phys.; 13, 5 (1878)	Hc, t = ?
1878BER2:	Berthelot, M.; "New Remarks on the Heat Release by the Reaction of Water with Sulfuric Acid in Great Excess"; Ann. Chim. Phys.; *(5)14, 443 (1878)	Hm, 20°C, in 70 H_2O.
1898BER:	Berthelot, M.; "On the Heat Released by the Reaction of Small Quantities of Water with Sulfuric Acid Used in Considerable Excess"; Ann. Chim. Phys.; *(7)13, 77 (1898)	Hm, 22°C, 1-4 H_2O.

60BEW:	Bewley, D.K.; "Heat of Reaction Between Ferrous Ammonium Sulphate and Hydrogen Peroxide in Aqueous Solution"; Trans. Faraday Soc.; 56, 1629-1632 (1960)	Hm, Ql(?), 25°C(?), dilution.
22BIC:	Bichowsky, F.R.; "Equilibrium in the Reaction Between Sulfur Dioxide and Water"; J. Am. Chem. Soc.; 44, 116 (1922)	Kk, t = 530-615K, $S(l)+H_2SO_4$.
1899BIN:	Binon, E.; "Heat Capacities of Water Solutions of Sulfuric Acid"; Russkue-Fiziko Khim. Obsh., Petr.; 31, 171 (1899)	Ql, m = 0-400 waters.
1889BOD:	Bode, F.; "Specific Heat of Sulfuric Acid"; Z. Angew. Chem.; 2, 244 (1889)	Ql, 15°C, 5-400 waters.
05BOS:	Bose, E.; "Observations on Julius Thomsen's Measurements of the Heat of Mixing of Acids"; Phys. Z.; 6, 550 (1905)	Hm, t = 18°C, 1-1600 waters.
52BRA/RUT:	Brand, J.C.D.; Rutherford, A.; "The Vapour Pressure of the System Sulphuric Acid-Disulphuric Acid"; J. Chem. Soc.; 3916 (1952)	Pv, 20-80°C, 50-63 mol% SO_3 or SO_4.
03BRI:	Briggs, E.; "The Vapour Pressures of Concentrated Solutions of Sulphuric Acid at High Temperatures"; J. Soc. Chem. Ind.; 22, 1275 (1903)	Pv, t = 100-200°C.
10BRO:	Bronsted, J.N.; "Studies on Chemical Affinity III. Mixing Affinity of Binary Systems. The Sulfuric Acid-Water System"; Z. Phys. Chem. (Leipzig); 68, 693 (1910)	Hm, Vx, t = 18°C?
45BRO:	Broughton, D.B.; Chem.; "Sulphuric Acid and Oleum Enthalpy Chart"; Chem. Met. Eng.; 52(4), 123 (1945)	Hm, 17°C, 0-100% H_2SO_4.
04BUR:	Burt, B.C.; "The Vapour Pressure of Sulphuric Acid Solutions and the Molecular Condition of Sulphuric Acid in Concentrated Solution"; J. Chem. Soc.; 85, 1339 (1904)	Pv, 55-105°C, vp of sol 55-235°C and for conc. 24.92-95.94% H_2SO_4.
72CAB/GIA:	Cabani, S.; Gianni, P.; "Analysis of Some Calorimetric Data Concerning the Formation of Bisulfate Ion in Aqueous Solution"; Anal. Chem.; 44, 253 (1972)	Kk, review of equilibria.

1889CAT:	Cattaneo, C.; "Sulla Caloricita Specifica delle Soluzioni Acquose dell'acido Solforico"; Nuovo Cimento; 26, 50 (1889)	Ql, 5-22°C.
33COL:	Collins, E.M.; "The Partial Pressures of Water in Equilibrium with Aqueous Solutions of Sulfuric Acid"; J. Phys. Chem.; 37, 1191 (1933)	Pv, 29.90-65.47% H_2SO_4.
65COV/DOB:	Covington, A.K.; Dobson; J.V.; Wynne-Jones, W.F.K.; "Stoichiometric Activity Coefficients of Sulphuric Acid and the Standard Potentials of the Lead Dioxide/Lead Sulphate and Mercury/Mercurous Sulphate Electrodes at 25°C"; Trans. Faraday Soc.; 61, 2050 (1965)	Ke, Da, m = 0.007-0.1. t = 25°C.
34COW/SHR:	Cowperthwaite, I.A.; Shrawder, J. Jr.; "The Partial Molal Heat of Dilution of Sulphuric Acid from Electromotive Force Measurements"; J. Am. Chem. Soc.; 56, 2345 (1934)	Ke, 0-50°C.
40CRA/VIN:	Craig, D.N.; Vinal, G.W.; "Thermodynamic Properties of Sulphuric-Acid Solutions and their Relation to the Electromotive Force and Heat of Reaction of the Lead Storage Battery"; J. Res. Nat. Bur. Stand.; A24, 475 (1940)	Ze, Ql, Hm, Ke, 20 and 25°C.
62D'A/FRE:	D'Ans, J.; Freund, W.E.; Woelk, N.H.; "Losungsgleichgewichte von festen und flussigen Stoffen in Flussikeiten"; 'Landolt-Bornstein Tabellen'; Auflage 6, Band II, Teil 2b, p. 3-11 (1962)	Px, -60 to 40°C, $x(H_2SO_4)$ = 0 to 1.
23DAU:	Daudt, W.; "Eine Differentialmethode zur Messung kleiner Drucke mittels der Warmeleitung"; Z. phys. Chem.; 106, 255 (1923)	Pv, -40 to -10°C, vp for 20-60 mol/kg.
52DAV/JON:	Davies C.W.; Jones, H.W.; Monk C.B.; "E.M.F. Studies of Electrolytic Dissociation. I. Sulphuric Acid in Water"; Trans Faraday Soc.; 48, 921 (1952)	Ke, 0-50°C.
33DAW:	Dawson, H.M.; "The Ionisation of Sulphuric Acid"; Proc. Leeds Phil. Lit. Soc.; 2, 359 (1933)	Kk, 25°C, m = 0.001-0.1, k determined from rates of hydrolysis of ethyl acetate.

54DEN/TAF:	Deno, N.C.; Taft, R.W., Jr.; "Concentrated Sulfuric Acid-Water"; J. Am. Chem. Soc.; 76, 244 (1954)	Da, 25°C, 83-99.8% H_2SO_4, act. of H_2O and acidity function.
1893DIE:	Dieterici, C.; "Uber die Dampfdrucke wasseriger Losungen bei 0°C"; Ann. Phys.; 286, 47 (1893)	Pv, 0°C, m(H_2SO_4) to 11.
1897DIE:	Dieterici, C; "Uber die Dampfdrucke verdunnter wasseriger Losungen bei 0°C"; Ann. Phys.; 298, 616 (1897)	Pv, 0°C, m(H_2SO_4) to 0.4.
1899DIE:	Dieterici, C.; "Uber die Dampfdrucke verdunnter wasseriger Losungen bei 0°C"; Ann. Phys.; 303, 859 (1899)	Pv, 0°C, m(H_2SO_4) to 0.5.
11DRU:	Drucker, K.; "Das Dissoziationsschema der Schwefelsaure und die Beweglichkeit des Hydrosulfations"; Z. Electrochem.; **17**, 398 (1911)	Kk, Da, 0-25°C, m = (H_2SO_4) < 0.1.
20DRU:	Drucker, C.; "Weitere Untersuchungen uber die Dissoziation ternarer Elektrolyte"; Z. Phys. Chem.; 96, 381-427 (1920)	Ke, 18°C, ioniz. from emf data.
34DRU:	Drucker, C.; "Salzeffecte in concentrirten Losungen. Die Veranderung der LOsungswarme von Kaliumchlorid durch andere Elektrolyte"; Ark. Kemi, Mineral. Geol.; 11A, 1-27 (1934)	Ql, 18°C, but mostly about Cp for KCl in H_2SO_4(aq).
68DUI/GIA:	Duisman, J.A.; Giauque W.F.; "Thermodynamics of the Lead Storage Cell. The Heat Capacity and Entropy of Lead Dioxide from 15 to 318K"; J. Phys. Chem.; 72, 562 (1968)	Ke, 0-60°C, EMF's from Third Law.
64DUN/NAN:	Dunsmore, H.S.; Nancollas, G.H.; "Dissociation of the Bisulfate Ion"; J. Phys. Chem.; 68, 1579 (1964)	Zr, Kk, 25°C.
65EDW/WAN:	Edward, J.T.; Wang, I.C.; "Ultraviolet Study of the Ionization of Bisulfate Ion"; Can. J. Chem.; 43, 2867 (1965)	Mm, m = 0.010 to 0.30.
55EIC/RAB:	Eichler, E.; Rabideau, S.; "The Determination of the Bisulfate Dissociation Quotient from Potentiometric Measurements"; J. Am. Chem. Soc.; 77, 5501 (1955)	Ke, Zr, t = ? bisulfate dissociation in aq. perchlorate, m = 0.01-1.

71EVA/MON:	Evans, C.E.; Monk, C.B.; "E.M.F. Studies of Electrolytic Dissociation"; Trans Faraday Soc.; 67, 2652 (1971)	Ke, 25°C, I = 0.006 to 0.06.
1853FAV/SIL:	Favre, P.A.; Silbermann, J.T.; "Recherches sur les Quantites de Chaleur Degagees dans les Actions Chimiques et Moleculaires Troisieme Partie"; Ann. Chim. Phys.; (3), 37, 4 (1853)	Hm, t = ?
74FEI/FUC:	Feilchenfeld, H.; Fuchs, J.; "Hydration Numbers of Some Acids and Salts"; Israel J. Chem.; 12, 899 (1974)	Kk, hydration at 25°C.
21FER/FRA:	Ferguson, A.L.; France, G.F.; "The Transference Numbers of Sulfuric Acid by the Concentration Cell Method"; J. Am. Chem. Soc.; 43, 2150-2160 (1921)	Ke, 25°C.
61FLI:	Flis, I.E.; "Energies of the Process of Formation of Ions SO_4^{2-} and HSO_4^- in Aqueous Solutions at Various Temperatures"; Zh. Prikl. Khim.; 34, 1744 (1961)	Ke, 10-15°C, enthalpy of bisulfate ion.
58FLI/MIS:	Flis, I.E.; Mishchenko, K.P.; Pakhomova, N.V.; "The Thermochemistry of Dissociation of Sulphuric and Hypochlorous Acids in Aqueous Solution"; Russ. J. Inorg. Chem.; 3, 1772 (1958)	Hr, 10-15°C, neutralization.
1884FOR:	de Forcrand, R.; "Sur les Sulfites et Bisulfites de Soude"; Ann. Chim. Phys.; (6), 3, 242 (1884)	Hm, 10°C.
50GAB/BET:	Gable, C.M.; Betz, H.F.; Maron, S.H.; "Phase Equilibria of the System Sulfur Trioxide-Water"; J. Am. Chem. Soc.; 72, 1445 (1950)	Pt, 1.5-93.7% SO_2, freezing points from -35 to +35°C.
69GAR/JEK:	Gardner, W.L.; Jekel, E.C.; Cobble, J. W.; "The Thermodynamic Properties of High-Temperature Aqueous Solutions. IX. The Standard Partial Molal Heat Capacities of Sodium Sulfate and Sulphuric Acid from 0 to 100°"; J. Phys. Chem.; 73, 2017 (1969)	Dm, Cp by integral heat method.
69GAR/MIT:	Gardner, W.L.; Mitchell, R.E.; Cobble, J.W.; "The Thermodynamic Properties of High-Temperature Aqueous Solutions. X. The Electrode Potentials of Sulphate Ion Electrodes from 0 to 100. Activity Coefficients and the Entropy of Aqueous Sulfuric Acid"; J. Phys. Chem.; 73, 2021 (1969)	Da, 0-100°C, third law method to calculate act and conc(0.1 to 4.0 mol/kg).

60GIA/HOR: Giauque, W.F.; Hornung, E.W.; Kunzler, J. E.; Rubin, T.R.; "The Thermodynamic Properties of Aqueous Sulfuric Acid Solutions and Hydrates from 15 to 300K"; J. Am. Chem. Soc.; 82, 62 (1960)

Hm, 15-300K.

56GIA/KUN: Giauque, W.F.; Kunzler, J.E.; Hornung, E.W.; "The Freezing Point Method of Determining Free Energies in a 2-Component System Forming Compounds. Concentrated Aqueous Sulphuric Acid"; J. Am. Chem. Soc.; 78, 5482 (1956)

Px, 0-2 H_2O, freezing points = 0.2 to -80°C.

81GIA/WUS: Giazitzoglou, Z.; Wuster, G.; "Das binare System H_2SO_4 H_2O; p,v,T-Daten und Dampfdruckkurven in weiten Konzentrationsbereichen bei erhohtem Druck"; Ber. Bun. Phys. Chem.; 85, 127-132 (1981)

Pv, 450 - 823 K, 1 - 50 bar, conc. = 20-98 mole percent H_2SO_4

50GIL: Gillespie, R.J.; "Cryoscopic Measurements in Sulphuric Acid. Part IV. Reactions of Ionised Sulphates in Sulphuric Oleum. Self-ionisation Equilibria in Sulphuric Acid, and Ionic Equilibria in Oleum. The Polysulphuric Acids"; J. Chem. Soc.; 2516 (1950)

Px, aq. ammonium sulfate and bisulfate in sulfuric acid.

50GIL/HUG: Gillespie, R.J.; Hughes, E.D.; Ingold C.K.; "Cryoscopic Measurements in Sulphuric Acid. Part I. Principles and Methods. The Cryoscopic Constant and Some Other Constants of Sulphuric Acid"; J. Chem. Soc.; 2473 (1950)

Hp, Px.

56GLU/KIT: Glueckauf, E.; Kitt, G.P.; "Thermodynamic Data on Concentrated Sulphuric Acid Solutions"; Trans Faraday Soc.; 52, 1074 (1956)

Da, bithermal isopiestic method, m = 20-65.

77GOL/STA: Goldberg, R.N.; Staples, B.R.; Nuttall, R.L.; Arbuckle, R.; Nat. Bur. Stand. (U.S.) Spec. Pub.; 'A Bibliography of Sources of Experimental Data Leading to Activity or Osmotic Coefficients for Polyvalent Electrolytes in Aqueous Solution'; No. 485, 49 pp. (1977)

Zr, bibliog. of activity data for sulfuric acid and other aq. systems.

60GOO/LAC: Good, W.D.; Lacina, J.L.; McCullough, J.P.; "Sulfuric Acid Heat of Formation of Aqueous Solutions by Rotating-bomb Calorimetry"; J. Am. Chem. Soc.; 82, 5589 (1960)

Hc, heat of formation of H_2SO_4, $115H_2O$.

73GOP/RAO: Gopinath C.R.; Rao, K.S.R.; "Thermodynamic Properties of Some Molecules of XO_2Y_2 and XO_2YZ Types"; Curr. Sci.; 42, 164 (1973)

Md, Zr, 100-1000K, set of thermo. properties.

1843GRA:	Graham, T.; "Experiments on the Heat Disengaged in Combinations"; Philos. Mag.; 22, 329 (1843)	Hm, t = ?
25GRE:	Greenewalt, C. H.; "Partial Pressure of Water Out of Aqueous Solutions of Sulfuric Acid"; Ind. End. Chem.; 17, 522 (1925)	Zr, Zc, 0-100°C, vp of water over 0-95% sulfuric acid.
31GRO:	Groenier, W.L.; "The Heats of Dilution of Sulphuric Acid Solutions"; Thesis, Univ. Chicago; (1931)	Hm, about 25°C, m = 0.003 to 4.0.
25GRO/FRA:	Grollman, A.; Frazer, J.C.W.; "The Vapor-Pressure Lowering of Aqueous Sulfuric Acid Solutions at 25°C"; J. Am. Chem. Soc.; 47, 712 (1925)	Pv, 25°C, m = 0.1 to 3.
58GUG/STO:	Guggenheim, E.A.; Stokes, R.H.; "Activity Coefficients of 2:1 and 1:2 Electrolytes in Aqueous Solution from Isopiestic Data"; Trans Faraday Soc.; 54, 1646 (1958)	Zc, Da, 25°C, m = 0.1.
65GUN:	Gunn, S.R.; "Comparison Standards for Solution Calorimetry"; J. Phys. Chem.; 69, 2902 (1965)	Hr, 25°C, reaction with NaOH.
12HAC:	Hacker, C.; "Uber die Anderung der Dampfspannung von wasserigen Schwefelsaurelosungen mit der Temperatur"; Ann. Phys.; 275, 1342 (1912)	Pv, 0-100°C, m = 2.9 to 9.2.
63HAL:	Hala, E.; "Liquid-Vapour Equilibrium in Systems of Electrolytic Components. I. Excess Free-Energy of Dilution and the Mean Rational Activity Coefficients of Ions"; Coll. Czech. Chem. Communications; 28, 1780 (1963)	Zc, 308-330°C, SO_3+H_2O.
35HAM:	Hamer, W. J.; "The Potential of the Lead Dioxide-Lead Sulfate Electrode at Various Temperatures"; J. Am. Chem. Soc.; 57, 9 (1935)	Px, 0-60°C, m = 0.005 to 7.
35HAM2:	Hamer, W.J.; "Temperature Variation in Transference Numbers of Concentrated Solutions of Sulfuric Acid as Determined by the Galvanic Cell Method"; J. Am. Chem. Soc.; 57, 662 (1935)	Ke, 0-60°C, m = 0.05 to 17.
33HAM/DEY:	Hammett, L.P.; Deyrup, A.J.; "Some Properties of Electrolytes in the Solvent Sulfuric Acid"; J. Am. Chem. Soc.; 55, 1900 (1933)	Pt, fp of sulfuric acid, m = 0.1 to 0.4.

35HAR/HAM:	Harned, H. S.; Hamer, W. J.; "The Thermodynamics of Aqueous Sulfuric Acid Solutions from Electromotive Force Measurements"; J. Am. Chem. Soc.; 57, 27 (1935)	Ke, 0-60°C, m = 0.05 to 17.5.
25HAR/STU:	Harned, H.S.; Sturgis, R.D.; "The Free Energy of Sulfuric Acid in Aqueous Sulfate Solutions"; J. Am. Chem. Soc.; 47, 945 (1925)	Ke, 25°C, m = 0.01 and 0.1.
15HAR:	Hartung, E. J.; "A New Method for Determining the Specific Heats of Liquids"; Trans. Faraday Soc.; 11, 64 (1915)	Ql, Q, 17 to 20°C.
02HAU:	Hausrath, H.; "Eine Differentialmethode zur Bestimmung kleiner Gefrierpunktsdepressionen"; Ann. Phys.; 314, 522 (1902)	Kk, Hp, t < 0°C, m = 0.0001 to 0.02.
76HEL/KIR:	Helgeson, H.C.; Kirkham, D.H.; "Theoretical prediction of the thermodynamic properties of aqueous electrolytes at high pressures and temperatures. III. Equation of state for aqueous species at infinite dilution"; Am. J. Sci.; 276, 97-240 (1976)	Kk, Zc, Ze, 25-300°C, 1-1000 atm.
81HEL/KIR:	Helgeson, H.C.; Kirkham, D.H.; Flowers, G.C.; "Theoretical prediction of the thermodynamic behavior of aqueous electrolytes at high pressures and temperatures: IV. Calculation of activity coefficients, osmotic coefficients, and apparent molal and standard and relative partial molal properties to 600°C and 5kB"; Am. J. Sci.; 281, 1249-1516 (1981)	Ze, Kk, Da, Dm, 0-600°C, 0-5kB.
1886HEL:	Helmholtz, R.; "Untersuchungen uber Dampfe und Nebel, besonders uber solche von Losungen"; Ann. Phys.; 263, 508 (1886)	Pv, 0-50°C, in 10, 17, and 50 H_2O.
41HER:	Herrmann, C.V.; "Heat of Formation of Oleums from Sulfur Trioxide and Water"; Ind. Eng. Chem.; 33, 898 (1941)	Zc, Hm, 18°C, diln. and soln.
28HEP:	Hepburn, J. R. I.; "The Vapour Pressure of Water over Sulphuric Acid-Water Mixtures at 25°C., and its Measurements by an Improved Dew-Point Apparatus"; Proc. Phys. Soc. London; 40, 249 (1928)	Hv, m = 7 to 12.5, dew point method.

62HOG:	Hogfeldt, E.; "On the Dissociation of Strong Acids. Comments on the Paper: 'Konzentrierte wassrige Losungen, II'"; Z. Phys. Chem.; 35, 260 (1962)	Kk, 25°C?, conc. sol, comment on 62KAN.
56HOR/BRA:	Hornung, E. W.; Brackett, T.E.; Giauque, W.F.; "The Low Temperature Heat Capacity and Entropy of Sulfuric Acid Hemihexahydrate. Some Observations on Sulfuric Acid Octahydrate"; J. Am. Chem. Soc.; 78, 5747 (1956)	Ql, 15-320K, H_2SO_4:6.5H_2O.
55HOR/GIA:	Hornung, E.W.; Giauque, W. F.; "The Vapour Pressure of Water over Aqueous Sulfuric Acid at 25 "; J. Am. Chem. Soc.; 77, 2744 (1955)	Hv, 23 to 70°C, m = 14-28.
55HOR/GIA2:	Hornung, E.W.; Giauque, W.F.; "The Heat Capacities and Entropies of Sulfuric Acid Tri- and Tetrahydrates"; J. Am. Chem. Soc.; 77, 2983 (1955)	Ql, Hp, 15-300K, props. of hydrates.
69IZA/EAT:	Izatt, R. M.; Eatough, D.; Christensen, J. J.; Bartholomew, C. H.; "Calorimetrically Determined Log K, H, and S Values for the Interaction of Sulphate Ion with H+, Na+, and K+ in the Presence of Tetra-n-alkyl-ammonium Ions"; J. Chem. Soc.; 1, 45 (1969)	Kk, Ke, thermo. prop. from titrations at 25° C.
63JOH/SUN:	Johnson, W. H.; Sunner, S.; "The Heats of Solution and Oxidation of Sulfur Dioxide"; Acta Chem. Scand.; 17, 1917 (1963)	Hm, 25°C, in 2500 H_2O.
1893JON:	Jones, H.C.; "Uber die Bestimmung des Gefrierpunktes von verdunnten Losungen einiger Sauren, Alkalien, Salz und organischen Verbindungen"; Z. Phys. Chem. (Leipzig); 12, 623 (1893)	Px, m = 0.001 to 0.1.
51JON:	Jones, F.R.; "An Accurate Method for the Determination of Aqueous Vapour Pressure: The Equilibrium Humidities of Solutions of Sulphuric Acid"; J. Appl. Chem.; 1, S144 (1951)	Pv, absorption method to calc. vp, m = 0.5 to 55.
02JON/GET:	Jones, H.C.; Getman, F.H.; "The Lowering of the Freezing-point of Water Produced by Concentrated Solutions of Certain Electrolytes, and the Conductivity of Such Solutions"; Am. Chem. J.; 27, 433 (1902)	Px, m = 0.1 to 2.8.

04JON/GET:	Jones, H.C.; Getman, F.H.; "On the Nature of Concentrated Solutions of Electrolytes-Hydrates in Solution"; Am. Chem. J.; 31, 303 (1904)	Px, m = 0.1-2.5, K(diss) at 0°C.
04JON/GET2:	Jones, H.C.; Getman, F.H.; "A Study of the Molecular Lowering of the Freezing-point of Water Produced by Concentrated Solutions of Electrolytes"; Phys. Rev.; 18, 146 (1904)	Px, m = 0.5-2.5.
07JON/GET:	Jones, H.C.; Getman, F.H.; Basset, H.P.; McMaster, L.; Uhler, H.S.; "Hydrates in Aqueous Solutions. Evidence for the Existence of Hydrates in Solution, their Approximate Composition, and Certain Spectroscopic Investigations Bearing Upon the Hydrate Problem"; Carnegie Institution of Washington, Publication No. 60, (1907)	Px, m = 0.1 to 6.4, freezing point lowering and conductivity.
07JON/PEA:	Jones, H.C.; Pearce, J.N.; "Dissociation as Measured by Freezing Point Lowering and by Conductivity-Bearing on the Hydrate Theory. The Approximate Composition of the Hydrate Formed by a Number of Electrolytes"; Am. Chem. J.; 38, 683 (1907)	Kk, Px, fp, m = 0.01-2.0.
62KAN:	Kangro, W.; "Konzentrierte wassrige Losungen. II"; Z. Phys. Chem.; 32, 273 (1962)	Kk, 25°C, interp. of part. press., see 62HOG.
24KAR:	Karve, D.D.; "Thermo-chemical Investigations on the Constitution of Acids in Solution"; J. Indian Chem. Soc.; 1-2, 247 (1924-25)	Hm, 0-40°C.
57KEN:	Kenttamaa, J.; "The Solubility of Silver Sulphate and the Dissociation of the Bisulphate Ion"; Suomen Kemi.; 30B, 9 (1957)	Kk, 25°C, from solubility of Ag_2SO_4 in acid.
57KER:	Kerker, M.; "The Ionization of Sulfuric Acid"; J. Am. Chem. Soc.; 79, 3664 (1957)	Kk, m = 0-1.80.
58KIR/WYA:	Kirkbride, B. J.; Wyatt, P.A.H.; "The Partial Molar Heat Contents of Solutes in Sulphuric Acid at 25°C. An Investigation of the Self-Dissociation of Sulphuric Acid"; Trans Faraday Soc.; 54, 4 (1958)	Hm, 25°C.

72KIR/TRU:	Kirintsev, A.N.; Trushnikova, L.N.; Lavrent'eva, V.G.; 'Handbook of Phase Diagrams of Inorganic Substances in water'; Khimiya, Leningrad, 105-106 (1972)	Px, -62 to 8°C, x = 0 to 1,
42KLO/ECK:	Klotz, I.M.; Eckert, C.F.; "The Apparent Molal Volumes of Aqueous Solutions of Sulfuric Acid at 25°C"; J. Am. Chem. Soc.; 64, 1878 (1942)	Dm, Xd, 25°C, m = .014-3.19.
01KNI:	Knietsch, R.; "Ueber die Schwefelsaure und ihre Fabrication nach dem Contactverfahren"; Ber. Deutsch. Chem. Gesellsch.; 34, 4069 (1901)	Ql, Hm, 20 and 30°C.
1898KOH/HOL:	Kohlrausch, F.; Holborn, L.; 'Das Levitvermogen der Elektrolyte'; Leipzig, B.G. Teubner, (1898)	Kk, Zc, 18, 25°C.
16KOH HOL:	Kohlrausch, F.; Holborn, L.; 'Ds Levitvermogen der Elektrolyte'; Second Edition, Leipzig, B.G. Teubner, (1916)	Kk, Zc, 18, 25°C.
52KUN/GIA:	Kunzler, J. E.; Giauque, W. F.; "The Heat Capacity and Entropy of Sulfuric Acid Trihydrate Glass and Cystals from 15 to 300K"; J. Am. Chem. Soc.; 74, 797 (1952)	Ql, 15-300K, liq, vit. and crystal trihydrate.
52KUN/GIA2:	Kunzler, J. E.; Giauque, W. F.; "Aqueous Sulfuric Acid. Heat Capacity. Partial Specific Heat Content of Water at 25 and -20"; J. Am. Chem. Soc.; 74, 3472 (1952)	Ql, 25°C.
52KUN/GIA3:	Kunzler, J.E.; Giauque, W.F.; "The Freezing Point Curves of Concentrated Aqueous Sulfuric Acid"; J. Am. Chem. Soc.; 74, 5271 (1952)	Px, m > 30.
50LAN/CRO:	Land, J.E.; Crockford, H.D.; "The Activity Coefficients of Sulfuric Acid in Aqueous 2-Propanol Solutions at 25"; J. Am. Chem. Soc.; 72, 1895 (1950)	Da, 25°C, m < 1, in water and aq. propanol.
33LAN/MON:	Lange, E.; Monheim, J.; Robinson, A.L.; "The Heats of Dilution of Aqueous Solutions of Zinc, Cadmium and Copper Sulfates and Sulfuric Acid at 25"; J. Am. Chem. Soc.; 55, 4733 (1933)	Hm, 25°C, m < 1.
76LAR/HEP:	Larson, J.W.; Hepler, L.G.; "Heats and entropies of ionziation"; 'Solute-Solvent Interactions', Coetzee, J.F. and Ritchie, C.D.(eds); Marcel Dekker, NY and London, (1969)	Zr, Hr, Kk, 25°C 2d ioniz.

37LAU/ODA:	Lauer, K.; Oda, R; "Der einfluss des Losungsmittels auf den Ablauf chemischer Reaktionen, XII. Mitteil.: Losungswarme und Aktivierungsenergie bei der Sulfurierung des Anthrachinons"; Ber. Bunsenges. Phys. Chem.; 70B, 333 (1937)	Hm, t = ? sol. of H_2O in conc. H_2SO_4.
37LAU/ODA2:	Lauer, K.; Oda, R.; "Der Einfluss des Losungsmittels auf den Ablauf chemischer Reaktionen, XIII. Mitteil.: Losungswarme und Aktivierungsenergie bei Umsetzungen, deren einer Teilnehmer als Losungsmittel dient"; Ber. Bunsenges. Phys. Chem.; 70B, 1707 (1937)	Hm, t = ? sol. of H_2O in conc. H_2SO_4.
80LEN/RAF:	Lennartz, H.; Rafflenbenl, L.; Hartmann, H.; "Verdampfungs-gleichgeurchte des Systems H_2O/H_2SO_4"; 'Hydrogen as an energy vector', Strub, A.A. and Imarisio, G. (eds); D. Reidel Publish. Co., Dordrecht, Holland, (1980)	Pv, Px, 200 to 500°C, 0 o 100% H_2SO_4, 1 to 15 bar.
14LEW/LAC:	Lewis, G.N.; Lacey, W.N.; "The Potential of the Copper Electrode and the Activity of Bivalent Ions"; J. Am. Chem. Soc.; 36, 804 (1914)	Ke, 25°C, m = 0.005 and 0.05.
19LEW/LIN:	Lewis, G. N.; Linhart, G. A.; "The Degree of Ionization of Very Dilute Electrolytes"; J. Am. Chem. Soc.; 41, 1951 (1919)	Kk, 0°C, interp. of freezing point lowering.
21LEW/RAN:	Lewis, G. N.; Randall, M.; "The Activity Coefficient of Strong Electrolytes"; J. Am. Chem. Soc.; 43, 1112 (1921)	Zr, Da, 25°C, review of early work.
61LIE/STO:	Lietzke, M.H.; Stoughton, R.W.; Young, T.F.; "The Bisulfate Acid Constant from 25 to 225° as Computed from Solubility Data"; J. Phys. Chem.; 65, 2247-2249 (1961)	Kk, 25-225°C, Psat, 2d ioniz., from solb. of Ag_2SO_4
75LIL/BRI:	Lilley, T. H.; Briggs, C.C.; "Stoichiometric Activity Coefficients of Aqueous H_2SO_4 Solution at 298.15K"; Electrochim. Acta; 20, 257 (1975)	Zr, Da, 25°C, m < 0.02.
58LIN:	Linke, W.F.; "Solubilities"; D. Van Nostrand, Princeton, 4th ed.; 1, 1153-1156 (1958); [originated by A. Seidel]	Ze, Pv, compiled and correlated solubilities.
69LIN/WIR:	Lindstrom, R.E.; Wirth, H.E.; "Estimation of the Bisulfate Ion Dissociation in Solutions of Sulfuric Acid and Sodium Bisulfate"; J. Phys. Chem.; 73, 218 (1969)	Zc, Kk, V, 25°C?, m < 0.01.

57LLO/WYA:	Lloyd, L.; Wyatt, P.A.H.; "The Partial Molar Heats of Solution of Water in Dinitrogen Pentoxide Solutions and of Potassium Nitrate and Sulphuric Acid in Nirtic Acid at 0°"; J. Chem. Soc.; 4262 (1957)	Ql, Hm, 0°C, in conc. aq HNO_3.
1893LOO:	Loomis, E.H.; "Ueber ein exacteres Verfahren bei der Bestimmung von Gefrierpunktserniedrigungen"; Ber. Bunsenges. Phys. Chem.; 26, 797 (1893)	Px, 0°C, m < 0.2, freezing point lowering, same data in 1894LOO.
1894LOO:	Loomis, E. H.; "On the Freezing-Points of Dilute Solutions. II."; Phys. Rev.; 1, 274 (1894)	Px, 0°C, m < 0.2, freezing point lowering.
1894LOO2:	Loomis, E.H.; "Ueber Ein Exacteres Verfahren bei der Bestimmung von Gefrierpunktserniedrigungen"; Ann. Physik.; 51, 500 (1894)	Kk, 0°C, m < 0.2, freezing point lowering, same data in 1894LOO.
56LUC:	Luchinskii, G.P.; "Vapor-liquid Equilibrium in System H_2O-SO_3. I. Physico-chemical Observations on the System H_2O-SO_3"; Zh. Fiz. Khim.; 30, 1207 (1956)	Pv, 20-200°C.
59LUC:	Luchinskii, G.P.; "Physico-chemical Investigation of the System H_2O-SO_3. II. The Heats of Interaction of the Components in the System H_2O-SO_3 with the Liquid Phase of Varying Composition"; Zh. Fiz. Khim.; 33, 1275 (1959)	Hm, 25°C?
33MAC/BLU:	MacDougall, F. H.; Blumer, D.R.; "The Activity of Each Component in Aqueous Solutions of Sulfuric Acid and Acetic Acid"; J. Am. Chem. Soc.; 55, 2236 (1933)	Ke, V, 25°C, $[H_2SO_4]$ = 0.05 to 2.2.
67MAK:	Maksimova, I.N.; "Free Energy, Entropy, and Enthalpy of Ionic Equilibria in Aqueous Solution at High Temperatures"; Russ. J. Phys. Chem.; 41, 27 (1967)	Kk, 20-300°C, few exper. data.
63MAN/SUN:	Mansson, M.; Sunner, S.; "The Heat of Formation of Sulphuric Acid"; Typescript, Thermochemistry Lab, Univ. of Lund; (1963)	Hc, 25°C, combustion of sulfur.
1876MAR:	Marignac, M.C.; "Specific Heat of Saline Solutions"; Arch. Sci. Phys. Nat.; 55, 113 (1876)	Ql, 16-18°C, 20-50 H_2O.
1876MAR2:	Marignac, M.C.; "Sur les Chaleurs Specifiques des Solutions Salines"; Ann. Chim. Phys.; *(5)8, 410 (1876)	Ql, 16-18°C, same data as in 1876MAR.

66MAR/JON:	Marshall, W. L.; Jones, E.V.; "Second Dissociation Constant of Sulfuric Acid from 25 to 350 Evaluated from Solubilities of Calcium Sulfate in Sulfuric Acid Solutions"; J. Phys. Chem.; 70, 4028 (1966)	Kk, 25-350°C, in $CaSO_4$(aq, sat).
1890MAT:	Mathias, M.E.; "Sur la Chaleur de Vaporisation des Gaz Liquefies"; Ann. Chim. Phys.; *(6)21, 69 (1890)	Hm, 16°C, H_2O into conc. H_2SO_4.
42MCC/MCK:	McCurdy, J.L.; McKinley C.; "The System Nitric Acid-Sulfuric Acid-Water"; Ind. Eng. Chem.; 34, 1002 (1942)	Zc, Qh, Hm, 32-500°F?, nomograph for mixt of $H_2SO_4/HNO_3/H_2O$.
27MCH:	McHaffie, I. R.; "The Vapour Pressure of Water over Sulphuric Acid-Water Mixture at 25"; J. Chem. Soc.; 112 (1927)	Pv, 25°C, 66-84% H_2SO_4.
32MEY:	von Meyeren, W.; "Eine einfache Methode zur Messung kleiner Dampfdrucke"; Z. Phys. Chem. (Leipzig); A160, 272 (1932)	Pv, 0-40°C, 60-70 wt% H_2SO_4.
42MOR:	Morgen, R. A.; "Heats of Solution of the System Sulfur Trioxide-Water"; Ind. Eng Chem.; 34, 571 (1942)	Zc, Dm, 18°C, enthalpies.
43MOR/BEN:	Morgan, J.J.; Bender, D.A.; Capell, R.G.; "Specific Heats of Mixed Acids at Higher Temperatures"; Chem. Met. Eng.; 50, 122 (1943)	Zc, Qh, 0-100°C, in H_2O and mixt. with HNO_3.
13MUL:	Muller, J. A.; "Sur les Chaleurs de Dilution a l'infini des Solutions Aqueuses Moleculaires d'Acide Chlorhydrique et d'Acide Sulfurique"; Bull. Soc. Chim. France; 13, 1053 (1913)	Hm, 14-38°C, at inf. dil.
28NAU:	Naude, S.M.; "Uber die Verdunnungswarme schwach konzentrierter Losungen"; Z. Phys. Chem. (Leipzig); 135, 209 (1928).	Hm, 18°C, [H_2SO_4] = 0.001-0.5.
60NEC:	Neckel, A.; "Gefrierpunktsniedrigung"; 'Landolt-Bornstein Tabellen'; Auflage 6, Band II Teil 2a, p.862 (1960)	Ze, Hm, 0°C, freezing point lowering.
07NOY:	Noyes, A.A.; 'The Electrical Conductivity of Aqueous Solutions'; Publ. 63, Carnegie Institution of Washington, 153-234, (1907)	Kk, 25-306°C.

10NOY/FAL:	Noyes, A.A.; Falk, K.G.; "The Properties of Salt Solutions in Relation to the Ionic Theory. I. Mol-Numbers Derived from the Freezing-Point Lowering"; J. Am. Chem. Soc.; 32,1017 (1910)	Zr, Kk, 0°C, freezing point lowering.
56PAP/CAN:	Papee, H.M.; Canady, W.J.; Laidler, K.J.; "The Heat of Neutralization of Strong Acids and Bases in Highly Dilute Aqueous Solutions"; Can. J. Chem.; 34, 1677 (1956)	Hr, 25°C, m < 3x10-2, neutralization.
20PAS/GAR:	Pascal, P.; Garnier, M.; "Chaleur Specifique des Acides Sulfuriques, des Acides Nitriques et de Leurs Melanges (1)"; Bull. Soc. Chim. France; 27, 8 (1920)	Ql, 20°C, $x(H_2SO_4)$ = .10 to 1.0.
1890PIC:	Pickering, S.U.; "The Nature of Solutions, as Elucidated by the Freezing Points of Sulphuric Acid Solutions"; J. Chem. Soc.; 57, 331 (1890)	Px, t < 20°C, solidus, $x(H_2SO_4)$ = 0 to 0.94.
1890PIC2:	Pickering, S.U.; "The Nature of Solutions, as Elucidated by a Study of the Density, Electric Conductivity, Heat Capacity, Heat of Dissolution and Expansion by Heat of Sulphuric Acid Solutions"; J. Chem. Soc.; 57, 64 (1890)	V, Vm, Q, Hr, 8-38°C, but diff for various props.
1891PIC:	Pickering, S.U.; Verhandlungen uber die Theorie der Losungen"; Z. Phys. Chem. (Leipzig); 7, 378 (1891)	Kk, t < 0°C, freezing point lowering, comment by J. Walker, pg 396.
1892PIC:	Pickering, S.U.; "Das kryoskopische Verhalten schwacher Losungen"; Ber. Deutsch. Chem. Ges.; 25, 1099 (1892)	Kk, t < 0°C, to 2 wt %, freezing point lowering.
76PIT:	Pitzer, K.S.; "Thermodynamic Properties of Dilute Sulfuric Acid and the Potential of the Lead Sulfate-Lead Electrode"; J. Phys. Chem.; 80, 2863 (1976)	Da, 25°C.
77PIT/ROY:	Pitzer, K.S.; Roy, R.N.; Silvester, L.F.; "Thermodynamics of Electrolytes. 7. Sulfuric Acid"; J. Am. Chem. Soc.; 99 4930 (1977)	Ze, Da, Kk, 25°C, 0-6 m.
73PLA:	Platford, R.F.; "Osmotic Coefficients of Aqueous Solutions of Seven Compounds at 0°C"; J. Chem. Eng. Data; 18, 215 (1973)	Da, 0°C, 1-11 m.

18POR:	Porter, A. W.; "The Thermal Properties of Sulphuric Acid and Oleum"; Trans Faraday Soc.; 13, 373 (1918)	Zr, Q, Hp, Hm, various t., dil. and conc. sol.
30PRE:	Pretat, M.; "Determination des Chaleurs de Dilutions des Melanges Sulfonitriques"; Mem. Poudres; 24, 119 (1930)	Hm, 20-25°C, conc. H_2SO_4 and H_2SO_4/HNO_3 mixt.
65QUI/MAR:	Quist, A.S.; Marshall, W.L.; Jolley, H.R.; "Electrical Conductances of Aqueous Solutions at High Temperatures and Pressure. II. The Conductances and Ionization Constants of Sulfuric Acid-Water Solutions from 0 to 800°C and at Pressures up to 4000 Bars"; J. Phys. Chem.; 69, 2726 (1965)	Kk, 0-800°C, p to 4000 bar, K1 and K2 (ioniz.), ΔH (ioniz) $m(H_2SO_4)$ < 0.01.
34RAD/JUL:	Radulescu, D.; Jula, O.; "Beitrage zur Bestimmung der Abstufung der Polaritat des Aminstickstoffes in den organischen Verbindungen"; Z. Phys. Chem. (Leipzig); B26, 390 (1934)	Ql, 15-18°C, $[H_2SO_4]$ = 2.
18RAN/CUS:	Randall, M.; Cushman, O.E.; "The Free Energy of Dilution of Sulfuric Acid"; J. Am. Chem. Soc.; 40, 393 (1918)	Ke, 25°C, $x(H_2SO_4)$ = 0.0001-0.128.
27RAN/LAN:	Randall, M.; Langford, C.T.; "The Activity Coefficient of Sulfuric Acid in Aqueous Solutions with Sodium Sulfate at 25"; J. Am. Chem. Soc.; 49, 1445 (1927)	Ke, Da, 25°C, $M(SO_4^{2-})$ = 0.2 to 2, $a(H_2SO_4)$ from EMF.
27RAN/SCO:	Randall, M.; Scott, G.N.; "The Freezing Point and Activity Coefficient of Aqueous Barium Nitrate, Sodium Sulfate and Sulfuric Acid"; J. Am. Chem. Soc.; 49, 647 (1927)	Px, Da, 0°C, $M(H_2SO_4)$ < 0.1, $a(H_2SO_4)$, $a(H_2O)$.
41RAN/TAY:	Randall, M.; Taylor, M. D.; "Heat Capacity and Density of Aqueous Solutions of Potasssium Iodate, Potassium Acid Sulfate, Iodic Acid, and Sulfuric Acid at 25°C"; J. Phys. Chem.; 45, 959 (1941)	Ql, Vx, 25°C, $m(H_2SO_4)$ = 0.04 to 2.2.
83RAR:	Rard, J.A.; "Isopiestic Determination of the Osmotic Coefficients of Aqueous H_2SO_4 at 25°C"; J. Chem. Eng. Data; 28, 384-387 (1983)	Pv, Da, 25°C, $m(H_2SO_4)$ = 0.14 to 3.1, isopiestic studies.
76RAR/HAB:	Rard, J. A.; Habenschuss, A.; Spedding, F.H.; "A Review of the Osmotic Coefficients of Aqueous H_2SO_4 at 25 °C"; J. Chem. Eng. Data; 21, 374-379 (1976)	Ze, Da, Pv, 25°C, $m(H_2SO_4)$ = 0.1 to 28, $a(H_2O)$.

77RAR/SPE:	Rard, J. A.; Spedding, F.H.; "Isopiestic Determination of the Osmotic Coefficients of Aqueous $CaCl_2$ Solutions at 25°C"; J. Chem. Eng. Data; 22, 56 (1977)	Da, Pv, 25°C, m = 2.6 to 8.8.
69REA/COB:	Readnour, J.M.; Cobble, J.W.; "Thermodynamics Properties for the Dissociation of Bisulfate Ion and the Partial Molal Heat Capacities of Bisulfuric Acid and Sodium Bisulfate over an Extended Temperature Range"; Inorg. Chem.; 8, 2174 (1969)	Hm, Q, Kk, 0-100°C, K2(ioniz.), enthalpy of solution of Na_2SO_4 in H_2SO_4.
1845REG:	Regnault, M.V.; "Etudes sur l'Hygrometrie"; Ann. Chem. Phys.; 15(3), 129 (1845)	Pv, 8-52°C, $H_2SO_4(H_2O)$ to $H_2SO_4(18H_2O)$.
38RHO/NEL:	Rhodes, F. H.; Nelson, C.C.; "Heats of Dilution of 'Mixed Acids'"; Ind. Eng. Chem.; 30, 648 (1938)	Hm, 18°C, H_2O/acid = 0-3.5, ΔH(sol): H_2SO_4, HNO_3 and their mixtures into H_2O.
39ROB:	Robinson, R.A.; "The Activity Coefficients of Sulphuric Acid and Lanthanum Chloride in Aqueous Solution at 25"; Trans Faraday Soc.; 35, 1229 (1939)	Pv, Da, 25°C, $m(H_2SO_4)$ = 0.2-3, isopiestic method vs. KCl.
45ROB:	Robinson, R.A.; "The Vapour Pressure of Solutions of Potassium Chloride and Sodium Chloride"; Trans. R. Soc. N.Z.; 75, 203 (1945)	Pv, 25°C, $m(H_2SO_4)$ = 1.3-4.3, isopiestic method vs. NaCl, $a(H_2O)$.
30ROT/GRA:	Roth, W.A.; Grau, R.; Meichsner, A.; "Beitrage zur Thermochemie des Schwefels. III"; Z. Anorg. Allgem. Chem.; 193, 161 (1930)	Hm, 18-20°C, $m(H_2SO_4)$ < 0.033, ΔH(sol), ΔH(dil).
31ROT:	Roth, W.A.; "Losungs-und Verdunnungswarme von Sauren und Basen"; 'Landolt-Bornstein Physikalisch-Chemsche Tabellen'; Auf. 5, Erg 2, 1547-50 (1931)	Ze, Hm, 8-18°C.
52RUB/GIA:	Rubin, T.R.; Giauque, W.F.; "The Heat Capacities and Entropies of Sulfuric Acid and its Mono- and Dihydrates from 15 to 300K"; J. Am. Chem. Soc.; 74, 800 (1952)	Ql, 15-300K, includes data on solutions above melting points of the hydrates.

07RUM:	Rumelin, G.; "Uber die Verdunnungswarme konzentrierter Losungen"; Z. Phys. Cpm. (Leipzig); 58, 449 (1907)	Hm, Pv, 10-16°C, H_2O/H_2SO_4 = 2-200.
64RYZ:	Ryzhenko, B.N.; "Determination of the Second Dissociation Constant of Sulfuric Acid and the Precipitation of Salts in the Reciprocal System Ca^{2+}, Ba^{2+}, SO_4^{2-}, CO_3^{2-} under Hydrothermal Conditions"; Geokhimiya; 1, 8 (1964)	Kk, 100-218°C, K2 and ΔH_2 (ioniz) from conductance of $KHSO_4$(aq).
74SAN:	San'ko, Yu. P.; "Heat Capacity of Aqueous Solutions of Sulfuric Acid at Low Temperatures (to -196°C)"; Inzh-fiz. Zh.; 27, 78 (1974)	Ql, -190 to 20°C, 40-95% H_2SO_4.
73SAU/SAW:	Saunders, A.; Sawistowski, H.; "Correlation of Activity Coefficients of Water in Solutions of Sulphuric Acid and Toluene Sulphonic Acid"; J. Appl. Chem. Biotechnol.; 23, 111 (1973)	Pv, t~100°C, vapor pressures, activity coefficients of ternary mixture.
38SCA/HAM:	Scatchard, G.; Hamer, W.J.; Wood, S.E.; "Isotonic Solutions. I. The Chemical Potential of Water in Aqueous Solutions of Sodium Chloride, Potassium Chloride, Sulfuric Acid, Sucrose, Urea and Glycerol at 25°"; J. Am. Chem. Soc.; 60, 3061 (1938)	Pv, Da, 25°C, m = 0.1-4.4, $a(H_2O)$, isopiestic method.
09SCH:	Schlesinger, H.; "Die spezifischen Warmen von Losungen. I"; Phys. Z.; 10, 210 (1909)	Ql, 0-70°C, 5 and 85% H_2SO_4.
65SCH/FER:	Schwabe, K.; Ferse, E.; "Untersuchungen an den Ketten: (Pt), H_2/H_2O, HCl, Hg_2Cl_2(S)/Hg und (Pt), H_2/H_2O, H_2SO_4, Hg_2SO_4(S)/Hg"; Ber. Bunsenges. Phys. Chem.; 69(5), 383 (1965)	Ke, 25°C, $m(H_2SO_4)$ < 0.01, EMF in the presence of Na_2SO_4 and Li_2SO_4.
39SHA/GOR:	Shankman, S.; Gordon, A.R.; "The Vapor Pressure of Aqueous Solutions of Sulfuric Acid"; J. Am. Chem. Soc.; 61, 2370 (1939)	Pv, 25°C, $m(H_2SO_4)$ = 2-23, isopiestic method, $a(H_2O)$.
70SHA/PRA:	Sharma, L.; Prasad, B.; "Standard E.M.F. of the Cell: Pt Q.H. $H_2SO_4/H_2SO_4/H_2SO_4$, Hg_2SO_4/Hg and the Standard Electrode Potential of Hg/Hg_2SO_4, SO_4^{2-} at 5, 15, 25, and 35°C"; J. Ind. Chem. Soc.; 47, 379 (1970)	Ke, Da, 5-35°C, $[H_2SO_4]$=0.008-0.32 $a(H_2SO_4)$.

39SHE/JAN:	Sheffer, H.; Janis, A.A.; Ferguson, J.B.; "The Activity of Water in Sulphuric Acid Solutions at 25°C by the Isopiestic Method"; Can. J. Res.; B17, 336 (1939)	Da, 25°C, $m(H_2SO_4)$ = 0.02-4.3, $a(H_2O)$, isopiestic method.
81SHE/VAL:	Shenfel'd, B.E.; Valeev, R.R.; Vasil'ev, B.T.; Sushcher, V.S.; Z. Prikl. Khim.; 56, 1142-1144 (1983)	Zc: Kk, 700-1200 K.
34SHR/COW:	Shrawder, J. Jr.; Cowperthwaite, I.A.; "The Activity Coefficients of Sulfuric Acid at Temperatures from 0 to 50"; J. Am. Chem. Soc.; 56, 2340 (1934)	Ke, Da, Dm, 0-50°C, $[H_2SO_4]$ = 0.001-0.02, $a(H_2SO_4)$, ΔH(dil).
64SIL/MAR:	Sillen, L.G.; Martell, A.E.; "Stability Constants of Metal-ion Complexes, Section I, Inorganic Ligands"; Special Publication No. 17, Chemical Society (London); 215-216 (1964)	Ze, Kk, compiled solution equilibria.
71SIL/MAR:	Sillen, L.G.; Martell, A.E.; 'Stability Constants of Metal-Ion Complexes. Supplement No., 1'; The Chemical Soc., London; Spec. Publ. 25 (1971)	Kk, 20-350°C, compiled data.
75SIN/PUR:	Sinha, O.P.; Puri, O.P.; "Specific Heat Anomaly of Sulphuric Acid with Dilution"; Chem. Phys. Letters; 32, 495 (1975)	Q, Vx, theoretical interpretation.
79SMI/GOL:	Smith-Magowan, D.; Goldberg, R.N.; "A Bibliography of Experimental Data Leading to Thermal Properties of Binary Aqueous Electrolyte Solutions"; Nat. Bur. Stand. (U.S.) Spec. Pub.; No. 537 (1979)	Hm, Ql, Vx, annotated bibliography.
76SMI/MAR:	Smith, R.M.; Martell, A.E.; 'Critical Stability Constants"; 4 (1976)	Ze, Kk, H, Q, evaluated solution equilibria.
24SMI/MAY:	Smith, D.F.; Mayer, J.E.; "The Free Energy of Aqueous Sulfuric Acid"; J. Am. Chem. Soc.; 46, 75 (1924)	Ke, 80°C, H_2SO_4 + 6HI = I2 + $4H_2O$ + S(s).
32SOC:	Socolik, A. S.; "Warmekapazitaten der wasserigen Losungen von Schwefelsaure"; Z. Angew. Chem.; 158, 305 (1932)	Q, 60 and 80°C, 5-100% H_2SO_4.
32SOC2:	Socolik, A.; "Heat Capacity of Solutions of Sulfuric Acid"; Zh. Obshchei Khim.; 2, 311 (1932)	Q, 60 and 80°C, 5-100% H_2SO_4.

1890SOR:	Sorel, E.; "The Manufacture of Sulphuric Acid"; J. Soc. Chem. Ind.; 9, 175 (1890)	Zr, Pv, 10-95°C, 44-82% H_2SO_4, review.
81STA:	Staples, B.R.; "Activity and Osmotic Coefficients of Aqueous Sulfuric Acid"; J. Phys. Chem. Ref. Data; 10, 779 (1981) of data.	Ze, Da, Dx, 25°C, $m(H_2SO_4)$ = 0 to 28, critical review
81STA/WOB:	Staples, B.R.; Wobbeking, T.F.; 'A Compilation of Thermodynamic and Transport Properties of Aqueous Sulfuric Acid', Nat. Bur. Stand., NBSIR; 81-2276 (1981)	Zr, bibliography.
45STO:	Stokes, R.H.; "The Derivation of Water Activities from Electromotive Force Data"; J. Am. Chem. Soc.; 67, 1686 (1945)	Zc, Da, 25°C.
47STO:	Stokes, R.H.; "The Measurement of Vapour Pressures of Aqueous Solutions by Bi-thermal Equilibration through the Vapor Phase"; J. Am. Chem. Soc.; 69, 1291 (1947)	Pv, Da, 25°C, $m(H_2SO_4)$ = 3-11.5, two temperature isopiestic method.
48STO:	Stokes, R.H.; "A Thermodynamic Study of Bivalent Metal Halides in Aqueous Solutions. Part XVII. Revision of Data for all 2:1 and 1:2 Electrolytes at 25, and Discussion of Results"; Trans Faraday Soc.; 44, 295 (1948)	Zr, Da, 25°C, $m(H_2SO_4)$ = 0.1-22, review, $a(H_2O)$.
63STU/SEC:	Stuckey, J.E.; Secoy, C.H.; J. Chem. Eng. Data; 8, 386-389 (1963)	Pt, Vc, 218-670°C.
41TAR/NEW:	Tartar, H.V.; Newschwander, W.W.; Ness, A.T.; "A Thermodynamic Study of the System Zinc Sulfate-Sulfuric Acid-Water at 25°"; J. Am. Chem. Soc.; 63, 28 (1941)	Ke, Pv, 25°C, $m(H_2SO_4)$ = 0.1 to 4.
13THI:	Thibaut, R.; "Die Elektromotorische Kraft des Bleiakkumulators in Abhangigkeit von Temperatur und Sauredichte"; Z. Electrochem.; 19, 881 (1913)	Ke, 15-45°C, $m(H_2SO_4)$ = 0.4-5.2, EMF of lead accumulator.
1882THO:	Thomsen, J.; 'Thermochemische Untersuchungen', J.A. Barth Verlag, Leipzig; 1, 36 (1882)	Ql, 18°C, 5-200 H_2O.
1883THO:	Thomsen, J.; 'Thermochemische Untersuchungen', J.A. Barth Verlag, Leipzig; 3, 39 (1883)	Hm, 20°C, H_2SO_4/H_2O = 1 to 800, dilution heats.

33TRI/EBE:	Trimble, H.M.; Ebert, P.F.; "The Effect of Ethylene Glycol upon the Activity of Sulfuric Acid in Aqueous Solutions"; J. Am. Chem. Soc.; 55, 958 (1933)	Ke, Dm, 25°C, $m(H_2SO_4)$ = 0.005-1, in H_2O and aq. ethylene glycol.
74TUR:	Turner, D.J.; "Dissociation of the Bisulphate Ion at Moderate Concentrations"; J. Chem. Soc. Faraday Trans. I; 70, 1346 (1974)	Kk, 25°C, $m[SO_4^{2-}]$ = 0.02-4, K_2(ioniz), ion pairing.
67VDO/LAZ:	Vdovenko, V.M.; Lazarev, L.N.; Khvorostin, Ya. S.; "Determination of the Dissociation Constants of Hydrogen Sulphate Ions in Solutions at Different Ionic Strengths and Temperatures"; Russ. J. Inorg. Chem.; 12, 610 (1967)	Kk, 20-35°C, I = 0 to 2m, K_2 in presence of Na salts.
29VOS/CRA:	Vosburgh, W.C.; Craig, D.N.; "The Lead Dioxide-Lead Sulfate Electrode"; J. Am. Chem. Soc.; 51, 2009 (1929)	Ke, 20-40°C, $m(H_2SO_4)$ = 0.1, EMF of Lead Sulfate-Sulfuric acid cell.
27VRE:	Vrevskii, M.S.; "Latent Heat of Vaporization of Pure Liquids and of Solutions"; Zh. Fiz. Khim. Obs.; 59, 69 (1927)	Hp, 96.5°C, 53% H_2SO_4, vaporization.
27VRE/NIK:	Vrevskii, M.S.; Nikol'skii; "Determination of the Latent Heat of Vaporization of H_2O from Solutions of Sulphuric Acid for 79.3 and the Comparison of the Thermal Effect and of Work of Dilution of these Aqueous Solutions"; Zh. Russ. Fiz. Khim. Obs.; 59, 77-78 (1927)	Hp, 80°C, 17-60 wt%, vaporiz.
82WAG/EVA:	Wagman, D.D.; Evans, W.H.; Parker, V.B.; Schumm, R.H.; Halow, I.; Bailey, S.M.; Churney, K.L.; Nuttall, R.L.; J. Phys. Chem. Ref. Data; 11, Supplement No 2 (1982); "The NBS Tables of Chemical Thermodynamic Properties"	Ze, H, K, Q, evaluated thermochemical data.
66WAL:	Wallace, R.M.; "Determination of the Second Dissociation Constant of Sulfuric Acid by Donnan Membrane Equilibrium"; J. Phys. Chem.; 70, 3922 (1966)	Kk, 25-50°C, K_2(ioniz) and H_2(ioniz).
69WAN/ZWI:	Wanders, A.C.M.; Zwietering, Th.N.; "Calculation of ΔH and K Values from Thermometric Titration Curves"; J. Phys. Chem.; 73, 2076 (1969)	Kk, calculation method for K_2(ioniz) and H_2.

00WHE:	Whetham, C.D.; "The Ionization of Dilute Solutions at the Freezing Point"; Phil. Trans A; 194, 321-360 (1900)	Kk, 0-70°C, 1st ioniz., m = .00005 - 0.02.
53WHI/LAN:	Whitten, W.N.; Land, J.E.; "The Thermodynamics of Aqueous 2-Propanol-Sulfuric Acid Solutions from Electromotive Force Measurements"; J. Am. Chem. Soc.; 75, 2202 (1953)	Ke, Da, Dm, 5-25°C, $[H_2SO_4]$ = 0.05-1, mixed solvent system.
21WIL:	Wilson, R.E.; "Humidity Control by Means of Sulfuric Acid Solutions, with Critical Compilation of Vapor Pressure Data"; Ind. Eng. Chem.; 13, 326 (1921)	Pv, Zc, 0-50°C, $x(H_2SO_4)$ = 0-1.
71WIR:	Wirth, H.E.; "Activity Coefficients in Sulphuric Acid and Sulphuric Acid-Sodium-Sulphate Mixtures"; Electrochim. Acta; 16, 1345 (1971)	Zc, Dm, 25°C, reevaluation and calculational method.
29WRE:	Wrewsky, M. S.; "Theoretische und experimentelle Untersuchung uber Verdampfung binarer Gemische. I. Methode der Bestimmung von Verdampfungswarmen reiner Flussigkeiten und Losungen"; Z. Phys. Chem.; A144, 244 (1929) [Vrevskii, M.S.]	Pv, Hp, 79.3°C, 53.66% H_2SO_4, transpiration method for H(uap). H_2SO_4 is test case.
57WU:	Wu, Y. C.; "Part I. Thermal Effects of the Interactions Between Univalent Ions. Part II. Heat of Dilution of Sulfuric Acid in Aqueous Solution"; Thesis, Univ. of Chicago (1957)	Hm, 25 C, $m(H_2SO_4)$ = 0.001-6.5, also data on LiCl and HCl.
80WU/YOU:	Wu, Y.C.; Young, T.F.; "Enthalpies of Dilution of Aqueous Electrolytes: Sulfuric Acid, Hydrochloric Acid, and Lithium Chloride"; J. Res. Nat. Bur. Stand.; 85, 11 (1980)	Hm, 25°C, $m(H_2S04)$ = 0.001-6.5, also data on LiCl and HCl, see 57WU.
60WYA:	Wyatt, P.H.A.; "The Constitution of 80-100% Aqueous Sulphuric Acid: A Case of Overlapping Equilibria"; Trans. Faraday Soc.; 56, 490 (1960)	Kk, 83-97% H_2SO_4, ionization constants, reassessment.
62YOU/IRI:	Young, T. F.; Irish, D. E.; "Solutions of Electrolytes"; Ann. Review Phys. Chem.; 13, 435 (1962)	Zr, Kk, Px, Hm, review of solution equilib. to 1961.
59YOU/MAR:	Young, T.F.; Maranville, L.F.; Smith, H.M.; "Raman Spectral Investigations of Ionic Equilibria in Solutions of Strong Electrolytes"; 'The Structure of Electrolytic Solutions', Hamer, W.J.(ed); John Wiley and Sons, Inc., New York, (1959)	Kk, Mm, 0-50°C, 0.05 - 18m.

63ZAR/VIN: Zarakhani, N.G.; Vinnik, M.I.; Russ. J. Phys. Chem.; 37, 260-263 (1963) Kk, 25°C.

NH_3-H_2O

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INTRODUCTION

Publications are listed in this bibliography that have data on equilibria in mixtures of ammonia and water and on the associated vapor-liquid equilibrium and solubilities(at low temperatures) as shown in phase diagrams. To a lesser extent, there are data on enthalpies of mixing, on activity coefficients and on the thermochemistry of the system.

References reporting measurements or presenting correlations or evaluations of data are included. Publications that consider only applications of existing data to specific systems but provide no new data have been avoided.

Ammonia is completely miscible with water but relatively volatile. It is a monoprotic base,abstracting a proton from water to form the ammonium cation. Ammonium salts have a wide variety of commercial applications and solutions of these have been studied extensively in association with the study of equilibria involving ammonia. Ammonia also complexes with many metal cations in solution .

The references are listed alphabetically by first author. Each citation is preceeded by a brief identification code composed of the year of publication and three letters from the last names of the first two authors. The citations list the names of authors; the title of the article,chapter or report as appropriate, and the source information, i.e. journal or book title,volume, year of publication. The structure of these citations does not conform to the specifications established by the American National Standards Institute but is the information necessary to direct the reader to a particular reference. In a few instances only an abstract or secondary reference was available. In these cases either the citation to Chemical Abstracts or source of the secondary citation is given.

Some titles have been translated, e.g. those in Russian. These translations come, by preference, from abstracts in the papers themselves or from Chemical Abstracts.(The titles from the latter may be condensations of the originals.)

Each publication has been annotated to show the class of data, the temperature range and, if appropriate, pressure, solution composition and pH. The data class designations are taken from the Bulletin of Chemical Thermodynamics. They are two letter codes with some mnemonic or physical chemical associations. A list is appended. No attempt has been made to assess the quality of the data, however, an annotation of "Ze" indicates that a particular reference constitutes or includes an evaluation of experimental data from several sources.

The bibliography has been prepared by searching the files of the NBS Chemical Thermodynamics Data Center, the Bulletin of Chemical Thermodynamics, and references in the papers retrieved from those sources. It covers a time period from the 19th century to 1982. Additions and corrections will be welcomed.

02ABE/RIE:	Abegg, R.; Riesenfeld, H.; "Uber das losungsvermogen von salzlosungen fur ammoniak nach messungen seines partialdrucks. I."; Z. Phys. Chem.; 40, 84-108 (1902)	Pv, 25,35°C, and in the presence of alkai and alkaline earth salts.
65ABL/BUR:	Ablov, A.V.; Burnasheva, Z.P.; Konunova, Ts.B.; "Heats of addition of amines to zinc halides"; Zh. Neorg. Khim.; 10, 2286-2292 (1965)	Hm, 25°C, in 2N HCl.
81ALL/WOO:	Allred, G.C.; Woolley, E.M.; "Heat capacities of aqueous acetic acid, sodium acetate, ammonia, and ammonium chloride at 283.15, 298.15, and 313.15 K: $\Delta C^{\circ}p$ for ionization of acetic acid and for dissociation of ammonium ion"; J. Chem. Thermodyn.; 13, 155-164 (1981)	Ql, Vx, 10-30°C, dil. solns.
1842AND:	Andrews, T.; "Sur la chaleur développée pendant la combinaison des acides avec les bases"; Ann. Chim. Phys.; [3], 4, 316-329 (1842)	Hr, 11-15°C(?), reaction with acid.
1870AND:	Andrews, T.; "On the heat developed in the combination of acids and bases"; J. Chem. Soc.; 23, 432-441 (1870)	Hr, 11-15°C(?), reaction with HCl(aq), HNO_3(aq) and acetic acid.
59ARN/FRE:	Arnold, E.; Freitag, H.; Patterson, A., Jr.; "Ionization equilibria in ammonia-water solutions from 5° to 55°C. as obtained from high field conductance measurements"; 'The structure of electrolytic solutions',W. J. Hamer,ed.; John Wiley and Sons, Inc., New York, 281-290 (1959)	Kk, Za, 5-55°C
78ART/KOC:	Artyukhov, A.P.; Kochetkov, V.N.; Vitkov, V.S.; Mikhailov, G.V.; "Equations for calculating heat capacity and enthalpy in the ammonia-phosphorus pentoxide-water systems"; Khim. Prom-st. (Moscow); *(8), 625-627 (1978); [CA 89:205121z]	Zc, Px, t=?, in phosphate sol., theoret.
71BAL/SPE:	Baldi, G.; Specchia, V.; "Solubilitia dell'ammoniaca in acqua"; Chim. Ind. (Milan); 53(10), 929-933 (1971)	Pv, 25°C, 0.65 atm., Solubility in solutions of alkali halides nitrates and sulfates.

71BAL/SPE2: Baldi, G.; Specchia, V.; "Solubilita dell'ammoniaca in soluzioni saline"; Chim. Ind. (Milan); 53(11), 1022-1027 (1971)

Pv, 25°C, 0.65 atm., Solubility in solutions of alkali halides nitrates and sulfates.

66BAT/CLE: Battino, R.; Clever, H.L.; "The solubility of gases in liquids"; Chem. Rev.; 66, 395-463 (1966)

Ze,Zr, Pv, methods, thermodynamic formulae, bibliography but no data.

49BAT/PIN: Bates, R.G.; Pinching, G.D.; "Dissociation constant of ammonium ion 0° to 50°C, and the base strength of ammonia"; J. Res. Nat. Bureau Standards; 42, 419-430 (1949)

Kk, Da, Hr, Q, 0-50°C, $m(NH_3)$ to 0.1, in $NH_4Cl(aq)$.

50BAT/PIN: Bates, R.G.; Pinching G.D.; "Dissociation constant of aqueous ammonia at 0° to 50° from E. M. f. studies of the ammonium salt of a weak acid"; J. Am. Chem. Soc.; 72, 1393-1396 (1950)

Kk, 0-50°C, $m(NH_3)$ to 0.1 in $NHF_4Cl(aq)$

09BAU/GAY: Baud, E.; Gay, L.; "Determination des hydrates, en solution, par la methode thermique. Application au systeme eau ammoniac liquide"; Ann. Chim. Phys.; [8]17, 398-418 (1909)

Hm, 12°C 1.atm., 17-63% NH_3 by weight.

14BAU/TYK: Baume, G.; Tykociner, A.; "Recherches quantitatives sur les systemes volatils. Courbe de fusibilite du system anhydride sulfureux-eau"; J. Chim. Phys.; 12, 270-275 (1914)

Px, -90 to 13°C, liquidus.

34BEC/ROT: Becker, G.; Roth, W.A.; "Die Bildungswarme von Ammoniak und Salpetersaure"; Z. Elektrochem.; 40, 836 (1934)

Ze, Hr, 20°C, reaction with $HNO_3(aq)$.

76BEG: Beggerow, G.; "Mixing and solution heats"; 'Landolt - Bornstein Zahlenwerte und functionen aus Naturwissenschaften und Technik'; *Gruppe IV, Neue Serie, Band 2, 79-80 (1976)

Hm, 3-61°C, 1-150 H_2O.

53BER/PAT: Berg, D.; Patterson, A., Jr.; "The high field conductance of aqueous solutions of ammonia at 25°C"; J. Am. Chem. Soc.; 75, 5731-5733 (1953)

Kk, 25°C.

1873BER:	Berthelot, M.; "Recherches calorimetriques sur l'etat des corps dans les dissolutions. Recherches sur les acides forts et les acides faibles et sur les sels qu'ils forment avec la potasse, la soude et l'ammoniaque"; Ann. Chim. Phys.; [4], 29, 433-514 (1873)	Hr, 18°C, reaction with HNO_3(aq) and HCl(aq).
1873BER2:	Berthelot, M.; "Parallele entre la formation des sels solides engendes par les acides picrique, chlorhydrique, azotique, sulfurique, acetique et benzoique"; Ann. Chim. Phys.; [4], 29, 328-351 (1873)	Hr, 18°C, reaction with HNO_3(aq) and HCl(aq).
1875BER:	Berthelot, M.; "Dissolution des acides et des alcalis, Septieme memoire. Sur la chaleur degagee dans la reaction entre l'eau et l'ammonique."; Ann. Chim. Phys.; [5], 4, 526-531 (1875)	Hm, 10°C, solution in 250-370 H_2O, also dilution data at 14°C.
1875BER2:	Berthelot, M.; "Recherches sur les acides gras et leurs sels alcalins"; Ann. Chim. Phys.; 80, 592-598 (1875)	Hr, 18°C, reaction with acetic acid.
1875BER3:	Berthelot, M.; "Recherches sur les acides gras et leurs sels alcalins"; Ann. Chim. Phys.; [5], 6, 325-334 (1875)	Hr, 18°C, reaction with acetic acid.
1881BER:	Berthelot, M.; "Recherches sur l'acide perchlorique"; Compt. Rend.; 93, 240-246 (1881)	Hr, 18°C, reaction with $HClO_4$.
1882BER:	Berthelot, M.; "Recherches sur l'acide perchlorique"; Ann. Chim. Phys.; [5], 27, 214-222 (1882)	Hr, 18°C, reaction with $HClO_4$.
25BIL/MES:	Biltz, W.; Messerknecht, C.; "Beitrage zur systematischen Verwandtschaftslehre XXXIII. Uber die Ammoniakate der Berylliumhalogenide"; Z. Anorg. Allgem. Chem.; 148, 157-169 (1925)	Hr, t = ?, reaction with HCl.
41BJE:	Bjerrum, J.; 'Metal ammine formation in aqueous solution. Theory of reversible step reactions', P. Haase and Son, Copenhagen; (1941)	Kk, 22 and 30°C, in NH_4NO_3 solutions.
03BOU:	Bouzat, M.; "Composes cuproammoniques"; Ann. Chim. Phys.; [7], 29, 305-383 (1903)	Hr, Hm, 13°C, reaction with HCl.

11BRI:	Brichaux, A.; "Loi relative a la solubilite de Pammoniague a differentes temperatures et sou differentes pressions"; Bull. Soc. Chem. Belge; 25, 145-153 (1911)	Zc, Pv, 15-120°C, 3-50% NH_3, reinterp. of 03PER and 08MOL.
17BRU/LEV:	Bruni, G.; Levi, G.; "Gli ammoniacati dei sali d'argento. Nota III."; Gazz. Chim. Ital.; 47, 259-272 (1917)	Hr, 12°C(?), reaction with HNO_3 and $HClO_4$.
33CAL:	Calvet, E.; "Measures thermochimiques directes en chimie organique. Vitesses et chaleurs de saponification des amides, II."; J. Chim. Phys.; 30, 140-149 (1933)	Hm, 17°C, dil. from 70 to 200 H_2O.
65CHA:	Chan, J.P.C.; "The heat capacity and entropy of ammonia di-hydrate"; Ph.D. Thesis, Univ of California, Berkeley; Diss Abstr. 652957, 25, 6250 (1965)	Ql, 15-298 ^{K}, NH_3-$2H_2O$ (cr and l).
71CHE:	Chernen'kaya, E.I.; "Experimental determination of the specific heats of aqueous solutions of NH_4HCO_3, Na_2CO_3, and of liquors of the soda industry at 25°C"; J. Appl. Chem. (USSR); 44, 1562-1566 (1971)	Ql, 25°C, m(NH_3) = 1-13.
71CHE2:	Chernen'kaya, E.I.; "Determination of the heat capacities of liquids of the soda industry at 25°C by calculation. Communication II"; J. Appl. Chem. (USSR); 44, 1744-1747 (1971)	Zc, Ql, 25°C, in mixt. of Cl^-, CO_3^{2-} and SO_4^{2-}.
75CHE/BRA:	Chernen'kaya, E.I.; Bratash, E.G.; "Calculation of specific heats of aqueous salts systems over a wide temperature range"; J. Appl. Chem. (USSR); 48, 1910-1912 (1975)	Zc, Ql, 25-60°C, NH_4Cl(aq) and NH_4HCO_3(aq).
33CLI/HUN:	Clifford, I.L.; Hunter, E.; "The system ammonia-water at the temperatures up to 150°C and at pressures up to twenty atmospheres"; J. Phys. Chem.; 37, 101 (1933)	Pv, Zc, 60-100°C to 1.5 atm., 0.02-10 atm., NH_3 to 25%, correlation to 10 atm.
82COB/MUR:	Cobble, J.W.; Murray, R.C., Jr.; Turner, P.J.; Chen, K.; "High temperature thermodynamic data for species in aqueous solution"; EPRI NP-2400 Research Project 1167-1; (1982)	Zr, 0-200°C, thermal functions.

73COU/PET:	Couturier, Y.; Petitfaux, C.; "Composition and stability of cupric and cuprous complexes of aminopyridines. II. complexes of 3-amino-pyridine in aqueous solution"; Bull. Soc. Chim. Fr.; *(2)(Pt.1), 445-451 (1973); [CA 78:128998j]	Kk, 20°C, Cited in 76SMI/MAR.
77D'A/SUR:	D'Ans, J.; Surawslio, H.; Synowietz, C.; "Specific heat of solutions"; 'Landolt - Bornstein Zahkerwerte und functionen aus Naturwissenschaften und Technik'; *Gruppe IV, Neue Serie, Band 1, Teil b, 274-275 (1977)	Ql, 2-61°C, 1-25 wt%.
1898DEL:	Delepine, M.; "Amines et amides derives des aldehydes"; Ann. Chim. Phys.; [7], 15, 469-574 (1898)	Hr, T = ?, reaction with HCl.
66DUR/SCH:	Durst, R.A.; Schmidt, P.G.; Feldman, I.; "Mass spectrometric method for the determination of the activity coefficient of ammonia in aqueous salt solutions"; J. Phys. Chem.; 70, 2058 (1966)	Px, Pv, Da, and 22°C, m(NH_3)=0-4 in salt solns.
63DVO/BOU:	Dvorak, K.; Boubkik, T.; "Liquid-vapour equilibria. XXIX. Measurement of equilibrium data in systems with high equilibrium ratio of the components"; Coll. Czech. Chem. Commun.; 28, 1249-1255 (1963)	Pv, 90°C, 0.3 - 2.3 wt% NH_3 in sol.
78EDW/MAU:	Edwards, T.J.; Maurer, G.; Newman, J.; Prausnitz, J.M.; "Vapor-liquid equilibria in multicomponent aqueous solutions of volatile weak electrolytes"; AIChE J.; 24(6), 966-976, (1978)	Zc, Pv, Kk, 0-170°C, I to 6m.
75EDW/NEW:	Edwards, T.J.; Newman, J.; Prausnitz, J.M.; "Thermodynamics of aqueous solutions containing volatile weak electrolytes"; AIChE J.; 21(2), 248-259, (1959)	Zc, Pv, 0-100°C, also NH_3 + H_2S mixt, m <2.
78EDW/NEW:	Edwards, T.J.; Newman, J.; Prausnitz, J.M.; "Thermodynamics of vapor-liquid equilibria for the ammonia-water system"; Ind. Eng. Chem. Fundam.; 17(4), 264-269 (1978)	Zc, Da, Pv, 60-170° F, X(NH_3) = 0-1
64EFR/PRY:	Efremova, G.D.; Pryanikova, R.O.; "Phase and volume relations in the adipodinitrile-ammonia system"; Zh. Fiz. Khim.; 38, 686 (1964)	Pv, Hm, 25-125°C.

24ELL:	Elliott, L.D.; "The freezing point curve of the system water-ammonia"; J. Phys. Chem.; 28, 887-888 (1924)	Px, -97 to -77°C, liquidus.
75EME/RUS:	Emerson, K.; Russo, C.; Lund, R.E.; Thurston, R.V.; "Aqueous ammonia equilibrium calcualtions. Effect of pH and temperature"; J. Fish. Res. Board Can.; 32, 2379-2383 (1975)	Kk, 0-30°C, pH 6-10.
79ERO/BAB:	Eroshchenkov, S.A.; Babichenko, A.K.; "Calculation of compositions of equilibrium phases of water-ammonia solutions"; Vestn. Khar'kov. Politekhn, In-ta; 78(145), 54-56 (1979) [CA 91:28082]	Pv? (not seen).
62ESV/TYR:	Esval, O.E.; Tyree, S.Y. Jr.,; "The activity coefficients of ammonium perchlorate in water at 25°"; J. Phys. Chem.; 66, 940-942 (1962)	Da 25°C, m(NH_4ClO_4) = 0.1-2.1.
54EVE/LAN:	Everett, D.H.; Landsman, D.A.; "A redetermination of the dissociation constant of the ammonium ion and the base strength of ammonia in water"; Trans. Faraday Soc.; 50, 1221-1229, (1954)	Kk, Hr, 25-45°C, [NH_4^+]<0.04m, in HCl(aq).
38EVE/WYN:	Everett, D.H.; Wynne-Jones, W.F.K.; "The dissociation of the ammonium ion and the basic strength of ammonia in water"; Proc. Roy. Soc.; A169, 190-204 (1938)	Kk, 5-45°C, I to 0.2m, in NH_4Cl(aq).
52EVE/WYN:	Everett, D.H.; Wynne-Jones, W.F.K.; "The dissociation constants of the ammonium and methyl ammonium ions in 60% aqueous methanol"; Trans. Faraday Soc.; 48, 531-536 (1952)	Kk, Hr, Q, 0-40°C, I<0.2m, NH_3/NH_4Cl in aq. MeOH.
1853FAV/SIL:	Favre, P.A.; Silbermann, J.T.; "Recherches sur les quantities de chaleur degages dans les actions chemiques et moleculaires"; Ann. Chim. Phys.; * (3)37, 406-508 (1853)	Hm, 15°C, dil. sol.
00GAU:	Gaus, W.; "Uber den Einfluss von Neutralsalzen auf die Tension des Ammoniaks aus wasseriger Losung"; Z. Anorg. Allgem. Chem.; 25, 236-264 (1900)	Pv, 25°C, m(NH_3)<1.0.

80GIG:	Giggenbach, W.F.; "Geothermal gas equilibria"; Geochim. Cosmochim. Acta; 44, 2021-2032 (1980)	Pv, 100-300°C, application of previously published data to geochemical equilibria.
1884GUN:	Guntz, A.; "Recherches thermiques sur les combinaisons du fluor avec les metaux"; Ann. Chim. Phys.; [6], 3, 5-66 (1884) earlier work.	Hr, 13°C, reaction with HF(aq), quoting
75HAK:	Hakuta, T.; "Vapor-liquid equilibrium of polluting materials in sea water. 1. Vapor-liquid equilibrium of ammonia-water system"; Nippon Kaisui Gakkai-Shi 28, 353-359 (1975)	Pv, 80-100°C, NH_3 = 1.2-10.6 ppm., pH 6-8, in borate buffer.
77HAK/EDW:	Hakuta, T.; Edwards, T.J.; Prausnitz, J.M.; "Vapor-liquid equilibria of some pollutants in aqueous and saline solutions. Part II. Correlation for dilute weak electrolytes in aqueous buffered solutions"; Desalination; 21, 23-33 (1977)	Pv Zc, Kk, 273-400 ^{K} Speciated model for weak electrolytes in water.
79HAL/DRE:	Hales, J. M.; Drewes, D. R.; "Solubility of ammonia in water at low concentrations"; Atmos. Environ.; 13, 1133-47 (1979)	Pv, 280-300 ^{K}, m(NH_3= $3x10^{-4}$ in H_2O and in very dilute H_2SO_4
30HAR/OWE:	Harned, H.S.; Owen, B.B.; "The thermodynamic properties of weak acids and bases in salt solutions, and an exact method of determining their dissociation constants"; J. Am. Chem. Soc.; 52, 5079-5091 (1930)	Ze, Kk, 25°C.
58HAR/OWE:	Harned, H.S.; Owen, B.B.; 'The Physical Chemistry of Electrolyte Solutions' Reinhold Publ. Corp., New York, 3d ed.; (1958)	Kk, 25°C.
28HAR/ROB:	Harned, H.S.; Robinson, R.A.; "The ionic concentrations and activity coefficients of weak electrolytes in certain salt solutions"; J. Am. Chem. Soc.; 50, 3157 (1928)	Kk, 25°C, I<1.5.
67HEL:	Helgeson, H.C.; "Thermodynamics of complex dissociation in aqueous solution at elevated temperatures"; J. Phys. Chem.; 71, 3121-3136, (1967)	Ze, Kk, 0-306°C.

76HEL/KIR:	Helgeson, H.C.; Kirkham, D.H.; "Theoretical prediction of the thermodynamic properties of aqueous electrolytes at high pressures and temperatures. III. Equation of state for aqueous species at infinite dilution"; Am. J. Sci.; 276, 97-240 (1976)	Kk, Zc, Ze, 25-3000°C, 1-1000 atm.
81HEL/KIR:	Helgeson, H.C.; Kirkham, D.H.; Flowers, G.C.; "Theoretical prediction of the thermodynamic behavior of aqueous electrolytes at high pressures and tempeatures: IV. Calculation of activity coefficients, osmotic coefficients, and apparent molal and standard and relative partial molal properties to 600°C and 5kB"; Am. J. Sci.; 281, 1249-1516 (1981)	Ze, Kk, Da, Dm, 0-600°C, 0-5kB.
11HER:	Herzen, E.; "Abaque des tensions de vapeur d'une solution aqueuse ammonicale"; Bull. Soc. Chem. Belge; 25, 154-157 (1911)	Zc, Pv, 0-150°C, 0-12% NH_3, nomogram.
53HIL/GIA:	Hildenbrand, D.L.; Giauque, W.F.; "Ammonium oxide and ammonium hydroxide. Heat capacities and thermodynamic properties from 15 to 300 K"; J. Am. Chem. Soc.; 75 , 2811-2818 (1953)	Ql, 25°C, on $NH_3(H_2O)$, and from -73 to -18°C, on more conc. sol.
76HIT/MES:	Hitch, B. F.; Mesmer, R. E.; "The ionization of aqueous ammonia to 300°C in KCl media"; J. Solution Chem.; 5, 667-79 (1976)	Kk, 50-300°C, p to 100 bar, in KCl.
75HOS/NAG:	Hoshino, D.; Nagahama, K.; Hirata, M.; "A new apparatus for measuring vapor-liquid equilibria of gas-solvent systems at constant pressure"; Bull. Jap. Petrol. Inst.; 17, 9-13 (1975)	Pv, x=0-1, 1 atm, E=-40-100°C.
25HOU:	Hougen, O.A.; " Absorption of ammonia "; Chem. Met. Eng.; 32(14), 704-705 (1925)	Zc, Pv, 15-25°C, p(NH_3) meas,
78IKE/SAS:	Ikemizu, K.; Sasaki, K.; Morooka, S.; Kato, Y.; Shinohara, H.; "Diffusivities and solubilities of NH_3 gas in aqueous solutions of ammonium salts"; Kagaku Kogaku Rombunshu; 4(3), 273-276 (1978)	Pv, 35-65°C, NH_3 = 3-12 m, solubility in water and aq. mixt. of NH_4NO_3 NH_4Cl and $(NH_4)_2SO_4$ <3 molal

71JAI/GAB:	Jain, P.C.; Gable, G.K.;"Equilibrium property data equations for aqua-ammonia mixtures"; Amer. Soc. Heat., Refrig. Air-Cond. Eng., Trans.; 77 (pt.1), 149-151 (1971)	Zc, Pv, 22-132°F, 50-350 psia, equation for data in 64MAC/EAK.
65JEN:	Jennings, B.H.; "Ammonia-water properties (Experimentally-determined P,V,T,x liquid-phase data)"; ASHRE Trans.; 71I, 21-29 (1965)	Pt, Xd, 10-100%wg NH_3, t=75-312°C, 7-540 psi
63JON:	Jones, M.E.; "Ammonia equilibrium between vapor and liquid aqueous phases at elevated temperatures"; J. Phys. Chem.; 67, 1113-1115 (1963)	Pv, 147-318°C, 2,20,200 ppm.
07KAN:	Kanolt, C.W.; "Ionization of water at 0° 18°and25° derived from conductivity measurements of the hydrolysis of the ammonium salt of diketotetrahydrothiazole"; J. Am. Chem. Soc.; 29, 1402-1416 (1907)	Kk, 0-25°C.
71KAR:	Karov, E.G.; "Isothermal invariant points"; Zh. Neorg. Khim.; 16(11), 3110-14 (1971)	Pv, 25°C, 720 mmHg.
57KAU/DOG:	Kauko, Y.; Doger, S.; "Bestimmung kleiner Mengen von Ammoniak in Gasmischungen"; Acta Chem. Scand.; 11, 804-810 (1957)	Pv, Kk, 25 and 40°C.
30KIN/HAL:	King, H.H.; Hall, J.L.; Ware, G.C.; "A study of the density, surface tension and adsorption in the water-ammonia system at 20°"; J. Am. Chem. Soc.; 52, 5128-5135 (1930)	Vx, 20°C, x(NH_3)= .20-1.00, density data.
72KIR/TRU:	Kirintsev, A.; Trushnikova, L.N.; Lavrent'eva, V.G.; 'Handbook of phase diagrams of inorganic substances in water'; Khimiya, Leningrad, 95-96 (1972)	Px, -100 to 0°C, x=0 to 1.
62KIS:	Kiseleva, E.V.; "About the state of ammonia in aqueous solutions"; Tr. Mosk. Khim.-Tekhnol. Inst.; *(38), 71 (1962)	Pv, 20 and 30°C, p(NH_3) and p(H_2O) meas.
24KLA:	Klarmann, E.; "Das Henrysche Gesetz bei wassrigen Ammoniaklosungen und die Hydrolyse der Ammonsalze"; Z. Anorg. Chem.; 132, 289-300 (1924)	Pv, Kk, 0-25°C, NH_3(aq) and NH_4Ac.

67KOM/SUN:	Komar', N.P.; Sung, N. T. S.; "Protonation of weak bases: The $NH_3 + H_3O^+ = NH_4^+ + H_2O$ system"; Russ. J. Inorg. Chem.; 12 (5), 669-675 (1967)	Kk, 25°C, I<3, NH_4Cl, NH_4
73KON/LAN:	Koneczny, H.; Lango, D.; Lango, M.; "System potassium chloride-ammonia-water"; Chem. Stosow.; 17, 115-125 (1973); [CA 80-41382w]	Px, 20-60°C, in sat. KCl(aq).
75KON/LAN:	Koneczny, H.; Lango, D.; Lango, M.; "Potassium sulfate-ammonia-water system"; Chem. Stostow.; 19, 27-36 (1975); [CA 83-33493e]	Px, 20-60°C, 0-25% NH_3, in sat. K_2SO_4(aq).
74KON/SAS:	Kononenko, A.F.; Sashevskaya, Z.G.; "Relation of density and viscosity to temperature for some salt solutions"; Zh. Priklad. Khim.; 47, 211-212 (1974)	Pv, Vx, -20 to 20°C, conc. NaCl(aq).
25KOW/HOU:	Kowalke, O.L.; Houge, O.A.; Watson, K.M.; "Absorption of ammonia in towers"; Chem. Met. Eng.; 32, 443-446 (1925)	Zc, Pv, 0-7% NH_3.
28KRA:	Kracek, F.C.; "P-T-X relations for systems of two or more components and containing two or more phases (L-V, L_1-L_2-V and S-L-V systems)"; 'International Critical Tables', Washburn, E.W., ed; 3, 351-385, (1928); p. 362 for NH_3.	Ze, Pv, Px, -89 to 170°C, 5-100% NH_3.
30KRA:	Kracek, F.C.; "Vapor pressures of solutions and the Ramsay-Young rule. Application to the complete system water-ammonia"; J. Phys. Chem.; 34, 499-521 (1930)	Ze, Pv, Px, -89 to 170°C, 5-100% NH_3.
24LAR:	Larsson, E.; Diss Lund.; (1924)	Kk, 25°C, in H_2O-EtOH, cited in 64SIL/MAR.
34LEW/SCH:	Lewis, G.N.; Schutz, P.W.; "The ionization of some weak electrolytes in heavy water"; J. Am. Chem. Soc.; 56, 1913-1915 (1934)	Kk, 25°C, ND_3 in D_2O.
65LIN:	Linke, W.F.; 'Solubilities'; American Cyanamid Co., Stamford, Conn., 4th ed.; 2, 590-603 (1965); originated by Atherton Seidell, Ph.D.	Zr, Pv, in H_2O, salt solns., organic solvents and mixed systems, major compilation.

04LOC/FOR:	Locke, J.; Forssall, J.; "The action of ammonia upon copper sulphate solutions"; Am. Chem. J.; 31, 268-302 (1904)	Pv, 25°C, [NH_3] to 1, [Cu^{-2}] to 0.11.
07LUN:	Lunden, H.; "Hydrolyse des sels des acides faibles et des bases faibles et sa variation avec la temperature"; J. Chim. Phys.; 5, 574-608 (1907)	Kk, 10-50°C, NH_3 and $NH_4H_2BO_3$.
08LUN:	Lunden, H.; "Influence de la temperature sur l'energie interne et l'energie libre des dissociations electrolytiques des acides et bases faibles"; J. Chim. Phys.; 6, 681-698 (1908)	Kk, Hr, 10-50°C, reaction with acid.
64MAC/EAK:	Macriss, R.A.; Eakin, B.E.; Ellington, R.T.; Huebler, J.; "Physical and thermodynamic properties of ammonia-water mixtures"; Research Bulletin, No. 34, American Gas Assn.; (1964)	Pv, 140-200°F, 96-100% NH_3, 200-500 psia, Ql, Qg, 106-441°F, 50-500 psia, Vt, Zc, -50 to 400°F, 0-450 psia.
71MAC/ROR:	MacKellar, W.J.; Rorabacher, D.B.; "Solvent effects in coordination kinetics. I. Inner-sphere effects in the reaction of solvated nickel(II) ion with ammonia in methanol-water mixtures"; J. Am. Chem. Soc.; 93, 4379-4387 (1971)	Kk, 25°C, citing 71ROR/MAC and unpub. work.
79MAE/ARN:	Maeda, M.; Arnek, R.; Biedermann, G.; "A potentiometric and calorimetric study of the system Ag^+-NH_3 in 3M $NaClO_4$, 3M $LiClO_4$ and 3M $NaNO_3$ media"; J. Inorg. Chem.; 41, 343-346 (1979)	Kk, Hr, 25°C, in ClO_4^-(aq) and NO_3^-(aq from data on Ag^+-NH_3 complexes.
1897MAL:	Mallet, J.W.; "On the solubility of ammonia in water at temperatures below 0°C"; Am. Chem. J.; 19, 804-809 (1897)	Pv, -40 to -10°C, 74mmHg.
41MAR/KOB:	Markham, A.E.; Kobe, K.A.; "The solubility of gases in liquids"; Chem. Rev.; 41, 519-588 (1941)	Zr, Pv, methods, thermodynamic formulae, bibliography, data quality but no values for solubilities.
67MAR/KAT:	Martynova, O.I.; Katkovskaya, K. Ya.; Vaineikis, A.; Dubrovskii, I. Ya.; Feodoseichuk, T. A.; "The effect of solution ionic composition on the distribution of ammonia between water and saturated vapor"; Teploenergetika; 14(12), 39-42 (1967)	Pv, 25 and 230-300°C, pH = 3 to 8, in nitrate sol.

02MAS:	Massol, G.; "Chaleurs de dissolution de l'ammoniaque solide et liquide prise vers -75° et chaleur latent de fusn de l'ammoniaque solide"; Compt. Rend.; 134, 653 (1902)	Hm, NH_3 (at -75°C) into water (at 10°C).
25MIC/MIZ:	Michaelis, L.; Mizutani, M.; "Die Dissoziation der schwachen Elektrolyte in wasserig-alkoholischen Losungen"; Z. Phys. Chem.; 116, 135-139 (1925)	Kk, 18°C.
55MIR:	Mironov, K.E.; Zh. Obshch. Khim.; 25, 1081-1086 (1955); "Diagram of the phase transformations of the system H_2O-NH_3"; J. Gen., Chem., USSR; 25, 1039 (1955)	Px, -123 to 0°C, $x(NH_3)$ = 0-1.0, liquidus.
08MOL:	Mollier, H.; "Dampfdruck von wassrigen Ammoniaklosugen"; Z. Ver. Dtch. Ing.; 52(3), 1315-1320 (1908)	Pv, 10-120°C, $x(NH_3)$ = 0.1-0.5.
12MOO/WIN:	Moore, T.S.; Winmill, T.F.; "The state of amines in aqueous solution"; J. Chem. Soc.; 101, 1635-1676 (1912)	Kk, 18-35°C(?), calc.
31MOR/MAA:	Morgan, O.M.; Maass, O.; "An investigation of the equilibria existing in gas-water systems forming electrolytes"; Can. J. Res.; 5, 162-199 (1931)	Pv, Kk, 0-25°C, P < 1 atm.
00NEW:	Newth, G.S.; "Note on partially miscible aqueous inorganic solutions"; J. Chem. Soc.; 77, 776-788 (1900)	Px, 1-43°C, sol. in K_2CO_3(aq).
21NEU/PAT:	Neuhausen, B.S.; Patrick, W.A.; "A study of the system ammonia-water as a basis for a theory of the solution of gases in liquids"; J. Phys. Chem.; 25, 693-720 (1921)	Pv, Vx, 0, 20, 40°C, 1000-4000mmHg, $p(NH_3)$ and $p(H_2O)$.
07NOY:	Noyes, A.A.; 'The electrical conductivity of aqueous solutions'; Publication 63, Carnegie Institution of Washington, 153-234 (1907)	Kk, 18-306°C,Psat NH_3(aq) and NH_4Ac(aq).
08NOY:	Noyes, A.A.; "The conductivity and ionization of salts, acids, and bases in aqueous solutions at high temperatures"; J. Am. Chem. Soc.; 30, 335-352 (1908)	Kk, 18-306°C,Psat
10NOY/KAT:	Noyes, A.A.; Kato, Y.; Sosman, R.B.; "The hydrolysis of ammonium acetate and the ionization of water at high temperatures"; J. Am. Chem. Soc.; 73, 159-178 (1910)	Kk, 18-306°C,Psat NH_3(aq) and NH_4Ac(aq).

10NOY/KAT2:	Noyes, A.A.; Kato, Y.; Sosman, R.B.; "Die Hydrolyse von Ammoniumacetat und die Ionisation von Wasser bei hohen temperaturen"; Z. Phys. Chem.; 73, 1-24 (1910); Translation of 10NOY/KAT	Kk, 0-300°C,Psat hydrolysis of NH_3(aq) and NH_4Ac.
75OLO:	Olofsson, G.; "Thermodynamic quantities for the dissociation of the ammonium ion and for the ionization of aqueous ammonia over a wide temperature range" J. Chem. Thermodyn.;7,507-14 (1975)	Kk, Hr, Qh, 278-418 K.
34OWE:	Owen, B.B.; "The determination of the dissociation constants of weak bases by the silver iodide electrode"; J. Am. Chem. Soc.; 56, 2785-2786, (1934)	Kk, 25°C.
65PAO/STE:	Paoletti, P.; Stern, J.H.; Vacca, A.; "Thermochemical studies. XV. Thermodynamics of protonation of triethylenediamine, trimethylamine, and ammonia in aqueous solution at 25°C"; J. Phys. Chem.; 69, 3759-3762 (1965)	Kk, Hr, 25°C, NH_4Cl.
65PAR:	Parker, V.B.; "Thermal properties of aqueous uni-univalent electrolytes"; NSRDS-NBS 2; 1-66, (1965)	Ze, Ql, Hm, 25°C, NH_3(aq) and ammonium salts.
37PEA/PUM:	Pearce, J.N.; Pumplin, G.G.; "The vapor pressures and activity coefficients of aqueous solutions of ammonium chloride at 25°C"; J. Amer. Chem. Soc.; 59, 1219-1220 (1937)	Pv, Da, 25°C, M(NH_4Cl) to 7.3.
80PEN/ROB:	Peng, D.-Y.; Robinson, D.B.; "Two- and three-phase equilibrium calculations for coal gasification and related processes"; ACS Symp. Ser.; No. 133, 393-414, (1980); Thermodyn. Aqueous Syst. Ind. Appl.	Zc, Pv, 100-300° F, 0-100% NH_3, Correlation of VLE data,
01PER:	Perman, E.P.; "Vapour pressure of aqueous ammonia solution. Part I"; J. Chem. Soc.; 81, 718-725 (1901)	Pv, 0-60°C, 4-30% NH_3.
01PER2:	Perman, E.P.; "Influence of sodium sulfate on the vapour pressure of aqueous ammonia solution"; J. Chem. Soc.; 81, 725-729 (1901)	Pv, 26-47°C, 10-17% NH_3, 4%Na_2SO_4.

02PER:	Perman, E. P.; "The influence of salts and other substances on the vapour pressure of aqueous ammonia solution"; J. Chem. Soc.; 81, 480-89 (1902)	Pv, 20-60°C 150-1000 mmHg, sol. in aq. urea, manitol KCl, NH_4Cl, $CuCl_2$.
03PER:	Perman, E.P.; "Vapour pressure of aqueous ammonia solution. Part II"; J. Chem. Soc.; 83, 1168-1184 (1903)	Pv, 0-60°C, 0-30% NH_3.
59PIE:	Pierre, B.; "Total vapor pressure in bars over aqueous ammonia-water solutions" Kyltek. Tidsk.; Aug (1959), sheet 14.	Pv, 175-650 psia, NH_3 up to 40 wt.%, as cited in 64MAC/EAK.
37PIT:	Pitzer, K.S.; "The heats of ionization of water, ammonium hydroxide, carbonic, phosphoric, and sulfuric acids. The variation of ionization constants with temperature and the entropy change with ionization"; J. Am. Chem. Soc.; 59, 2365-2371 (1937)	Hr, Ql, 25°C, ionization.
75POL/LU:	Polak, J.; Lu, B.C.-Y.; "Vapor-liquid equilibria in system ammonia-water at 14.69 and 65 psia"; J. Chem. Eng. Data; 20, 182-3 (1975)	Pv, 90-100°C, 15,65 psia, $x(NH_3)$ to 0.043.
20POS:	Postma, S.; "Le systeme ammoniaque - eau"; Rec. Trav. Chim.; 39, 515-536 (1920)	Pv, Px, -103 to +65°C.
68QUI/MAR:	Quist, A.S.; and Marshall, W.L.; "Ionization equilibria in ammonia-water solutions to 700°C and to 4000 bars of pressure"; J. Phys. Chem.; 72(9), 3122-8 (1968)	Kk, 0-700°C, up to 4000 bar, $m(NH_3)$=0.01-0.05.
74RAB/OZU:	Rabenstein, D. L.; Ozubko, R.; Libich, S.; Evans, C.A.; Fairhurst, M.T.; Suvanprakorn, C.; "Nuclear magnetic resonance studies of the solution chemistry of metal complexes X. Determination of the formation constants of the methylmercury complexes of selected amines and aminocarboxylic acids"; J. Coord. Chem.; 3(4), 263-271 (1974); [CA 82:65120b]	Kk, as cited in 76SMI/MAR.
31RAM/HAN:	Ramstetter, H.; Hantke, G.; "Eine neue Methode zur Messung von Warmetonungen"; Z. Phy. Chem. Bodenstein Festband; 662-668 (1931)	Hm, 20°C, $m(NH_3)$ = 0.15 - 2.6.

1874RAO:	Raoult, F.-M.; "Recherches sur l'absorption de l'ammoniaque par les dissolutions salines"; Ann. Chim. France; *[5] 1, 262-274 (1874)	Pv, 0-28°C, in water and salt solutions.
67RAS/CHE:	Rashkovskaya, E.A.; Chernen'kaya, E.I.; "Densities of solutions of NH_4HCO_3, $NaHCO_3$, NH_4Cl and of ammonia in the 20-100° range"; Zh. Prikl. Khim.; 40, 301-308 (1967); Russ. J. Appl. Chem.; 40, 289-295 (1967)	Xd, 2-16% NH_3 20-100°C p=1 atm.
03REI:	Reisenfeld, H.; "Uber das Losungsvermogen von Salzlosungen fur Ammoniak nach Messungen seines Partial drukes. II."; Z. phys. Chem.; 45, 467 (1903)	Pv, 35°C, in aq. soln. of K and Na salts.
77RIC/NED:	Rice, N.M.; Nedved, M.; "Dissociation constant of ammonium ions at high ionic strength"; Chem. Ind.; July 2, 539-540 (1977)	Kk, 25°C, $\sim 10^{-3}$m NH_3, I=
59ROB/STO:	Robinson, R.A.; Stokes, R.H.; 'Electrolyte solutions' Butterworths, London, 2nd Ed.; (1959)	Ze, Kk, Da, various temperatures.
56ROL/VUI:	Rollet, A.P.; Vuillard, G.; "Sur un nouvel hydrate de l'ammoniac"; Compt. Rend.; 243, 383-386 (1956)	Px, -50 to -103°C, liquidus.
71ROR/MAC:	Rorabacher, D.B.; MacKellar, W.J.; Shu, F.R.; Bonavita, M.; "Solvent effects on protonation constants. Ammonia, acetate, polyamine, and polyaminocarboxylate ligands in methanol-water mixtures"; Anal. Chem.; 43, 561-572 (1971)	Kk, 25°C, in H_2O and mixt. with MeOH.
10RUP:	Rupert, F.F.; "The solid hydrates of ammonia. II."; J. Am. Chem. Soc.; 32, 748-749 (1910)	Px, -100 to 0°C, liquidus.
51SAN/YOU:	Sanders, B.H.; Young, D.A.; "Graphical correlation of physical properties of a ternary system Vapor pressure and specific gravity for ammonia-ammonium nitrate-water"; Ind. Eng. Chem.; 43, 1430-1433 (1951)	Vx, Pv, Zc, 30-120°F, binary and ternary systems correlated, no new data.
47SCA/EPS:	Scatchard, G.; Epstein, L.F.; Warburton, J., Jr.; Cody, P.J.; "Thermodynamic properties of NH_3-H_2O liquid and vapor mixtures from -60°F to 370°F and from 0-100% NH_3 in liquid"; J. Am. Soc. Refrig. Eng.; 413-419, 446, 450, 452 (1947)	Zc, Pv, Vg, -60-370°F, x(NH_3)= 0-1, enthalpy and PvTx.

25SCH/WIJ:	Scheffer, F.E.C.; de Wijs, H.J.; "Sur des solutions d'ammoniac"; Rec. Trav. Chim.; 44, 655 (1925)	Pv, 25°C.
73SCH:	Schulz, S.C.G.; "Equations of state for the system ammonia-water for use with computers"; Progr. Refrig. Sci. Technol., Proc. Int. Congr. Refrig.; 13th, 2, 431-6 (1973)	Zc, Vg, Vx, 200-450 K 0.01-25 bar, theory, data, sources not cited.
36SCH/EPP:	Schwarzenbach, G.; Epprecht, A.; Erlenmeyer, H.; "Uber Dissoziationskonstanten in Wasser und Deuteriumoxyd. Messungen mit der Deuteriumelektrode"; Helv. Chim. Acta; 19, 1292-1304 (1936)	Kk, 20°C, m = 0.007, NH_4Cl and ND_4Cl in NaOH(aq).
25SHE:	Sherwood, T.K.; "Solubilities of sulfur dioxide and ammonia in water"; Ind. Eng. Chem.; 17, 745-747 (1925)	Zc, Pv, 0-60°C, p = 10-1000 mmHg.
62SHU/MAK:	Shul'ts, M.M.; Makarov, L.L.; Yu-jeng, S.; "Activity coefficients of NH_4Cl in binary and ternary solutions at 25°"; Russ. J. Phys. Chem.; 36(10), 1181-1183 (1962)	Da, 25°C, m(NH_4Cl) = 2 to 7.
66SHU/SIM:	Shul'ts, M.M.; Simanova, S.A.; "Activity coefficients of ammonium bromide in aqueous solutions at 25°"; Russ. J. Phys. Chem.; 40(2), 247-248 (1966)	Da, 25°C, 1.1-7.9 m, activity of NH_4Br(aq).
73SIN:	Singh, N.M.; "Transport and equilibrium properties of water-ammonia gaseous mixtures"; Progr. Refrig. Sci. Technol., Proc. Int. Congr. Refrig.; 13th, 2, 473-80 (1973)	Zc, Vg, 323-673 K, fugacity.
72SLO/ORE:	Slobodkina, G.L.; Orekhov, I.I.; Sverdlova, V.P.; "Vapor pressures of water and ammonia over ammoniated phosphoric acid solutions"; Tr. Sev.-Zap. Zaoch. Politekh. Inst.; *(21), 8-12 (1972); [CA 80:41154y]	Pv, Hp, Da, 30-90°C, in 13-60% H_3PO_4(aq).
53SPI:	Spike, C.G.; "Entropy factors in chelation"; Diss. Abstr. Publ. No. 5098; U. Michigan, (1953)	Kk, Cited in 76SMI/MAR.
77SYN:	Synowietz, C.; "Densities of binary aqueous systems"; 'Landolt - Bornstein Zahlenwerte und functionen aus Natuwissenschaften und Technik'; *Gruppe IV, Neue Serie, Band 1, Teil b, 69-70 (1977)	Vx, 0-100°C, 1-100 wt%.

1882THO:	Thomsen, J.; 'Thermochemische Untersuchungen', Barth, Leipzig; (1882-86)	Hm, 18°C, (vol. 2 pg 72), Hr, 18°C, neutral. (vol. 1, pg 312)
80THU/RUS:	Thurston, R.V.; Russo, R.C.; Emerson, K.M.; Gov. Rep. Announce. Index (U.S.); "Aqueous ammonia equilibrium - tabulation of percent un-ionized ammonia"; 80(1); 55 (1980)	Kk, Zc, 0-40°C pH=5-12, Tables of % un-ionized NH_3,
65TSI/LIN:	Tsiklis, D.S.; Linshits, L.R.; Goryunova, N.P.; "Phase equilibria in the system ammonia-water"; Russ. J. Phys. Chem.; 39, 1590-1592 (1965)	Pv, 0-100%wg NH_3 t=97-320°C.
72VAN/KIN:	Vanderzee, C.E.; King, D.L.; "The enthalpies of solution and formation of ammonia"; J. Chem. Thermodynamics; 4, 675-683 (1972)	Ze, Hm, 25°C, $_{vf}H(NH_3,g)$.
72VAN/KIN2:	Vanderzee, C.E.; King, D.L., Wadso, I.; "The enthalpy of ionization of aqueous ammonia"; J. Chem. Thermodyn.; 4, 685-689 (1972)	Hr, 25°C, sol. of NH_4Cl, ionization.
68VAS/KOC:	Vasil'ev, V.P.; Kochergina, L.A.; "Heat of ionisation of ammonium hydroxide in sodium nitrate solutions at various temperatures"; Russ. J. Physical Chemistry; 42(2), 199-202 (1968)	Hr, 18-40°C, I = 0.5-3m, in acidified aq. $NaNO_3$.
60VOR/PRI:	Vorob'ev; A.F.; Privalova, N.M.; Monaenkova, A.S.; Skuratov, S.M.; "Standard enthalpy of formation of hydrochloric acid and some perchlorates"; Dokl. Akad. Nauk SSSR; 135(6), 1388-1390 (1960)	Hr, 25°C, neutralization.
23VRE/KAI:	Vrewskii, M.S.; Kaigorodov, A.N.; "Heat capacity of aqueous solutions of HCL and NH_3"; Zhur. Russ. Fiz-Khim. Obschest, Chast Fiz ches.; 54, 336-347 (1923)	Ql, Pv, 2.4°C - 60.9°C, 1.39% to 40.1% NH_3, based on 03PER.
23VRE/ZAV:	Vrewskii, M.S.; Zavaritskii, N.N.; "Measuring the heat of solution of gas in water"; Zhur. Russ. Fiz. Khim., Obshch. Clast; 54, 348 (1923)	Hm, 199, 41°C, m(=.3405 to 0.61).
	VREWSKII, SEE ALSO WREWSKY	

06WHE: Whetham, W.C.D.; "Die elektrische Leitfahigkeit verdunnter Losungen von Schwefelsaure"; Z. Phys. Chem.; 55, 200-205 (1906)

Kk, 18°C, with added CO_2 and KCl.

80WIL/OWE: Wilson, G.M.; Owens, R.S.; Roe, M.W.; "Sour water equilibria. Ammonia volatility down to ppm levels. pH vs. composition and effect of electrolytes on ammonia volatility"; ACS Symp; Ser. 133 (1980); (Thermodyn. Aqueous Syst. Ind. Appl.)

Pv, 80-120°C, NH_3=0.09-10 wt%, [NH_3] and p(NH_3) meas; includes effect of NaOH and Na-acetate (0-25%).

25WIL: Wilson, T.A.; "The total and partial vapor pressures of aqueous ammonia solutions"; Bull., Univ. Ill. Eng. Expt. Sta.; 146, (1925)

Pv, 32-190°F, P to 170 psia, as cited in 64MAC/EAK.

53WIS/STO: Wishaw, B.F.; Stokes, R.H.; "The osmotic and activity coefficients of aqueous solutions of ammonium chloride and ammonium nitrate at 25°"; Trans. Faraday Soc.; 49, 27-31 (1953)

Da, 25°C, m(NH_4Cl) to 7.4, m(NH_4NO_3) to 25.9.

54WIS/STO: Wishaw, B.F.; Stokes, R.H.; "Activities of aqueous ammonium sulphate solutions at 25°"; Trans. Faraday Soc 50, 952-954 (1954)

Da, 25°C, m(NH_4SO_4) = 0.1 to 5.8.

80WON/SEL: Won, K.W.; Selleck, F.T.; Walker, C.K.; "Vapor-liquid equilibria of the ammonia-water system"; EFCE Publ. Ser. 11 (Phase Equilib. Fluid Prop. Chem. Ind.); 45-9 (1980)

Zc,Vg, No new data. Reassessment of work of 64MAC/EAK and 32CLI/HUN.

74WOR/DUN: Worswick, R.D.; Dunn, A.G.; Staveley, L.A.K.; J. Chem. Thermodyn.; "The enthalpy of solution of ammonia in water and in aqueous solutions of ammonium chloride and ammonium bromide"; 6(6); 565-70 (1974)

Hm, 298.15 K, m(NH3)=1-4 in H_2O, NH_4Cl(aq) and NH_4Br(aq).

24WRE: Wrewsky, M.; "Uber das Gleichgewicht zwischen Dampf und Flussigkeit wasseriger Losungen des Ammoniaks"; Z. Phys. Chem.; 112, 117-127 (1924)

Hm, 3-60°C, m = 0.8-2.8.

24WRE/KAI: Wrewsky, M.; Kaigorodoff, A.; "Warmekapazitat wasseriger Losungen von Chlorwasserstoff und Ammoniak bei verschiedenen Temperaturen"; Z. Physik. Chem.; 112, 83-89 (1924)

Ql, 3-60°C, m = 0.8-2.8.

24WRE/SAW:	Wrewsky, M.; Sawaritzky, N.; "Die Bildungswarmen waseriger Losungen von HCl und NH_3 bei verschiedenen Temperaturen"; Z. Phys. Chem.; 112, 90-96 (1924)	Ql, Hm, 3-60°C, sol. and dil.

	WREWSKY, SEE ALSO VREWSKII	

32WUC:	Wucherer, J.; "Messung von Druck, Temperatur und Zusammensetzung der flussigen und dampfformigen Phase von Ammoniak-Wassergemischen im Sattigungszustand. 6. Beurteilung der Ergebnisse und Vergleich mit fruheren Messungen"; Z. Gesamtes Kalte-Ind.; 39, 97-104, 136-140 (1932)	Zc, -3 to 200°C, x = 0 to 1, summary and tables.

78ZAT/DER:	Zatorskii, A.A.; Dergachev, A.G.; Kokhanskii, A.I.; "Determination of parameters of a water-ammonia solution"; Kholod. Tekh. Tekhnol.; 25, 67-71 (1978); [CA 89:221886h]	Zc, t=?, theoret.

39ZHA:	Zhavoronkov, N.M.; "The partial pressure of ammonia, carbon dioxide and water over copper ammonium solutions"; J. Chem. Ind.; 16(10), 36-37 (1939)	Pv, 20-80°C, Copper-ammonium formate solutions.

34ZIN:	Zinner, K.; "The heat content of mixtures of ammonia and water dependent upon the composition and temperature"; Z. Gesamt. Kalte-Ind.; 41, 21-29 (1934)	Hm, 50°F, 0-100% NH_3, as cited in 64MAC/EAK.

H_2S-H_2O

INTRODUCTION

Listed in this bibliography are publications that have data on the vapor-liquid equilibrium between H_2S gas and its solutions in water or that contain information on the ionization equilibria in solution among $H_2S(aq)$, $HS^-(aq)$, $S^{2-}(aq)$ and $H^+(aq)$.

To a lesser extent there are references on measurement or calculation of the enthalpies of those processes, on activity coeffients, and on the thermochemistry of the species mentioned above. Publications reporting measurements and those presenting correlations or evaluations of data are included, however, references that concern only applications of existing data to specific problems or models have been avoided.

The citations are listed alphabetically by first author. Each is preceeded by a brief identification code (composed of the year of publication and the first three letters of the first two authors' names) and contains the author names; the title of the article, report, or chapter; the name of the source (journal,book, or issuing agency)and the year of publication. The structure of these citaions does not conform to the specifications established by the American Standards Institute but the information given is sufficient to direct the reader to the particular reference. In a few instances only an abstract or secondary reference was available. In these cases either the citation to Chemical Abstracts or the source of the secondary citation is given.

Some titles have been translated, e.g. those in Russian. These translations come, preferably, from abstracts in the papers themselves or from Chemical Abstracts. (The titles from the latter may be condensations of the original).

Each reference is annotated to show the class of data, the temperature range and, if appropriate, pressure, solution composition, and pH. The data class designations are taken from the Bulletin of Chemical Thermodynamics and are two-letter codes with some mnemonic or physical chemical associations. A list is appended. No attempt has been made to assess the quality of the data, however, an annotation of "Ze" indicates that a particular reference constitutes or includes an evaluation of experimental data from several sources.

The bibliography was prepared by searching the files of the NBS Chemical Thermodynamics Data Center, the Bulletin of Chemical Thermodynamics and references in the publications retrieved from those sources. It covers a time period from the 19th century to 1982. Additions and corrections will be appreciated.

04AUE:	Auerbach, F.; "Der Zustand des Schwefelwasserstoffs in Mineralquellen"; Z. Phys. Chem.; 49, 217-223 (1904)	K, 18°C conductivity
28AUM:	Aumeras, M.; "Sur l'etat d'ionisation des solutions d'hydrogene sulfure"; Compt. Rend.; 186, 1724-1726 (1928)	Kk, 16 or 25°C?, 2d, ioniz., from CdS solubility.
66BAT/CLE:	Battino, R.; Clever, H.L.; "The solubility of gases in liquids"; Chem. Rev.; 66, 395-463 (1966)	Pv, 0-60°C, 0-2000mmHg., bibliography.
67BER:	Berner, R. A.; "Thermodynamic stability of sedimentary iron sulfides"; Am. J. Sci.; 265, 773-785 (1967)	Kk, 25°C, 1st. ioniz.
49BON/RUS:	Bond, D.C.; Russell, N.B.; "Effect of antifreeze agents on the formation of hydrogen sulfide hydrate"; Trans. AIME; 179, 192-198 (1949)	Px, 29.5°C.
82BRE:	Brewer, L.; "Thermodynamic values for desulfurization processes"; Am. Chem. Soc. Symp. Ser.; 188, 1-40 (1982)	Ze, H, Kk, Qh, 25°C and higher thermochemical data.
69BUR/GER:	Burgess, M. P.; Germann, R.P.; "Physical properties of hydrogen sulfide-water mixtures"; AIChE J.; 15, 272-275 (1969)	Zc, Pv, 30-170°C, P(total)=250-340 psia, refit of tabulated data.
30BUT/MAA:	Butler, K.H.; Maass, O.; "Hydrogen disulfide"; J. Am. Chem. Soc.; 43, 2539-2548 (1930)	Qg, 25°C, H_2S_2, Cp.
81CAD:	Cady, G.H.; "Composition of chlathrate gas hydrates of $CHClF_2$, CCl_3F, Cl_2, ClO_3F, H_2S, and SF_6"; J. Phys. Chem.; 85, 3225-3230 (1981)	Kk, hydration data, 0°C.
71CLA/GLE:	Clarke, E. C. W.; Glew, D. N.; "Aqueous nonelectrolyte solutions. part VIII. Deuterium and hydrogen sulfides solubilities in deuterium oxide and water"; Can. J. Chem.; 49, 691-698 (1971)	Pv, 0-50°C, 0.5-1 atm.
64COB:	Cobble, J. W.; "The thermodynamic properties of high temperature aqueous solutions. VI. Applications of entropy correspondence to thermodynamics and kinetics"; J. Am. Chem. Soc.; 86, 5394-5401 (1964)	Zc, Qh, Da, Pv, Kk, 0-300°C, 1st and 2nd ioniz.

82COB/MUR: Cobble, J. W.; Murray, R. C. Jr.; Turner, P. J.; Chen, K.; 'High-temperature thermodynamic data for species in aqueous solution', EPRI Report NP-2400, Electric Power Research Institute, Palo Alto, CA, (1982) — Ze, Kk, Pv, 0-350°C, 1st and 2d ioniz.

80COX: Cox, J. D.; "Tentative set of key values for thermodynamics, part VIII"; CODATA Special Report 8; (1980) — Ze, 25°C, $\Delta_f H$, $\Delta_f G$, S for S^{2-}

78EDW/MAU: Edwards, T. J.; Maurer, G.; Newman, J.; Prausnitz, J. M.; "Vapor-liquid equilibria in multicomponent aqueous solutions of volatile weak electrolytes"; AIChE J.; 24, 966-975 (1978) — Zc, Pv, Kk, 0-170°C, I to 6m.

75EDW/NEW: Edwards, T. J.; Newman, J.; Prausnitz, J. M.; "Thermodynamics of aqueous solutions containing volatile weak electrolytes"; AIChE J.; 21, 248-259 (1975) — Zc, Pv, Kk, 0-100°C, m = 0 to 1, 1st ioniz.

61ELL/AND: Ellis, A. J.; Anderson, D. W.; "The first acid dissociation constant of hydrogen sulphide at high pressures"; J. Chem. Soc.; 4678-4680 (1961) — Kk, 25°C, m to 0.4, 1-2000 atm., 1st ioniz.

71ELL/GIG: Ellis, A. J.; Giggenbach, W.; "Hydrogen sulphide ionization and sulphur hydrolysis in high temperature solution"; Geochim. Cosmochim. Acta.; 35, 247-260 (1971) — Kk, 25-270°C, 1st and 2d ioniz. in strong alkali.

59ELL/GOL: Ellis, A. J.; Golding, R. M.; "Spectrophotometric determination of the acid dissociation constants of hydrogen sulphide"; J. Chem. Soc.; 127-130 (1959) — Kk, 25°C. 1st and 2d ioniz.

67ELL/MIL: Ellis, A. J.; Milestone, N. B.; "The ionization constants of hydrogen sulfide from 20 to 90°C"; Geochim. Cosmochim. Acta.; 31, 615-620 (1967) — Kk, 20-90°C, 1st and 2d ioniz.

38EPP: Epprecht, A. G.; "Die Dissoziationskonstante der ersten Stufe des Schwefelswasserstoff"; Helv. Chim. Acta; 21, 205-211 (1938) — Kk, t = 20°C(?), 1st ioniz., dil. H_2S HS^- sol.

76EVE/MOO:	Evelein, K. A.; Moore, R. G.; Heidemann, R. A.; "Correlation of the phase behavior in the systems hydrogen sulfide-water and carbon dioxide-water"; Ind. Eng. Chem., Process Des. Dev.; 15, 423-428 (1976)	Pv, 298-444 K,200 atm., phase behavior predicted using Redlich-Kwong equation. No new data
47FEH/HEU:	Feher, F.; Heuer, E.; "Zur thermochemie der polyschwefelwasserstoffe"; Z. Anorg. Allgem. Chem.; 255, 185-194, (1947)	Hr, 25°C, polysulfides. heat of decomposition.
63FEH/SEY:	Feher, F.; Seyfried, K.; "Die spezifiechen Warmen der sulfane ion fussigen Zustand"; Z. Anorg. Allgem. Chem.; 322, 155-161 (1963)	Qh, 25°C, polysulfides.
57FEH/WIN:	Feher, F.; Winkhaus, G.; "Zur thermochemie der sulfane Bildungsenthalpien und Bindungsenergien"; Z. Anorg. Allgem. Chem.; 292, 210-223 (1957)	Hc, 25°Ç, polysulfides, heat of combustion.
1883FOR:	de Forcrand, R.; "Recherches sur les hydrates sulfhydres"; Ann. Chim. Phys.;[5], 28, 5-67 (1883)	Hr, Kd, 0.5 - 28.5°C 1.1 - 16 atm. H_2O-$6H_2O$
1888FOR/VIL:	de Forcrand, R.; Villard, P.; "Sur l'hydrate d'hydrogene sulfure"; Compt. Rend.; 106, 939-941 (1888)	Kd, 20°C?, H_2S-$6H_2O$
72GAL/MIL:	Galley, M.R.; Miller, A.I.; Atherley, J.F.; Mohn, M.; "GS (Girdler-sulfide) process physical properties"; At. Energy Can. Ltd.; *AECL-4255, 78pp (1972); [CA 77-146735e]	Zc, Pv, Qh, V, t?
67GAM/RAI:	Gamsjaeger, H.; Rainer, W.; Schindler, P.; "Loslichkeitskonstanten und freie Bildungsenthalpien von Metallsulfiden, 4. Mitt.: Die Loslichkeit von H_2S in $HClO_4$-$NaClO_4$-H_2O-Mischungen"; Monatsh. Chem.; 98, 1793-1802 (1967)	Ze, Hm, Pv, 25°C, 1 atm.?, I < 3m, solution in presence of electrolytes.
69GAM/SCH:	Gamsjaeger, H.; Schindler, P.; "Loslichkeiten und Aktivitatskoeffizienten von H_2S in Elektrolytmischungen"; Helv. Chim. Acta.; 52, 1395-1402 (1969)	Pv, Da, 25°C, 1 atm.?, solubility as function of pH and salt concn.
72GER:	Gerrard, W.; "Solubility of hydrogen sulphide, dimethyl ether, methyl chloride and sulfur dioxide in liquids. Prediction of solubility of all gases"; J. Appl. Chem. Biotechnol.; 22(5), 623-650 (1972); [CA 80-31037y]	Pv, Zc, several temps, 1 bar.

71GIG:	Giggenbach, W. F.; "Optical Spectra of Highly Alkaline Sulfide Solutions and the Second Dissociation Constant of Hydrogen Sulfide"; Inorg. Chem.; 10, 1333-1338 (1971)	Kk, 25-250°C, 2d ioniz. in conc. NaOH(
80GIG:	Giggenbach, W. F.; "Geothermal gas equilibria"; Geochim. Cosmochim. Acta; 44 2021-2032 (1980)	Pv, 100-300°C, application of previously published data to geochemical equilibria.
80GIL/WIL:	Gillespie, P.C.; Wilson, G.M.; 'Vapor-liquid equilibrium data on water-substitute gas components: N_2-H_2O, H_2-H_2 CO-H_2O, H_2-CO-H_2O, and H_2S-H_2O'; Research Report-41, Gas Processors Association; Tulsa, Okla.; 1-34 (1980)	Pr, t = 100 - 600°F, p=50-2000 psi
52GOA/GOR:	Goates, J. R.; Gordon, M. B.; Faux, N. D.; "Calculated values of the solubility product constants of the metallic sulfides"; J. Am. Chem. Soc.; 74, 835-836 (1952)	Kk, 25°C, 2d ioniz. based on 49KON/LEB.
75GOL/KAP:	Goldhaber, M. B.; Kaplan, I. R.; "Apparent dissociation constants of hydrogen sulfide in chloride solutions"; Marine Chem.; 3, 83-104 (1975)	Kk, 7.5-25°C, 1st and 2d ioniz.
10GOL/LAR:	Goldschmidt, H.; Larsen, H.; "The reduction of the nitro group by hydrogen sulphide. A study of catalysis"; Z. Phys. Chem.; 71, 437-512 (1910); (see p. 449-454)	Pv, 15-45°C, P = 1 atm ? Solubility in the presence of NaHS, polysulfides.
58GOL:	Golovin, F. I.; "The thermodynamic dissociation constant of hydrogen sulfide and its application to analysis of water"; Trudy Molodykh Nauch Rabotnikov Akad. Nauk Kirgiz. SSR; 119-137 (1958); [CA 55-4130f]	Kk, Pv, 18-45°C.
61GOL/NEM:	Golovin, F. I.; Nemirov, G. V.; "Hydrolysis of NaHS"; Gidrokhim. Materialy; 33, 160-165 (1961); [CA 57-9281d]	Kk, 18-45°C, in NaHS solutions, 1st. ioniz.
70GOR:	Gorbunov, L. V.; "Correlation between thermodynamic parameters and the solubility of salts and gases in water at increased temperatures"; Geokhimiya; *(1), 116 (1970); [CA 72-82795m]	Px, Hm, 40-90°C, also S and chem. pot.

67HEL:	Helgeson, H. C.; "Thermodynamics of complex dissociation in aqueous solution at elevated temperatures"; J. Phys. Chem.; 71, 3121-3136 (1967)	Ze, Kk, Hm, 25-300°C, 1st and 2d ioniz.
76HEL/KIR:	Helgeson, H.C; Kirkham, D.H.; "Theoretical prediction of the thermodynamic properties of aqueous electrolytes at high pressures and temperatures. III. Equation of state for aqueous species at infinite dilution"; Am. J. Sci.; 276, 97-240 (1976)	Kk, Zc, Ze, 25-300°C, 1-1000 atm.
81HEL/KIR:	Helgeson, H.C.; Kirkham, D.H.; Flowers, G.C.; "Theoretical prediction of the thermodynamic behavior of aqueous electrolytes at high pressures and temperatures: IV. Calculation of activity coefficients, osmotic coefficients and apparent molal and standard and relative partial molal properties to 600°C and 5kB"; Am. J. Sci.; 281, 1249-1516 (1981)	Ze, Kk, Da, Dm, 0-600°C, 0-5kB.
76HER/HEL:	Herr, F. L. Jr.; Helz, G. R.; "Measurement of the activity coefficient of aqueous NaHS to 80°C and 0.2m in the system NaHS-H_2S-H_2O"; J. Solution Chem.; 5, 833-852 (1976)	Da, 12-83°C, m(NaHS) < 0.2m, p(H_2S) < 1 atm.
80ISA/OTT:	Isaacs, E. E.; Otto, F. D.; Mather, A. E.; "Solubility of mixtures of H_2S and CO_2 in a monoethanolamine solution at low partial pressures"; J. Chem. Eng. Data; 25, 118-120 (1980)	Pv, 100°C, P < 3.4 kPa, in monoethanolamine.
33JEL:	Jellinek, K.; "Lehrbuch der physikalischen Chemie"; F. Enke, Stuttgart; *IV, 62 (1933)	Kk, 25°C, data from 22JEL/CZE, 1st and 2d ioniz.
22JEL/CZE:	Jellinek, K.; Czerwinski, J.; "Uber die Dissoziation von H_2S, Na_2S und NaHS in wasseriger Losung"; Z. Phys. Chem.; 102, 438-479 (1922)	Kk,Ke, Px, 25°C, Na_2S, NaSH. 1st and 2d ioniz.
54JUZ/LAU:	Juza, R.; Laurer, P.; "Zur Kenntnis des Lithiumhydrogensulfids"; Z. Anorg. Allgem. Chem.; 275 79-93 (1954)	Hr, 25°C, LiOH(aq) + H_2S(aq).
41KAP/ANV:	Kapustinsky, A. F.; Anvaer, B. I.; "Setschenoff's rule and the solubility of hydrogen sulfide in hydrochloric acid solutions"; Compt. Rend. Acad. Sci. URSS; 30, 625-628 (1941); [CA 37-2981]	Pv, 25°C, 1 atm. Aq. solutions of $FeCl_2$ and $ZnCl_2$ in HCl.

58KAR/KAN: Kapustinskii, A. F.; Kan'kovskii, R. T.; "Thermochemistry of Isotopes. I. Calorimetric determination of the heat of formation of hydrogen sulfide and deuterium sulfide"; Zh. Fiz. Khim.; 32, 2810-2816 (1958)

Hc, 25°C, $H_2S(g)$ heat of condensation.

21KEN/AND: Kendall, J.; Andrews, J. C.; "The solubilites of acids in aqueous solutions of other acids"; J. Am. Chem. Soc.; 43, 1545 (1921)

Pv, 25°C, 1 atm, sol in HCl(aq).

65KHO/ZHO: Khodakovskii, I. L.; Zhogina, V. V.; Ryzhenko, B. N.; "Dissociation constants of hydrogen sulfide at elevated temperatures"; Geokhimiya; 7, 827-833 (1965)

Ze, Kk, 0-50°C, 1st and 2d ioniz.

37KIS/LAJ: Kiss, A. v.; Lajtai, I.; Thury, G.; "Uber die Loslichkeit von Gasen in Wasser-Nichtelektrolytgemischen"; Z. Anorg. Allgem. Chem.; 233, 346-352 (1937)

Pv, 0-25°C, 1 atm., in aq. sol. of alcohol, glycerine and carbamide.

06KNO: Knox, J.; "Zur Kentniss der Ionenbildung des Schwefels und der Komplexionen des Quecksilbers"; Z. Elektrochem; 12, 477 (1906)

Kk, 2d ioniz. cited in 64SIL/MAR.

31KOL: Kolthoff, I. M.; "The solubilities and solubility products of metallic sulfides in water"; J. Phys. Chem.; 35, 2711-2721 (1931)

Kk, 1st and 2d ioniz., cited in 64SIL/MAR, Source of data not given.

49KON/LEB: Konopik, N.; Leberl, O.; "Die zweite Dissoziationskonstante von Schwefelwasserstoff"; Monatsh. Chem.; 80, 781-787 (1949)

Kk, 20°C, 2d ioniz., in Na_2S sol.

31KOR/SCH: Korvezee, A.E.; Scheffer, F.E.C.; "La composition de l'hydrate de l'hydrogene sulfure"; Rec. Trav. Chim. Pays. Bas.; 50, 256-260 (1931)

Px, Pv, -25 to -2°C, H_2O-$6H_2O$, reinterp. of 19SCH/MEY

64KOZ: Kozintseva, T. N.; "Solubility of hydrogen sulfide in water at elevated temperature"; Geokhimiya; 758-765 (1964); [CA 61-9292b]

Pv, 160-330°C.

65KOZ: Kozintseva, T. N.; "The solubility of H_2S in water and the salt solutions at elevated temperatures"; Geokhim. Issled. v Obl. Povyshennykh Davlenii i Temperatur., Akad. Nauk SSSR, Inst. Geokhim. i Analit. Khim., Sb. Statei; 121-134 (1965); [CA 64-10459b]

Pv, 150-330°C, 1 and 2 atm in water, NaCl, $CaCl_2$, and Na_2SO_4 sol.

73KRY/STA:	Kryukov, P. A.; Starostina, L. I.; Tarasenko, S. Ya.; Pavlyuk, L. A.; Smolyakov, B. S.; Larionov, E. G.; "Ionization constants of carbonic acid, hydrogen sulfide, boric acid, and sulfuric acid at high temperatures"; Mezhdunar. Geokhim. Kongr. [Dokl.] 1st, (1971); 2, 186-198 (1973); [CA 81-69193]	Kk, 25-150°C, 1st and 2d ioniz.
74KRY/STA:	Kryukov, P. A.; Starostina, L. I.; Tarasenko, S. Ya.; Primanchuk, M. P.; "Second ionization constant of hydrogen sulfide at temperatures up to 150°C"; Geokhimiya; 1003-1013 (1974)	Kk, 25-150°C, 2d ioniz.
46KUB:	Kubli, H.; "Die Dissoziation von Schwefelwasserstoff"; Helv. Chim. Acta.; 29, 1962-1973 (1946)	Kk, 20°C, m(Na_2S) = 0.04 - 0.08, 1st and 2d ioniz.
53KUR/ZIE:	Kury, J. W.; Zielen, A. J.; Latimer, W. M.; "Heats of formation and entropies of HS- and S--. Potential of sulfide-sulfur couple"; J. Electrochem. Soc.; 100, 468-470 (1953)	Hr, 25°C, 1st and 2d ioniz.
05KUS/HEB:	Kuster, F. W.; Heberlein, E.; "Beitrage Zur Kenntnis der Polysulfide I."; Z. Anorg. Allgem. Chem.; 43, 53-84 (1905)	Kk, hydrolysis of Na_2S, polysulfides. See 22JEL/CZE
69LAR/HEP:	Larson, J.W.; Hepler, L.G.; "Heats and Entropies of Ionization"; 'Solute-Solvent Interactions', Marcel-Dekker, New York and London, 1969 and 1976; 1, chapter 1 (1969)	Zr, Kk, Hr, 25°C 1st and 2d ioniz.
76LAW/GAR:	Lawson, J. D.; Garst, A. W.; "Gas sweetening data: Equilibrium solubility of hydrogen sulfide and carbon dioxide in aqueous monoethanolamine and aqueous diethanolamine solutions"; J. Chem. Eng. Data; 21, 20-30 (1976)	Pv, 80-300°F, p to 27,800mmHg, in H_2O/ ethanolamines.
77LEE/MAT:	Lee, J.I.; Mather, A. E.; "Solubility of hydrogen sulfide in water"; Ber. Bunsenges. Phys. Chem.; 81, 1020-1023 (1977)	Pv, 10-180°C, P to 6.7 MPa.

73LEE/OTT:	Lee, J. I.; Otto, F. D.; Mather, A. E.; "Solubility of hydrogen sulfide in aqueous diethanolamine solutions at high pressures"; J. Chem. Eng. Data.; 18, 71-73 (1973)	Pv, 25-120°C, .02-20 atm., in H_2O/diethanolamine solution.
73LEE/OTT2:	Lee, J. I.; Otto, F. D.; Mather, A. E.; "Partial pressures of hydrogen sulfide over aqueous diethanolamine solutions."; J. Chem. Eng. Data; 18, 420 (1973)	Pv, 25-120°C, .0007-20 atm., in H_2O/diethanolamine solution.
74LEE/OTT:	Lee, J. I.; Otto, F. D.; Mather, A. E.; "Solubility of mixtures of carbon dioxide and hydrogen sulfide in aqueous diethanloamine solutions"; Can. J. Chem. Eng.; 52, 125-127 (1974); [CA 81-30275]	Pv, 50 and 100°C, .01-840 psia, H_2S/CO_2 = 0-67 in H_2O-diethanolamine mixt.
76LEE/OTT:	Lee, J. I.; Otto, F. D.; Mather, A. E.; "Equilibrium in hydrogen sulfide-monoethanolamine-water system"; J. Chem. Eng. Data; 21, 207-208 (1976)	Pv, 25-120°C, $p(H_2S)$ = .15 to 2317 kPa, ethanolamine-water mixt.
76LET/THO:	Letoffe, J. M.; Thourey, J.; Perachon, G.; Bousquet, J.; "Determination des enthalpies standards de formation des polysulfures de sodium et de lithium"; Bull. Soc. Chim. France; 424 (1976)	Hm, 25°C, Na_2S and polysulfides.
58LIN:	Linke, W. F.; D. Van Nostrand, Princeton; "Solubilities"; 4th ed.; 1, 1153-1156 (1958); [originated by A. Seidel]	Ze, Pv, 0-100°C, 270-3500mmHg, in water and salt solutions, data compiled.
28LOO:	Loomis, A. G.; in Washburn, E. W.; "Solubilities of gases in water"; ed., "International Critical Tables", McGraw Hill, N.Y.; *III, 259 (1928)	Pv, 0-100°C, Winkler's data (06WIN).
61LOY/HIM:	Loy, H. L.; Himmelblau, D. M.; "The first ionization constant of hydrogen sulfide in water"; J. Phys. Chem.; 65, 264-267 (1961)	Kk, 0-50°C, 1st ioniz.
41MAR/KOB:	Markham, A. E.; Kobe, K. A.; "The solubility of gases in liquids"; Chem. Rev.; 28, 519 588 (1941)	Zr, Pv, methods, bibliography, data quality, no values for solubilities.
59MAR:	Maronny, G.; "Constantes de dissociation de l'hydrogene sulfure"; Electrochim. Acta; 1, 58-69 (1959)	Kk, 0-25°C. 2d ioniz. and polysulfides.

59MAR2:	Maronny, G.; "Fonctions thermodynamiques standards des ions sulfurs et polysulfures en solution aqueuse II. Determination des tensions standards"; J. Chim. Phys.-Phys.-Chim. Biol.; 56, 202-213 (1959)	Kk, 25°, polysulfides.
59MAR3:	Maronny, G.; "Fonctions thermodynamiques standards des ions sulfures et polysulfures en solution aqueuse"; J. Chim. Phys. Phys.-Chim. Biol.; 56, 214-221 (1959)	Kk, Hr, 20-25°C, polysulfides. 2d ioniz.
55MAR/VAL:	Maronny, G.; Valensi, G.; "Calorimetric determination of thermodynamical functions of the S_5^{2-} ion"; Compt. Rend. de la Septieme Reunion, Lindau; 266-274 (1955)	Kk, Hr, 25°C, polysulfides.
03MCL:	McLauchlan, W. H.; "Uber den Einfluss von Salzen auf die Wasserloslichkeit von Schwefelwasserstoff, Jod und Brom"; Z. Phys. Chem.; 44, 600-633 (1903)	Pv, 25°C, 1 atm., in water and salt solutions.
83MEY/WAR:	Meyer, B.; Ward, K.; Koshlap, K.; Peter, L.; "Second dissociation constant of hydrogen sulfide"; Inorg. Chem.; 22, 2345-2346 (1983)	Kk, 25°C, 2d ioniz., in conc. NaOH.
75MIL/WIL:	Miles, D.H.; Wilson, G.M.; "Vapor-liquid equilibrium data for design of sour water strippers"; Annual Report to American Petroleum Institute, 1974; (1975)	Pv, as cited by 78EDW/MAU
61MUH/SUN:	Muhammad, S. S.; Sundaram, E. V.; "The spectrophotometric determination of the dissociation constants of hydrogen sulfide"; J. Sci. Ind. Res. (Delhi); 20B, 16-18 (1961)	Kk, 30°C, 1st and 2d ioniz.
77NAS/MAT:	Nasir, P.; Mather, A. E.; "The measurement and prediction of the solubility of acid gases in monoethanolamine solutions at low partial pressures"; Can. J. Chem. Eng.; 55, 715-717 (1977); [CA 88-42271]	Pv, 80-100°C, P to 9 kPa, H_2S,CO_2 and their mixt. in H_2O/ethanolamine.
77NOW/CHA:	Nowak, E. S.; Chan, J. S.; "A mixture saturation theory and experimental measurements of the thermal properties of a two component-two phase system"; Proc. Symp. Thermophys. Prop.; 7, 538-545 (1977)	Qh, 300-400 K, 10-20 bar, liq and gas mixt.
1899PAU:	Paul, T.; "Tuberinger Chemische Gesellschaft Sitzung, 2 Juni"; Chem. Ztg.; 23, 535 (1899)	Kk, 1st ioniz., conductivity cited in 77RAO/HEP and 64SIL/MAR.

76PAV/KRY:	Pavlyuk, L. A.; Kryukov, P. A.; "Spectrophotometric determination of the first ionization constant of hydrogen sulfide at elevated temperatures"; Izv. Sib. Otdel. Akad. Nauk SSSR; *(6), 25 (1976)	Kk, 25-110°C. 1st ioniz.
80PEN/ROB:	Peng, D.-Y.; Robinson, D.B.; "Two-and three-phase equilibrium calculations for coal gasification and related processes"; ACS Symp. Ser.; No. 133, 393-414 (1980)	Zc, Pv, 100-340°F 100-5000 psia, correlation of VLE data.
49PES/VAL:	Peschanski, D.; Valensi, G.; "Contribution a L'electrochimie des solutions aqueuses de polysulfures"; J. Chim. Phys.; 46, 602-619 (1949)	Ke, 20°C, polysulfide.
61POH:	Pohl, H. A.; "Thermodynamics of the hydrogen sulfide-water system relevant to the dual temperature process for the production of heavy water"; J. Chem. Eng. Data; 6, 515 (1961)	Zc, Pv, Qh, 0-160°C, 0-400 psia.
62POH:	Pohl, H. A.; "Solubility of iron sulfides"; J. Chem. Eng. Data; 7, 295 (1962)	Ze, Kk, 25°C, values from 52LAT/KUR selected.
09POL:	Pollitzer, F.; "Uber das Gleichgewicht der Reaktion H_2SI+ 2J I 2HJ + S und die Dissoziation des Schwefelwasserstoffs"; Z. Anorg. Allgem. Chem.; 64, 121-148 (1909)	Pv, 40-60°C, from a study of reaction equilibrium.
1895PRY/HOL:	Prytz, K.; Holst, H.; "Die Absorptionscoefficienten der Kohlensaure und des Schwefelwasserstoffs in Wasser bei dessen Gefrierpunkt"; Ann. Phys.; 290(54 3rd ser.), 130-138 (1895)	Pv, 0°C, 1 atm.
77RAO/HEP:	Rao, S. R.; Hepler, L. G.; "Equilibrium constants and thermodynamics of ionization of aqueous hydrogen sulfide"; Hydrometallurgy; 2, 293 299 (1977)	Ze, Kk, Hr, 25-200°C, 1st and 2d ioniz.
1881SAB:	Sabatier, P.; "Les sulfures"; Ann. Chim. et Phys.; 22[5], 5-98 (1881)	Hr, 15°C, NaOH(aq) + H_2S(aq) polysulfides.
13SCH:	Scheffer, F.E.C.; "Das System Schwefelwasserstoff-Wasser"; Z. Phys. Chem.; 84, 734-745 (1913)	Pv, Px, -25 to-2°C, H_2S-6H_2O.

19SCH/MEY:	Scheffer, F.E.C.; Meyer, G.; "On an indirect analysis of gas-hydrates by a thermodynamic method and its application to the hydrate of sulphuretted hydrogen"; Proceedings of the Section of Sciences; 21(6-10) Pt. 2, 1338-1348 (1919)	Pv, Px. -25 to -2°C, H_2S-$6H_2O$ sol. and vap. press.
60SCH/FIS:	Schwarzenbach, G.; Fischer, A.; "Die Aciditat der Sulfane und die Zusammensetzung wasseriger Polysulfidlosungen"; Helv. Chim. Acta; 43, 1365-1390 (1960)	Kk, 20°C, I=0.1m, H_2S, H_2S_3, H_2S_4, H_2S_5
52SEL/CAR:	Selleck, F. T.; Carmichael, L. T.; Sage, B. H.; "Phase behavior in the hydrogen sulfide-water system"; Ind. Eng. Chem.; 44, 2219-2226 (1952)	Pv, Px, 100-340°F, P to 5200 psia. good summary.
64SIL/MAR:	Sillen, L. G.; Martell, A. E.; "Stability constants of metal-ion complexes, Section I, Inorganic ligands"; Special Publication No. 17, Chemical Society (London); 215-216 (1964) early references.	Ze, Kk, 0-200°C, 1st and 2d ioniz. compiled data, see for
71SIL/MAR:	Sillen, L.G.; Martell, A.E.; 'Stability constants of metal-ion complexes. Supplement No 1'; The Chemical Soc., London; Spec. Pub. 25 (1971)	Kk, 20-350°C, compiled data.
28SMI:	Smith, D. F.; in Washburn, E. W.; "The solubility of gases in solution"; ed., International Critical Tables, McGraw Hill, N.Y.; *III, 274, (1928)	Pv, 0-30°C, HCl, HI, NaCl, and NaHS solutions.
76SMI/MAR:	Smith, R. M.; Martell, A.E.; 'Critical stability constants' Plenum Press, N.Y.; 4, 76 (1976)	Ze, Kk, 20 and 25°C, evaluated data.
50SOU/SCH:	Souchay, P.; Schaal, R.; "Determination cryoscopique des constantes de dissociation d'acides tres faibles"; Bull. Soc. Chim. France; 819-824 (1950)	Kk, 32, 38°C, 2d ioniz. in $Na_2SO_4(10H_2O)$.
74SRE:	Sretenskaya, N. G.; "Electrical conductivity of hydrogen sulfide aqueous solutions and the first constant of hydrogen sulfide acid dissociation at various temperatures"; Geokhimiya; 996-1002 (1974)	Kk, 25-90°C. 1st ioniz.
71STE/COB:	Stephens, H. P.; Cobble, J. W.; "Thermodynamic properties of the aqueous sulfide and bisulfide ions and the second ionization constant of hydrogen sulfide over extended temperatures"; Inorg. Chem.; 10, 619-625 (1971)	Kk, Hr, Qh, Zc, 25°C, 95°C, from K HS(cr) + KOH(aq)

64STE/TOR:	Ste-Marie, J.; Torma, A. E.; Gubeli, A. O.; "The stability of thiocomplexes and solubility products of metal sulphides"; Can. J. Chem; 42, 662 (1964)	Kk, 25°C, 1st and 2d ioniz.
57SUN/WAD:	Sunner, S.; Wadso, I.; "The heat of hydrolysis of thiolacetic acid"; Trans. Faraday Soc.; 53, 455-459 (1957)	Hm, 25°C. in acid sol.
69SYR/KRA:	Syrkina, I. G.; Krasheninnikova, A. A.; Zaliopo, V. M.; "Solubility of sulfur dioxide, hydrogen sulfide, and chlorine in hydrochloric acid"; Zh. Neorg. Khim.; 14(5), 1331-1334 (1969); [CA 71-33884k]	Pv, 2.5-75°C, in HCl solutions.
78TAG/POL:	Tagieva, L. V.; Poltoratskii, G. M.; Maksimov, V. F.; Tyutyunnik, L. F.; "Equilibrium between the liquid and the vapor in the water-sodium sulfide-sodium hydrogen sulfide system"; Zh. Priklad. Khim.; 51, 49-52 (1978)	Pv, Da, Dm, 298-343 K.
71TED:	Teder, A.; "The equilibrium between elementary sulfur and aqueous polysulfide solutions"; Acta Chem. Scand.; 25, 1722-1728 (1971)	Kk, 25 and 80°C, S, polysulfide equilib.
1882THO:	Thomsen, J.; "Thermochemische Untersuchen"; Leipzig; 4, 188 (1882-86)	Hm, 18°C.
76TSO/COU:	Tsonopoulos, C.; Coulson, D. M.; Inman, L. B.; "Ionization constants of water pollutants"; J. Chem Eng. Data; 21, 190-193 (1976)	Kk, 25-150°C. 1st and 2d ioniz.
57TUM/MIS:	Tumanova, T. A.; Mishchenko, K. P.; Flis, I. E.; "The dissociation of hydrogen sulfide in aqueous solutions at various temperatures"; J. Inorg. Chem., USSR; 2, 1990 (1957)	Kk, 10-15°C. 1st ioniz.
82WAG/EVA:	Wagman, D. D.; Evans, W. H.; Parker, V. B.; Schumm, R. H.; Halow, I.; Bailey, S. M.; Churney, K. L.; Nuttall, R. L.; "The NBS tables of chemical thermodynamic properties"; J. Phys. Chem. Ref. Data; 11, Supplement No 2 (1982)	Kk, 25°C. $\Delta_f G$, S, $\Delta_f H$,
00WAL/COR:	Walker, J.; Cormack, W.; "The dissociation constants of very weak acids"; J. Chem. Soc.; 77, 5 (1900)	Kk, cited in 77RAO/HEP and 64SIL/MAR, 1st ioniz., conduct.

23WAS:	Wasastjerna, J. A.; "Hydrolysis of potassium hydrosulfide in aqueous solution"; Soc. Sci. Fennica Com. Phys.-Mat.; 1(39), 1-15 (1923); [CA 18-1076]	Hr, 25°C, 2d ioniz.
23WAS2:	Wasastjerna, J.A.; "Hydrolysis of potassium monosulfide"; Soc. Sci. Fennica Com. Phys.-Mat.; 1(40), 1-24 (1923); [CA 18-1076]	Kk, Hr, 0 and 25° 2d ioniz.
11WEN/RUP:	Wenzel, H.; Rupp, W.; "Calculation of phase equilibria in systems containing water and supercritical components"; Chem. Eng. Sci.; 33, 683 (1978)	Zc, Pv, Px, 410-444 K, p:to 350 bar, phase equilibria calc. using Redlich-Kwong equation.
77WIL/BAT:	Wilhelm, E.; Battino, R.; Wilcock, R. J.; "Low-pressure solubility of gases in liquid water"; Chem. Rev.; 77, 219-262, (1977)	Ze, Pv, 0-100°C, P=1 atm, methods, tables, thermodynamic properties, correlations and theory.
06WIN:	Winkler, L. W.; "Gesetzmassigkeit bei der Absorption der Gase in Flussigkeiten"; Z. Phys. Chem.; 55, 344 (1906)	Zr, Pv, 0-60°C, analysis of early meas. Data in 58LIN p. 1153.
32WRI/MAA:	Wright, R. H.; Maass, O.; "The solubility of hydrogen sulphide in water from the vapor pressures of the solutions"; Can. J. Research; 6, 94 (1932)	Pv, 25°C.
32WRI/MAA2:	Wright, R. H.; Maass, O.; "Electrical conductivity of aqueous solutions of hydrogen sulfide and the state of the dissolved gas"; Can. J. Research; 6, 588 (1932)	Kk, 25°C, 1st ioniz.
51YUI:	Yui, N.; "On the ionization constant of hydrogen sulfide"; Sci. Repts. Tohoku Imp. Univ.; 35[1], 53-61 (1951)	Kk, 25°C, 1st and 2d ioniz.
60ZAV/KRY:	Zavodnov, S. S.; Kryukov, P. A.; "The magnitude of the second dissociation constant of hydrogen sulfide"; Izvest. Akad. Nauk SSSR, Otdel. Khim. Nauk; 1704-1706 (1960)	Kk, 20-60°C. 2d ioniz. in Na_2S sol.
34ZEU/ROT:	Zeumer, H.; Roth, W. A.; "Die Bildungswarme und Losungswarme von Schwefelwasserstoff"; Z. Elektrochem.; 40, 777-783 (1934)	Hm, 20°C.

$ZnCl_2$-H_2O

T. L. Jobe, Jr. and R. N. Goldberg

INTRODUCTION

Aqueous zinc chloride solutions are of both scientific and industrial importance. The purpose of this bibliography is to identify papers which contain either experimental thermodynamic data for these systems or reviews or correlations of this data. The thermodynamic properties of interest include most types of equilibrium data: activity and osmotic coefficients, equilibrium constants in solution, enthalpies, and heat capacities. Density and solubility data are not included in this bibliography. The search of the literature was based upon a search of the following sources: a computer aided search of Chemical Abstracts from 1967 to 1983, the Bulletin of Chemical Thermodynamics [1] from 1960 to 1981, the files of the Chemical Thermodynamics Data Center at the National Bureau of Standards, and of the references found in the papers identified in the search itself. The authors would appreciate learning of any papers which may have been missed in the search.

The papers are listed alphabetically by first author. Each bibliographic citation includes a brief reference citation (the year and three letters from the names of the first two authors), the authors names, the title of the article and the source. When only an abstract was available only the Chemical Abstracts citation is given. The attempt was made to adhere to the journal abbreviations used in the Chemical Abstracts Source Index [2].

For each paper we have indicated the type of data, the temperature range and, if appropriate, the pressure, solution composition, and pH. The codes used for the properties are from the Bulletin of Chemical Thermodynamics [1]; they are reproduced in Table I.

The Russian titles have been translated into English. These translations come, by preference, from the papers themselves or from Chemical Abstracts. The titles from the latter source may be condensations of the originals.

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[1] Bulletin of Chemical Thermodynamics, R. D. Freeman, editor, Thermochemistry, Inc., Stillwater, OK, 1977 to 1981.

[2] Chemical Abstracts Service Source Index: 1907-1979 Cumulative, in two volumes; American Chemical Society, Washington, DC, 1979.

TABLE I

Property Symbol: Category	Subgroup	Description of Properties
D		Derived Quantities of Special Interest (not listed elsewhere)
	Da	Activity, fugacity
	Dm	Partial molar quantities
	Dx	Excess functions for mixtures
H		Enthalpy Changes for Processes, by Calorimetry
	Hc	for combustion in O_2 or F_2
	Hr	for other chemical reactions
	Hm	for mixing: solution, dilution, etc.
	Hp	for phase transitions, fusion, vaporization
	Hs	for surface processes: adsorption, desorption, etc.
K		Reaction Equilibria and Related Data
	Kd	Dissociation/decomposition pressures and derived enthalpy/entropy changes.
	Ke	Electrochemical cell potentials, etc. and derived enthalpy/entropy changes.
	Kk	Equilibrium constants for chemical reactions and derived enthalpy/entropy changes.
M		Thermodynamic Quantities Calculated from Molecular Parameters
	Md	Data (e.g., structural or spectroscopic) for molecular parameters; atomic energy levels; ionization potentials.
	Mi	Ideal gases: thermodynamic functions (e.g., tabulations).
	Mg	Real gases: intermolecular potentials, derived equations of state
	Mm	Mixtures
	Mx	Crystal, solid and liquid states.
	Mb	Bond energies; non-bonded interactions.
P		Phase Equilibria
	Pt	Temperatures: freezing point, boiling point, triple point, other phase transitions.
	Pp	Vapor pressure and derived quantities for vaporization and/or sublimation, pure substances
	Pv	Vapor/liquid equilibria and related phase diagrams, mixtures
	Px	Condensed phase equilibria: solubility, freezing points, phase diagrams.
	Po	Osmotic pressure/membrane equilibria
	Ps	Surface phenomena: surface tension, surface energy, adsorption, etc.
Q		Thermal Properties for Non-Reacting Systems, by Calorimetry
	Ql	Condensed phase, $T \leq 400$ K: heat capacity, enthalpy, entropy, etc.
	Qh	Condensed phase, $T \geq 400$ K: heat capacity, enthalpy, entropy, etc.
	Qg	Gas phase: heat capacity, enthalpy, entropy etc. as f(T,P).
V		Volume as f(T,P); Empirical Equations of State
	Vg	Gases: PVT, and related data
	Vc	Critical state properties
	Vx	Condensed phases: compressibility, thermal expsansivity
	Vt	Tables and charts of data, e.g., Mollier diagrams.
X		Physical Properties of a Single Phase
	Xd	Density
	Xv	Viscosity
	Xr	Refractive index
Z		Compilations, Correlations and Reviews
	Za	Analysis of experimental data and of errors
	Zc	Empirical Correlations
	Ze	Evaluations and compilations
	Zr	Reviews

hysical States: (c)rystal, solid; (amorp)hous; (liq)uid; (g)as; (aq)ueous; (nonaq)ueous, includes fused salts, solid solutions; (Ads)orbed

65ABL/BUR:	Ablov, A. V.; Burnasheva, Z. P.; Konunova, Ts. B.; "Heats of addition of amines to zinc halides"; Zh. Neorg. Khim.; *10, 2286 (1965)	Hm, 25 °C, in H_2O and 2N HCl
28BAG:	Bagdasaraian, A. B.; "Reduction of metallic chlorides by hydrogen"; Trans. Am. Electrochem. Soc.; *51, 449 (1928)	Pv, Kk, 600 to 725 °C
04BAU:	Baud, M. E.; "Sur quelques combinaisons du chlorure et du fluorure d'aluminium"; Ann. Chim. Phys.;[8] *1, 8 (1904)	Hr, 15 °C
33BEC/ROT:	Becker, G.; Roth, W. A.; "Uber die Bildungswarme von Cadmiumoxyd, Cadmiumhydroxyd und Zinkoxyd"; Z. Phys. Chem. Abt. A; *167, 1 (1933)	Hr, 20 °C, in HCl(aq)
75BEL/ALO:	Belousov, E. A.; Alovyainikov, A. A.; "Determination of the stability constants of zinc and cadmium chloro-complexes in aqueous solutions by the distribution method"; Zh. Neorg. Khim.; *20, 1428 (1975)	Kk, 25 °C
81BEL/IVA:	Belousov, E. A.; Ivanov, V. M.; Chugunova, N. V.; Prokuev, V. A.; "Stability constants of chloride complexes of copper(II), zinc(II), and cadmium(II) in hydrochloric acid solutions"; Issled. Po. Khimii, Tekhnol. i. Primeneniyu Radioaktiv. Veshchestv, L.; p.81 (1981)	Kk, 25 °C
75BER/VAN:	Berg, R. L.; Vanderzee, C. E.; "The enthalpies of solution of zinc oxide in perchloric and hydrochloric acids, and the standard enthalpy of formation of aqueous zinc ion"; J. Chem. Thermodynam.; *7, 229 (1975)	Hr, 25 °C
22BIL/HOH:	Biltz, W.; Hohorst, G.; "Beitrage zur Systematischen Verwandtschaftslehre XV. Die Bildungswarmen der Verbindungen von metallischem Magnesium mit metallischem Zink, Cadmium, Aluminium und Calcium"; Z. Anorg. Allg. Chem.; *121, 1 (1922)	Hr, 18 °C
1884BLU:	Blumcke, A.; "Ueber den Einfluss des Concentrationsgrades auf die specifische Warme wasseriger und alkoholischer Losungen von Metallchloriden"; Ann. Phys. (Leipzig); *23, 161 (1884)	Ql, 15 to 17 °C

34BRU:	Brull, L.; "L'attivita nelle soluzioni di $ZnCl_2$"; Gazz. Chim. Ital.; *64, 261 (1934)	Da, Xd, 25 °C, I = 0.84 to 0.0017
00CHA/FRA:	Chambers, V. J.; Frazer, J. C. W.; "On a minimum in the molecular lowering of the freezing-point of water, produced by certain acids and salts"; Am. Chem. J.; *23, 512 (1900)	Px, 0 °C
1899DIE:	Dietz, R.; "Die Loslichkeit der Halogensalze des Zinks und Cadmiums"; Z. Anorg. Chem.; *20, 240 (1899)	Px, -5 to +100 °C
43EGA/PAR:	Egan, D. M.; Partington, J. R.; "Activity coefficients of zinc chloride, bromide and iodide from electromotive forces"; J. Chem. Soc.; p. 157 (1943)	Da, 25 and 35 °C, 0.5 to 0.001 mol kg^{-1}
1853FAV/SIL:	Favre, P. A.; Silbermann, J. T.; "Recherches sur les quantites de chaleur degagees dans les actions chimiques et moleculaires"; Ann. Chim. Phys.; [3] *37, 406 (1853)	Hm, T = ?
27FOX/SHU:	Foxton, F.; Shutt, W. J.; "The activity of zinc chloride in concentrated solution"; Trans. Faraday Soc.; *23, 480 (1927)	Da, Pv, 60.48 to 80.40 °C
27FRI/HAV:	Fricke, R.; Havestadt, L.; "Verdunnungsarbeiten und Verdunnungswarmen im Gebiet Konzentrierter Losungen"; Z. Elektrochem.; *33, 441 (1927)	Pv, Hm, 0 to 10 °C
29FRI/LUK:	Fricke, R.; Luke, J.; "Zum Thermodynamischen Verhalten Konzentrierter Losungen"; Z. Elektrochem.; *35, 631 (1929)	Hm, 20 °C
80GAI/SIL:	Gaizer, F.; Silber, H. B.; "Stability constants of zinc chloride complexes in DMSO-water mixtures"; J. Inorg. Nucl. Chem.; *42, 1317 (1980)	Kk, 25 °C, 0.5 M NH_4ClO_4

81GOL:	Goldberg, R. N.; "Evaluated activity and osmotic coefficients for aqueous solutions: Bi-univalent compounds of zinc, cadmium, and ethylene bis(trimethylammonium) chloride and iodide"; J. Phys. Chem. Ref. Data; *10, 1 (1981)	Ze, Po, Da, 25 °C
1844GRA:	Graham, T.; "Experiments on the heat disengaged in combinations. Part II. Neutralization of various acids by hydrate of potash"; Philos. Mag.; [3], *24, 401 (1844)	Hm, T = ?
72GRA/SCH:	Grauer, R.; Schindler, P.; "Die Loslichkeitskonstanten der Zinkhydroxidchloride-ein Beitrag zur Kenntnis der Korrosionsprodukte des Zinks"; Corros. Sci.; *12, 405 (1972)	Kk, 25 °C, I = 0.2 M
58HAR/OWE:	Harned, H. S.; Owen, B. B.; 'The physical chemistry of electrolyte solutions' 3rd edition, Reinhold Publishing Corp., New York; p. 560 (1958)	Zr, Da, 25 °C
40HAR/PAR:	Harris, A. C.; Parton, H. N.; "The transport numbers of zinc chloride from E.M.F. measurements"; Trans. Faraday Soc.; *36, 1139 (1940)	Da, 25 and 35 °C, 0.5 to 12 mol kg^{-1}
31HIE/APP:	Hieber, W.; Appel, H.; "Zur Kenntnis der Stabilitatsverhaltnisse von Metallsalzkomplexen mit organischen Molekulkomponenten: Zinkhalogenidverbindungen mit Aminen und ihre Bildungswarmen"; Z. Anorg. Allg. Chem.; *196, 193 (1931)	Hr, 0 °C
19HOR:	Horsch, W. G.; "Potentials of the zinc and cadmium electrodes"; J. Am. Chem. Soc.; *41, 1787 (1919)	Da, Kk, 25 °C, 0.0003 to 0.01 M
30ISH/KIM:	Ishikawa, F.; Kimura, G.; Murooka, T.; "Thermodynamic properties of zinc chloride and of cadmium chloride"; Rikagaku Kenkyusho Iho; *9, 744 (1930)	Ke, Hm, 18 °C and 25 to 42 °C
32ISH/KIM:	Ishikawa, F.; Kimura, G.; Murooka, T.; "Thermodynamic data on zinc chloride and cadmium chloride"; Sci. Rep. Tokohu Imp. Univ. Ser. I; *21, 455 (1932)	Kk, Hm, 18 to 42.5 °C

37ISH/TAK:	Ishikawa, F.; Takai, I.; "Free energies of the formation of $ZnCl_2$, $CdCl_2$, $CdBr_2$ and CdI_2 solutions"; Rikagaku Kenkyusho Iho; *16, 1251 (1937)	Pv, 25 °C, 0.52 to 3.15 mol kg^{-1}
77JAC/SKO:	Jacobsen, T.; Skou, E.; "A simple hydration treatment of activity coefficients in concentrated electrolyte solutions"; Electrochim. Acta; *22, 161 (1977)	Da, 25 °C, in 1.0 to 4.6 M $NaClO_4$
76JED/CEL:	Jedinakova, V.; Celeda, J.; "Aquo and halo complexes of Zn^{2+} ion in isomolar series perchlorate halide"; Collect. Czech. Chem. Commun.; *41, 2829 (1976)	Kk, T = ?, 0.1 M $HClO_4$
1893JON:	Jones, H. C.; "Uber die Bestimmung des Gefrierpunktes sehr verdunnter Salzlosungen"; Z. Phys. Chem. (Leipzig); *11, 529 (1893)	Px, 0 °C
03JON/GET:	Jones, H. C.; Getman, F. H.; "The molecular-lowering of the freezing-point of water produced by concentrated solutions of certain electrolytes"; Z. Phys. Chem. (Leipzig); *46, 244 (1903)	Px, 0 °C
07JON/GET:	Jones, H. C.; Getman, F. H.; Basset, H. P.; McMaster, L.; Uhler, H. S.; "Hydrates in aqueous solution. Evidence for the existance of hydrates in solution, their approximate composition, and certain spectroscopic investigations bearing upon the hydrate problem"; Carnegie Inst. Washington Publ.; *No 60, 145 pp. (1907)	Px, 0 °C
37JUZ/FAS:	Juza, R.; Fasold, K.; Kuhn, W.; "Untersuchungen uber Zink- und Cadmiumamid Metallamide"; Z. Anorg. Allg. Chem.; *234, 86 (1937)	Hm, 18 °C, in 2.717 N HCl
38JUZ/NEU:	Juza, R.; Neuber, A.; Hahn, H.; "Zur Kentnis des Zinknitrides Metallamide und Metallnitride"; Z. Anorg. Allg. Chem.; *239, 273 (1938)	Hr, 18 to 19 °C, in 2.717 N HCl

75KAK/GIE:	Kakolowicz, W.; Giera, E.; "Heat of formation of chelate complexes of some d-electron elements and metal-oxygen bond energy"; Conf. Intern. Thermodyn. Chim. Quat.; *1, 73 (1975)	Hr, 25 °C, in 4.36 M HCl
41KAP:	Kapustinskii, A. F.; "The heat of the precipitation reactions of the tin chloride and of the substitution of tin by zinc and the entropy of the tin ion"; Zh. Fiz. Khim.; *15, 645 (1941)	Hm, 25 °C
67KAR/DRA:	Karapet'yants, M. Kh.; Drakin, S. I.; Lantukhova, L. V.; "Apparent heat capacities of univalent ions in methanol"; Zh. Fiz. Khim.; *41, 2653 (1967)	Ql, 25 °C
27KLE/BRA:	Klemm, W.; Brautigam, M.; "Beitrage zur Systematischen Verwandlschaftslehre. XXXIX. Messungen an Indiumhalogeniden. II. Die Buildungswarmen der Indiumchloride"; Z. Anorg. Allg. Chem.; *163, 225 (1927)	Hr, 0 °C
79LAM/TIK:	Lamanski, L. Yu.; Tikhonov, K. I.; "Complex formation by zinc with chloride ions in mixed aqueous dimethylformamide solutions"; Russ. J. Inorg. Chem.; *24, 669 (1979)	Kk, 25 °C
00LEH:	Lehfeldt, R. A.; "Elektromotorische Kraft und Osmotischer Druck"; Z. Phys. Chem. (Leipzig); *35, 257 (1900)	Da, Ke, 20 °C
75LEW:	Lewandowski, A.; "Thermodynamic studies of zinc chloride in mixed aqueous solvents from electromotive force measurements I. Methanol-water mixtures"; Electrochim. Acta; *23, 1303 (1978)	Kk, 298 to 313 K, 0.004 to 0.1 mol kg^{-1}
75LIB/TIA:	Libus, Z.; Tialowska, H.; "Stability and nature of complexes of the type MCl^+ in aqueous solution (M = Mn, Co, Ni and Zn)"; J. Solution Chem.; *4, 1011 (1975)	Kk, 25 °C, 0 to 1.0 mol kg^{-1} $Zn(ClO_4)_2$
02LOU/SCH:	Louguinine, W.; Schukareff, A.; "Etude thermique de quelques alliages entre zinc et aluminium et cuivre et aluminium pris en proportion definie"; Arch. Sci. Phys. Nat.; [4] *13, 5 (1902)	Hr, 18 °C, in $HCl \cdot 10\ H_2O$

76LUT/DUN:	Lutfullah; Dunsmore, H. S.; Paterson, R.; "Re-determination of the standard electrode potential of zinc and mean molal activity coefficients for aqueous zinc chloride at 298.15 K"; J. Chem. Soc. Faraday Trans. I; *72, 495 (1976)	Da, Ke, 25 °C, 0.005 to 1.0 mol kg^{-1}
81LYA/CHU:	Lyashchenko, A. K.; Churagulov, B. R.; "Influence of pressure on the temperature coefficients of the solubility of electrolytes in water"; Zh. Neorg. Khim.; *26, 1190 (1981)	Px, p = 0 to 10 kbar, 25 to 50 °C, 4.83 to 34.59 mol kg^{-1}
30MAI:	Maier, C. G.; "The heat of formation of zinc oxide"; J. Am. Chem. Soc.; *52, 2159 (1930)	Hr, 25 °C
1876MAR:	Marignac, M. C.; "Sur les chaleurs specifiques des solutions salines"; Arch. Sci. Phys. Nat.; *55, 113 (1876)	Ql, 19 to 52 °C, 10 to 200 H_2O
1876MAR:	Marignac, M. C.; "Sur les chaleurs specifiques des solutions salines"; Ann. Chim. Phys.; *8, 410 (1876)	Ql, 19 to 51 °C
82MAR/BUR:	Marcos, E. S.; Burgos, F. S.; Alvarez, A. M.; "Activity coefficients of zinc chloride in the presence of lithium, sodium, and magnesium perchlorates, and magnesium nitrate in aqueous solution at 25 °C"; J. Solution Chem.; *11, 889 (1982)	Da, Ke, 25 °C, 0.0025 to 0.10044 M
32MAS:	Masaki, K.; "Concentration cell with ternary electrolyte"; Bull. Chem. Soc. Japan; *7, 35 (1932)	Ke, 30 °C
65MED/BER:	Medvedev, V. A.; Bergman, G. A.; Gurvich, L. V.; Yungman, V. S.; Vorob'ev, A. F.; Kolesov, V. P.; and others; 'Thermal constants of substances'; Gluschko, V. P. (ed.), VINITI, Moscow; vol. 1-10, (1965 to 1982)	Ze, Hm, 25 °C
74MIH:	Mihailov, M. H.; "A correlation between the overall stability constants of metal complexes-I. Calculation of the stability constants using the formation function n"; J. Inorg. Nucl. Chem.; *36, 107 (1974)	Kk, T = ?, 0.05 to 0.69 M Cl^-

64MIR/KUL:	Mironov, V. E.; Kul'ba, F. Ya.; Ivanov, Yu. E.; "Complexes of zinc with alkali metal chlorides"; Zh. Neorg. Khim.; *9, 1633 (1964)	Kk, 298.15 K, in 4 M $Li(ClO_4,Cl)$
51PEP/NEW:	Peppler, R. B.; Newman, E. S.; "Heat of solution of zinc oxide in 2 N hydrochloric acid"; J. Res. Nat. Bur. Stand.; *46, 121 (1951)	Hm, 25 °C, 2 N HCl
1888PIC:	Pickering, S. U.; "The heat of dissolution of substances in different liquids, and its bearing on the explanation of the heat of neutralisation, and on the theory of residual affinity"; J. Chem. Soc. Trans.; *53, 865 (1888)	Hm, 18 °C
73PIT/MAY:	Pitzer, K. S.; Mayórga, G.; "Thermodynamics of electrolytes. II. Activity and osmotic coefficients for strong electrolytes with one or both ions univalent"; J. Phys. Chem.; *77, 2300 (1973)	Zc, Da, 25 °C
79PIT:	Pitzer, K. S.; "Theory: Ion interaction approach;" in 'Activity coefficients in electrolyte solutions' Pytkowicz, R. M. (ed.); CRC Press, Boca Raton; Vol. 1, p. 157 (1979)	Zr, Da, Kk, 25 °C
10RIC/BUR:	Richards, T. W.; Burgess, L. L.; "The adiabatic determination of the heats of solution of metals in acids"; J. Am. Chem. Soc.; *32, 431 (1910)	Hr, 20 °C, in HCl(aq)
10RIC/ROW:	Richards, T. W.; Rowe, A. W.; Burgess, L. L.; "The adiabatic determination of heats of solution of metals in acids. Part II. The heat of dilution of the acid solutions"; J. Am. Chem. Soc.; *32, 1176 (1910)	Hr, 20 °C, HCl (8.8 to 200 H_2O)
22RIC/THO:	Richards, T. W.; Thorvaldson, T.; "The heat of solution of zinc in hydrochloric acid"; J. Am. Chem. Soc.; *44, 1051 (1922)	Hr, 20 °C
40ROB/STO:	Robinson, R. A.; Stokes, R. H.; "Part IV. The thermodynamics of zinc chloride solutions"; Trans. Faraday Soc.; *36, 740 (1940)	Da, Ke, 10 to 40 °C, 0.005 to 1.0 mol kg^{-1}

59ROB/STO:	Robinson, R. A.; Stokes, R. H.; 'Electrolyte solutions'; Second edition revised, Butterworths, London; 571 pp. (1959)	Ze, Da, Kk, 25 °C
34ROT/BUC:	Roth, W. A.; Buchner, A.; "Uber die Ionisationswarmen einiger Metalle"; Z. Elektrochem; *40, 87 (1934)	Hm, 20 °C
28ROT/CHA:	Roth, W. A.; Chall, P.; "Die Thermische Verfolgung einiger Metallurgisch Wichtiger Reaktionen in einem bei Hoherer Temperatur Arbeitenden Calorimeter"; Z. Elektrochem.; *34, 185 (1928)	Hr, 50 °C, in 2 N HCl
76SAT/MUR:	Sato, T.; Murakami, S.; "Determination of the activity coefficient of tricaprylmethylammonium chloride and the stability constants of the aqueous complexes formed in the extraction of zinc(II) from hydrochloric acid solutions"; Anal. Chim. Acta; *82, 217 (1976)	Da, Kk, 20 °C
30SCA/TEF:	Scatchard, G.; Tefft, R. F.; "Electromotive force measurements on cells containing zinc chloride. The activity coefficients of the chlorides of the bivalent metals"; J. Am. Chem. Soc.; *52, 2272 (1930)	Da, Ke, 25 °C, 0.003 to 1.5 M
26SIE/GOT:	Sieverts, A.; Gotta, A.; "Bildungswarmen und Dichten von Hydriden"; Z. Elektrochem.; *32, 105 (1926)	Hm, 19 to 26 °C
28SIE/GOT:	Sieverts, A.; Gotta, A.; "Uber die Eigenschaften einiger Metall-wasserstoffe"; Z. Anorg. Allg. Chem.; *172, 1 (1928)	Hr, 19 °C, in $HCl \cdot 20H_2O$
64SIL/MAR:	Sillen, L. G.; Martell, A. E.; 'Stability constants of metal-ion complexes'; Special Publication No. 17, The Chemical Society, London; p. 289 (1964)	Zr, Kk, 10 to 150 °C
71SIL/MAR:	Sillen, L. G.; Martell, A. E.; 'Stability constants of metal-ion complexes'; Special Publication No. 25, The Chemical Society, London; p. 179 (1971)	Zr, Kk, 25 °C

77SKO/JAC: Skou, E.; Jacobsen, T.; van der Hoeven, W.; Atlung, S.; "On the zinc-chloride complex formation"; Electrochim. Acta; *22, 169 (1977) — Kk, 25 °C, 1 to 4.6 M

76SMI/MAR: Smith, R. M.; Martell, A. E.; 'Critical stability constants'; Plenum Press, New York; Vol. 4, p. 108 (1976) — Zr, Kk, 25 °C

13SOM: Somermeier, E. E.; "Determination of the heat of solution of metals by means of a vacuum flask calorimeter"; Phys. Rev.; [2] *1, 141 (1913) — Hr, 16.3 to 21.5 °C

48STO: Stokes, R. H.; "A thermodynamic study of bivalent metal halides in aqueous solution. Part XVII Revision of data for all 2:1 and 1:2 electrolytes at 25 °, and discussion of results"; Trans. Faraday Soc.; *44, 295 (1948) — Da, Pv, Po, 25 °C, 0.1 to 22.0 M

1883THO: Thomsen, J.; 'Thermochemische Untersuchungen'; Band III, J. A. Barth, Leipzig; (1883) — Hm, 18 °C

61TSE/FLI: Tseyan-Shen, Ya.; Flid, R. M.; Makhlin, V. A.; "The investigation of the liquid phase hydration of acetylene with non-mercuric catalysts"; Izv. Vyssh. Uchebn. Zaved. Khim. Khim. Tekhnol."; *4, 218 (1961) — Hr, 105 to 159 °C

71VOR/BRO: Vorob'ev, A. F.; Broier, A. F.; "Enthalpy of formation of zinc(II) ions in an infinitely dilute aqueous solution"; Zh. Fiz. Khim.; *45, 1307 (1971) — Hr, T = ?, dilute HCl

68WAG/EVA: Wagman, D. D.; Evans, W. H.; Parker, V. B.; Halow, I.; Bailey, S. M.; Schumm, R. H.; 'Selected values of chemical thermodynamic properties. Tables for the first thirty-four elements in the standard order of arrangement', Nat. Bur. Stds. (U.S.) Tech. Note 270-3, U. S. Government Printing Office, Washington, DC; p. 234 (1968) — Ze, Hm, Kk, 25 °C

82WAG/EVA: Wagman, D. D.; Evans, W. H.; Parker, V. B.; Schumm, R. H.; Halow, I.; Bailey, S. M.; Churney, K. L.; Nuttall, R. L.; "The NBS tables of chemical thermodynamic properties"; J. Phys. Chem. Ref. Data; *11, Suppl No. 2, 392 pp. (1982) — Ze, Hm, Kk, 25 °C

14WAR: von Wartenberg, H.; "Die Metastabilitat unserer Metallwelt als Folge von Allotropie und deren Bedeutung fur Chemie, Physik und Technik"; Z. Elektrochem.; *20, 443 (1914) — Hr, T = ?, dilute HCl

26WAS: Washburn, E. W. (ed.); 'International critical tables of numerical data physics, chemistry and technology'; McGraw Hill, New York; 1 (1926) — Zr, Px, Kk, Ql

73WER/BEL: Wertz, D. L.; Bell, J. R.; "Solute species and equilibria in concentrated zinc chloride/hydrochloric acid solutions"; J. Inorg. Nucl. Chem.; *35, 861 (1973) — Kk, T = ?

79WHI/PYT: Whitfield, M.; Pytkowicz, R.M. (ed.); 'Activity coefficients in electrolyte solutions'; CRC Press, Boca Raton; Vol 2, p. 154 (1979) — Zr, Kk, 25 °C

1884WRI/THO: Wright, C. R. A.; Thompson, C.; "On the determination of chemical affinity in terms of electromotive force. Part VIII."; Philos. Mag.; [5] *17, 377 (1884) — Hm, T = ?, 0.5 to 25 mol kg^{-1}

53YAT/KHA: Yatsimirskii, K. B.; Kharitonov, V. V.; "On the thermochemistry of anthranide compounds"; Zh. Fiz. Khim.; *27, 799 (1953) — Hm, 25 °C, in 6.24 mol kg^{-1} HCl

H_3PO_4-H_2O

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INTRODUCTION

Aqueous phosphoric acid solutions are of both scientific and industrial importance. The purpose of this bibliography is to identify papers which contain either experimental thermodynamic data for these systems or reviews or correlations of this data. The thermodynamic properties of interest include most types of equilibrium data: activity and osmotic coefficients, equilibrium constants in solution, enthalpies, and heat capacities. Density and solubility data are not included in this bibliography. The search of the literature was based upon a search of the following sources: a computer aided search of Chemical Abstracts from 1967 to 1983, the Bulletin of Chemical Thermodynamics [1] from 1960 to 1981, the files of the Chemical Thermodynamics Data Center at the National Bureau of Standards, and of the references found in the papers identified in the search itself. The authors would appreciate learning of any papers which may have been missed in the search.

The papers are listed alphabetically by first author. Each bibliographic citation includes a brief reference citation (the year and three letters from the names of the first two authors), the authors names, the title of the article and the source. When only an abstract was available only the Chemical Abstracts citation is given. The attempt was made to adhere to the journal abbreviations used in the Chemical Abstracts Source Index [2].

For each paper we have indicated the type of data, the temperature range and, if appropriate, the pressure, solution composition and pH. The codes used for the properties are from the Bulletin of Chemical Thermodynamics [1]; they are reproduced in Table I.

The Russian and Japanese titles have been translated into English. These translations come, by preference, from the papers themselves or from Chemical Abstracts. The titles from the latter source may be condensations of the originals.

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[1] Bulletin of Chemical Thermodynamics, R. D. Freeman, editor, Thermochemistry, Inc., Stillwater, OK, 1977 to 1981.

[2] Chemical Abstracts Service Source Index: 1907-1979 Cumulative, in two volumes; American Chemical Society, Washington, DC, 1979.

TABLE I

Property Symbol: Category	Subgroup	Description of Properties
D		Derived Quantities of Special Interest (not listed elsewhere)
	Da	Activity, fugacity
	Dm	Partial molar quantities
	Dx	Excess functions for mixtures
H		Enthalpy Changes for Processes, by Calorimetry
	Hc	for combustion in O_2 or F_2
	Hr	for other chemical reactions
	Hm	for mixing: solution, dilution, etc.
	Hp	for phase transitions, fusion, vaporization
	Hs	for surface processes: adsorption, desorption, etc.
K		Reaction Equilibria and Related Data
	Kd	Dissociation/decomposition pressures and derived enthalpy/entropy changes.
	Ke	Electrochemical cell potentials, etc. and derived enthalpy/entropy changes.
	Kk	Equilibrium constants for chemical reactions and derived enthalpy/entropy change
M		Thermodynamic Quantities Calculated from Molecular Parameters
	Md	Data (e.g., structural or spectroscopic) for molecular parameters; atomic energy levels; ionization potentials.
	Mi	Ideal gases: thermodynamic functions (e.g., tabulations).
	Mg	Real gases: intermolecular potentials, derived equations of state
	Mm	Mixtures
	Mx	Crystal, solid and liquid states.
	Mb	Bond energies; non-bonded interactions.
P		Phase Equilibria
	Pt	Temperatures: freezing point, boiling point, triple point, other phase transiti
	Pp	Vapor pressure and derived quantities for vaporization and/or sublimation, pure substances
	Pv	Vapor/liquid equilibria and related phase diagrams, mixtures
	Px	Condensed phase equilibria: solubility, freezing points, phase diagrams.
	Po	Osmotic pressure/membrane equilibria
	Ps	Surface phenomena: surface tension, surface energy, adsorption, etc.
Q		Thermal Properties for Non-Reacting Systems, by Calorimetry
	Ql	Condensed phase, $T \leq 400$ K: heat capacity, enthalpy, entropy, etc.
	Qh	Condensed phase, $T \geq 400$ K: heat capacity, enthalpy, entropy, etc.
	Qg	Gas phase: heat capacity, enthalpy, entropy etc. as f(T,P).
V		Volume as f(T,P); Empirical Equations of State
	Vg	Gases: PVT, and related data
	Vc	Critical state properties
	Vx	Condensed phases: compressibility, thermal expsansivity
	Vt	Tables and charts of data, e.g.. Mollier diagrams.
X		Physical Properties of a Single Phase
	Xd	Density
	Xv	Viscosity
	Xr	Refractive index
Z		Compilations, Correlations and Reviews
	Za	Analysis of experimental data and of errors
	Zc	Empirical Correlations
	Ze	Evaluations and compilations
	Zr	Reviews

Physical States:		
	(c)rystal, solid	(aq)ueous
	(amorp)hous	(nonaq)ueous, includes fused salts, solid solutions
	(liq)uid	
	(g)as	(Ads)orbed

09ABB/BRA:	Abbott, G. A.; Bray, W. C.; "The ionization relations of ortho- and pyrophosphoric acids and their sodium salts", J. Am. Chem. Soc.; *31, 729 (1909)	Kk, 18 °C
80AKH:	Akhumov, E. I.; "Hydration of orthophosphoric acid in water-orthophosphoric acid solutions at 25 °C ; Zh. Prikl. Khim. (Leningrad); *53, 1628 (1980)	Kk, 25 °C
72ARN/BUR:	Arnett, E. M.; Burke, J. J.; Carter, J. V.; Douty, C. F.; "Solvent effects in organic chemistry. XV. Thermodynamics of solution for nonelectrolytes in aqueous acid and salt solutions"; J. Am. Chem. Soc.; *94, 7837 (1972)	Hm, 25 °C, 30.5 to 85.0 % H_3PO_4
1889ARR:	Arrhenius, S.; "Uber die Dissociationswarme und den Einfluss der Temperatur auf den Dissociationsgrad der Elektrolyte"; Z. Phys. Chem. Stoechiom. Verwandschaftsl.; *4, 96 (1889)	Kk, Hr, 21 to 35 °C
56BAE:	Baes, C. F., Jr.; "A spectrophotometric investigation of uranyl phosphate complex formation in perchloric acid solution"; J. Phys. Chem.; *60, 878 (1956)	Kk, 25 °C
69BAL/SIL:	Baldwin, W. G.; Sillen, L. G.; "Some phosphate equilibria I. The dissociation of phosphoric acid in 3 M $NaClO_4$"; Ark. Kemi; *31, 391 (1969)	Kk, 25 °C, in 3 M $NaClO_4$
47BAT:	Bates, R. G.; "Activity coefficients in aqueous mixtures of phosphates with sodium chloride, sodium bromide, and sodium iodide, and the pH of phosphate buffer solutions"; J. Res. Natl. Bur. Stand.; *39, 411 (1947)	Kk, Da, 25 °C, I = 0.04 25 mol kg^{-1}
51BAT:	Bates, R. G.; "First dissociation constant of phosphoric acid from 0° to 60 °C; limitations of the electromotive force method for moderately strong acids"; J. Res. Natl Bur. Stand. *47, 127 (1951)	Kk, 0 to 60 °C

43BAT/ACR:	Bates, R. G.; Acree, S. F.; "pH values of certain phosphate-chloride mixtures, and the second dissociation constant of phosphoric acid from 0° to 60 °C"; J. Res. Natl. Bur. Stand.; *30, 129 (1943)	Kk, 0 to 60 °C
56BER:	Bernhard, S. A.; "Ionization constants and heats of tris(hydroxy-methyl) aminomethane and phosphate buffers"; J. Biol. Chem.; *218, 961 (1956)	Kk, 5 to 50 °C, in 0.6 M KCl
1875BER/LOU:	Berthelot, M.; Louguinine, W.; "Thermochimie.-Recherches thermiques sur l'acide phosphorique"; Compt. Rend.; *81 1011 (1875)	Hr, 16-19 °C, 0.17 M
1875BER/LOU:	Berthelot, M.; Louguinine, W.; "Thermochimie. -Sur la constitution des phosphates"; Compt. Rend.; *81, 1072 (1875)	Hr, 13 °C, 0.17 M
54BEU/RIE	Beukenkamp, J.; Rieman, W.; Lindenbaum, S.; "Behavior of the condensed phosphates in anion-exchange chromatography"; Anal. Chem.; *26, 505 (1954)	Kk, 25 °C
80BHA/MAN:	Bhattacharyya, A.; Mandal, A. K.; Lahiri, S. C.; "Acid ionization constants of phosphoric acid in ethanol + water mixtures"; Indian J. Chem.; *19A, 532 (1980)	Kk, 25 °C
02BIL:	Biltz, W.; "Zur Kenntnis der Losungen anorganischer Salze in Wasser"; Z. Phys. Chem. (Leipzig); *40, 185 (1902)	Px, 0 °C
68BIR/SKI	Birley, G. I.; Skinner, H. A.; "Heat of hydrolysis of phosphorus penta-chloride, and heat of formation of aqueous orthophosphoric acid"; Trans. Faraday Soc.; *64, 3232 (1968)	Hr, 25 °C
29BJE/UNM:	Bjerrum, N.; Unmack, A.; "Elektrometrische Messungen mit Wasserstoffelektroden in Mischungen von Sauren und Basen mit Salzen"; Mat.-Fys. Medd.-K. Dan. Vidensk. Selsk.; *9, No. 1, 1 (1929)	Kk, 18 to 37 °C

20BLA:	Blanc, E.; "Determination de la constante de dissociation de quelques acides mineraux"; J. Chim. Phys.; *18, 28 (1920)	Kk, 18 and 25 °C
05BOS:	Bose, E.; "Bemerkungen uber Julius Thomsens Messungen der Mischungswarmen von Sauren"; Phys. Z.; *6, 548 (1905)	Hm, T = ?
27BRI:	Britton, H. T. S.: "Electrometric study of the precipitation of phosphates"; J. Chem. Soc.; *1927, 614 (1927)	Kk, 20 °C
32BRI/ROB:	Britton, H. T. S.; Robinson, R. A.; "The use of the glass electrode in titrimetric work and precipitation reactions. The application of the principle of the solubility product to basic precipitates"; Trans. Faraday Soc.; *28, 531 (1932)	Kk, 18 °C
61BRU/NEL:	Bruckenstein, S.; Nelson, D. C.; "Acid-base dissociation constants in 1.0 M sodium chloride"; J. Chem. Eng. Data; *6, 605 (1961)	Kk, 25 °C
63CAD:	Cadiot-Smith, M.; "Contribution a l'etude des complexes metalliques de la triethanolamine. III. Cadmium"; J. Chim. Phys.; *60, 991 (1963)	Kk, 25 °C
00CHA/FRA:	Chambers, V. J.; Frazer, J. C. W.; "On a minimum in the molecular lowering of the freezing-point of water, produced by certain acids and salts"; Am. Chem. J.; *23, 512 (1900)	Px, 0 °C
55CHE/DAV:	Cher, M.; Davidson, N.; "The kinetics of the oxygenation of ferrous iron in phosphoric acid solution"; J. Am. Chem. Soc.; *77, 793 (1955)	Kk, 30 °C, in 1.0 M $NaCl O_4$
69CHI:	Childs, C. W.; "Equilibria in dilute aqueous solutions of orthophosphates"; J. Phys. Chem.; *73, 2956 (1969)	Kk, 37 °C
70CHI:	Childs, C. W.; "A potentiometric study of equilibria in aqueous divalent metal orthophosphate solutions"; Inorg. Chem.; *9, 2465 (1970)	Kk, 37 °C

67CHR/HAN: Christensen, J. J.; Hansen, L. D.; Izatt, R. M.; Partridge, J. A.; "Application de la calormetrie de la titration thermometrique de haute precision a plusieurs systemes chimiques"; Colloq. Int. C. N. R. S.; *No. 156, 207 (1967) — Hr, Kk, 25 °C

62CHR/IZA: Christensen, J. J.; Izatt, R. M.; "Thermodynamics of proton dissociation in dilute aqueous solution. II. Heats of proton dissociation from ribonucleotides and related compounds determined by a thermometric titration procedure"; J. Phys. Chem.; *66, 1030 (1962) — Hr, Kk, 25 °C

66CHR/IZA: Christensen, J. J.; Izatt, R. M.; Hansen, L. D.; Partridge, J. A.; "Entropy titration. A calorimetric method for the determination of ΔG, ΔH, and ΔS from a single thermometric titration"; J. Phys. Chem.; *70, 2003 (1966) — Hr, Kk, 25 °C

27COH: Cohn, E. J.; "The activity coefficients of the ions in certain phosphate solutions. A contribution to the theory of buffer action"; J. Am. Chem. Soc.; *49, 173 (1927) — Za, Kk, 25 °C

67COR/OUW: Cordfunke, E. H. P.; Ouweltjes, W.; "Heats of formation of Ag_3PO_4 and Ag_3AsO_4"; Rec. Trav. Chim.; *86, 93 (1967) — Hr, 25 °C

55CUT/POL: Cuta, F.; Polej, B.; "Druha disociani konstanta kyseliny fosforecne od 60° do 90 °C"; Chem. Listy; *49, 473 (1955) — Kk, 60 to 90 °C

1893DIE: Dieterici, C.; "Ueber die Dampfdrucke wasseriger Losungen bei 0 °C"; Ann. Phys. (Leipzig); *50, 47 (1893) — Px, 0 °C

61DRO/KRY: Drozdov, N. S.; Krylov, V. P.; "On the dissociation constants of weak acids"; Zh. Fiz. Khim.; *35, 2557 (1961) — Kk, 20 °C

59DUM: Dumbaugh, W. H., Jr.; "Thermometric titrations involving proton transfer processes"; Ph.D. Thesis, Pennsylvania State Univ. (1959); Diss. Abstr.; *20, 1559 (1959) — Hr, Kk, 25 °C

57DUR/STU:	Durell, J.; Sturtevant, J. M.; "The synthesis of methionine by enzymic transmethylation II. Enthalpy change in the methyl-transfer from dimethylacetothetin"; Biochim. Biophys. Acta; *26, 282 (1957)	Hr, 25 °C, I = 0.15 to 0.20 mol kg^{-1}
58EGA/LUF:	Egan, E. P., Jr.; Luff, B. B.; Wakefield, Z. T.; "Heat capacity of phosphoric acid solutions, 15 to 80 °C"; J. Phys. Chem. *62, 1091 (1958)	Ql, 15 to 80 °C
61EGA/LUF:	Egan, E. P., Jr.; Luff, B. B.; "Heat of solution of orthophosphoric acid"; J. Phys. Chem.; *65, 523 (1961)	Hm, 25 °C
62EGA/LUF:	Egan, E. P., Jr.; Luff, B. B.; "Partial molal heat contents and free energies in phosphoric acid solutions"; J. Chem. Eng. Data; *7, 385 (1962)	Za, Hm, 15 to 80 °C, 5 to 85 wt. %
57EGA/WAK:	Egan, E. P., Jr.; Wakefield, Z. T.; "Low temperature heat capacity and entropy of crystalline orthophosphoric acid"; J. Phys. Chem.; *61, 1500 (1957)	Ql, 10 to 300 K
61EGA/WAK:	Egan, E. P., Jr.; Wakefield, Z. T.; Luff, B. B.; "Low temperature heat capacity, entropy and heat of formation of crystalline and colloidal ferric phosphate dihydrate"; J. Phys. Chem.; *65, 1265 (1961)	Hm, 25 °C
61ELL/AND:	Ellis, A. J.; Anderson, D. W.; "The effect of pressure on the first acid dissociation constants of 'sulphurous' and phosphoric acids"; J. Chem. Soc.; *1961, 1765 (1961)	Kk, 25 °C, 1 to 2000 atm
58ELL/SHA:	Elliot, J. S.; Sharp, R. F.; Lewis, L.; "The apparent dissociation constants of phosphoric acid at 38° at ionic strengths from 0.1 to 0.5"; J. Phys. Chem.; *62, 686 (1958)	Kk, 38 °C, I = 0.1 to 0.5 mol kg^{-1}
65ELM/HAT:	Elmore, K. L.; Hatfield, J. D.; Dunn, R.L.; Jones, A.D.; "Dissociation of phosphoric acid solutions at 25 °C"; J. Phys. Chem.; *69, 3520 (1965)	Da, Kk, 25 °C, 0.1 to 10 mol kg^{-1}

46ELM/MAS:	Elmore, K. L.; Mason, C. M.; Christensen, J. H.; "Activity of orthophosphoric acid in aqueous solution at 25° from vapor pressure measurements"; J. Am. Chem. Soc.; *68, 2528 (1946)	Pv, Da, 25 °C, 0.16 to 8.7 mol kg^{-1}
57END/TEL:	Ender, F.; Teltschik, W.; Schafer, K.; "Elektrochemische und thermodynamische Untersuchungen von Phosphatpuffern in Wasser-Methanolgemischen"; Z. Elektrochem.; *61, 775 (1957)	Kk, 25 to 60 °C
39EVE/WYN:	Everett, D. H.; Wynne-Jones, W. F. K.; "The thermodynamics of acid-base equilibria"; Trans. Faraday. Soc.; *35, 1380 (1939)	Zc, Kk, 298.15 K
50FAR:	Farr, T. D.; "Phosphorus: properties of the element and some of its compounds"; Tenn. Val. Auth. Chem. Eng. Rep.; *No. 8, 93 pp (1950)	Zc, Hr, Pt, Pp, Kk, Ql, 25 °C
76FER:	Ferroni, G.; "Potentiometric studies on association and dissociation equilibria of orthophosphoric acid, in water-KCl 3M medium, at 25 °C"; Electrochim. Acta; *21, 283 (1976)	Kk, 25 °C, in 3 M KCl
78FLY/KOR:	Flyantikova, G. V.; Korolenko, L. I.; "A general method for the calculation of the thermodynamic ionization constants of tri-basic acids"; Zh. Fiz. Khim.; *52, 2760 (1978)	Kk, 25 °C
51FON:	Fontana, B. J.; "The vapor pressure of water over phosphoric acids"; J. Am. Chem. Soc.; *73, 3348 (1951)	Pv, 35 to 280 °C
1899FOS:	Foster, W., Jr.; "The conductivity and dissociation of some electrolytes"; Phys. Rev.; *8, 257 (1899)	Xd, Kk, 18 °C, m = 0.001 to 1.00
60FRA/SIN:	Franzosini, P.; Sinistri, C.; Ajroldi, G.; "Criometrie in eutettico ghiaccio-nitrato potassico. Nota II"; Ric. Sci.; *30, 1707 (1960)	Px, Kk, 0 °C
81GAM:	Gamble, D. S.; "Orthophosphoric acid: calculation of concentration quotients for the first ionization equilibrium at 25.0 °C."; Can. J. Chem.; *59, 1630 (1981)	Za, Kk, 25 °C

64GAR/BAT:	Gary, R.; Bates, R. G.; Robinson, R. A.; "Second dissociation constant of deuteriophosphoric acid in deuterium oxide from 5 to 50°. Standardization of a pD scale"; J. Phys. Chem.; *68, 3806 (1964)	Kk, 5 to 50 °C, in D_2O
79GHO/GHO:	Ghosh, A. K.; Ghosh, J. C.; Prasad, B.; "Second dissociation constant of phosphoric acid: a recalculation from alkaline solutions using modified Davies equation"; J. Indian Chem. Soc.; *56, 489 (1979)	Za, Kk, 0 to 50 °C
80GHO/GHO:	Ghosh, A. K.; Ghosh, J. C.; Prasad, B.; "Third dissociation constant of phosphoric acid from 283.15 K to 323.15 K"; J. Indian Chem. Soc.; *57, 1194 (1980)	Za, Kk, 283.15 to 323.15 K
82GHO/GHO:	Ghosh, A. K.; Ghosh, J. C.; "First dissociation constant of phosphoric acid at a number of temperatures"; J. Indian Chem. Soc.; *59, 745 (1982)	Za, Kk 0 to 50 °C
03GIR:	Giran, H.; "Thermochimie. -Sur la chaleur de combustion du phosphore et sur les anhydrides phosphoriques"; Compt. Rend.; *136, 550 (1903)	Hr, T = ?, solution of P_2O_5
03GIR2:	Giran, H.; "Recherches sur le phosphore et les acides phosphoriques"; Ann. Chim. Phys.; *30, 203 (1903)	Hr, T = ?
60GLA/LON:	Glasoe, P. K.; Long, F. A.; "Use of glass electrodes to measure acidities in deuterium oxide"; J. Phys. Chem.; *64, 188 (1960)	Kk, 25 °C, in D_2O
59GRE/THO:	Greenwood, N. N.; Thompson, A.; "The mechanism of electrical conduction in fused phosphoric and trideuterophosphoric acids"; J. Chem. Soc.; *1959, 3485 (1959)	Kk, 25 to 60 °C
40GRI/MCK:	Griffith, R. O.; McKeown, A.; "Kinetics of the reaction of iodine with phosphorous acid and with phosphites"; Trans. Faraday Soc.; *36, 766 (1940)	Kk, 18 and 45 °C, $I = 0.56$ mol kg^{-1}

58GRZ:	Grzybowski, A. K.; "The standard potential of the calomel electrode and its application in accurate physicochemical measurements. II. Thermodynamics of the second ionization of orthophosphoric acid"; J. Phys. Chem.; *62, 555 (1958)	Kk, 5 to 50 °C
34GUG/SCH:	Guggenheim, E. A.; Schindler, T. D.; "Studies of cells with liquid-liquid junctions. V Standards for hydrogen ion measurements and the second dissociation constant of phosphoric acid"; J. Phys. Chem.; *38, 533 (1934)	Kk, 25 °C
30HAH/KLO:	Hahn, F. L.; Klockmann, R.; "Die hoheren Dissoziationsstufen der Phosphorsaure und der Borsaure"; Z. Phys. Chem.; *151A, 80 (1930)	Za, Kk, 25 °C
65HAN/CHR:	Hansen, L. D.; Christensen, J. J.; Izatt, R. M.; "Entropy titration. A calorimetric method for the determination of $\Delta G°$ (K), $\Delta H°$ and $\Delta S°$"; Chem. Commun.; *No. 3, 36 (1965)	Hr, Kk, 25 °C
34HAR/EMB:	Harned, H. S.; Embree, N. D.; "The temperature variation of ionization constants in aqueous solutions"; J. Am. Chem. Soc.; *56, 1050 (1934)	Kk, 10 to 50 °C
58HAR/OWE:	Harned, H. S.; Owen, B. B.; 'The physical chemistry of electrolyte solutions'; 3rd edition, Reinhold Publishing Corp., New York; p. 315 (1968)	Zr, Ke, Kk, 25 °C
74HAV/HOG:	Havel, J.; Hogfeldt, E.; "On some phosphate equilibria. V. The system magnesium-phosphoric acid in 3 M (Na, Mg)$C\ell O_4$"; Chem. Scr.; *5, 164 (1974)	Kk, 25 °C
70HEA/LEW:	Head, A. J.; Lewis, G. B.; "Thermodynamic properties of phosphorus compounds 3. The enthalpy of formation of aqueous orthophosphoric acid"; J. Chem. Thermodyn.; *2, 701 (1970)	Hr, 50 °C
62HOL:	Holmes, W. S.; "Heat of combustion of phosphorus and the enthalpies of formation of P_4O_{10} and H_3PO_4"; Trans. Faraday Soc.; *58, 1916 (1962)	Hr, Hm, 25 °C

61IRA/CAL:	Irani, R. R.; Callis, C. F.; "Metal complexing by phosphorus compounds. IV. Acidity constants"; J. Phys. Chem.; *65, 934 (1961)	Kk, 25 °C, I= 1.0 mol kg^{-1}
66IRA/TAU:	Irani, R. R.; Taulli, T. A.; "Metal complexing by phosphorus compounds-IX. Thermodynamics of ionization of ortho-, pyro- and tripolyphosphoric acids"; J. Inorg. Nucl. Chem.; *28, 1011 (1966)	Kk, Hr, 25 °C
67IRV/MCK:	Irving, R. J.; McKerrell, H.; "Standard heat of formation of aqueous orthophosphoric Acid"; Trans. Faraday Soc.; *63, 2582 (1967)	Hr, 25 °C
73IVA/VOR:	Ivakin, A. A.; Voronova, E. M.; "Equilibrium in solutions of orthophosphoric acid"; Zh. Neorg. Khim.; *18, 885 (1973)	Kk, 25 °C
75IVA/VOR:	Ivakin, A. A.; Voronova, E. M.; Kurbatova, L. D.; "A spectrophotometric study of the formation of vanadium (IV) complexes with orthophosphoric acid"; Zh. Neorg. Khim.; *20, 1246 (1975)	Kk, 25 °C, I = 1.0 mol kg^{-1}
59JAM:	Jameson, R. F.; "The composition of the 'strong' phosphoric acids"; J. Chem. Soc.; *1959, 752 (1959)	Kk, 0 to 80 °C
1885JOL:	Joly, A.; "Sur un hydrate cristallise de l'acide phosphorique"; Compt. Rend.; *100 , 447 (1885)	Hm, 13 °C
1886JOL:	Joly, A.; "Sur les produits de decomposition de l'acide hypophosphorique"; Compt. Rend.; *102, 760 (1886)	Hr, 70 °C
1893JON:	Jones, H. C.; "Uber die Bestimmung des Gefrierpunktes von verdunnten Losungen einiger Sauren, Alkalien, Salze und organischen Verbindungen"; Z. Phys. Chem. (Leipzig); *12, 623 (1893)	Px, 0 °C
03JON/GET:	Jones, H. C.; Getman, F. H.; "The molecular-lowering of the freezing-point of water produced by concentrated solutions of certain electrolytes"; Z. Phys. Chem. (Leipzig); *46, 244 (1903)	Px, 0 °C

04JON/GET:	Jones, H. C.; Getman, F. H.; "Hydrates in solution"; Am. Chem. J.; *31, 322 (1904)	Px, 0 °C
07JON/GET:	Jones, H. C.; Getman, F. H.; Bassett; H. P.; McMaster, L.; Uhler, H. S.; "Hydrates in aqueous solution. Evidence for the existence of hydrates in solution, their approximate composition, and certain spectroscopic investigations bearing upon the hydrate problem"; Carnegie Inst. Washington Publ.; *No. 60, 145 pp.(1907)	Px, 0 °C
70JON/LEE:	Jones, G. P.; Lee, D. A.; "The enthalpy of dilution of concentrated orthophosphoric acid"; J. Chem. Thermodyn.; *2, 760 (1970)	Hm, 25 °C
59JOR/DUM:	Jordan, J.; Dumbaugh, W. H., Jr.; "Enthalpies and entropies of ionization of acids in aqueous solution": Bull. Chem. Thermo.; No. *2, 9 (1959)	Hr, 25 °C
29JOW/MIL:	Jowett, M.; Millet, H.; "The ionization constants of phosphoric acid"; J. Am. Chem. Soc.; *51, 1004 (1929)	Kk, 25 and 37.5 °C
32JOW/PRI:	Jowett, M.; Price, H. I.; "Solubilities of the phosphates of lead"; Trans. Faraday Soc.; *28, 668 (1932)	Kk, 37.5 °C
35KAB/ZAG:	Kablukov, I. A.; Zagwosdkin, K. I.; "Die Dampfspannungen der Phosphorsaurelosungen"; Z. Anorg. Allgem. Chem.; *224, 315 (1935)	Pv, 25 to 80 °C
58KER/ESP:	Kerker, M.; Espenscheid, W. F.; "Transference number of phosphoric acid by the e.m.f. method"; J. Am. Chem. Soc.; *80, 776 (1958)	Ke, 25 °C
58KIN/DAV:	King, J.; Davidson, N.; "Kinetics of the ferrous iron-oxygen reaction in acidic phosphate-pyrophosphate solutions"; J. Am. Chem. Soc.; *80, 1542 (1958)	Kk, 25 °C
1885KOH:	Kohlrausch, F.; "Ueber das Leitungsvermogen einiger Electrolyte in ausserst verdunnter wasseriger Losung"; Ann. Phys. (Leipzig); *26, 163 (1885)	Kk, 18 °C

20KOL:	Kolthoff, I. M.; "De Beteekenis der Dissociatieconstanten bij de Identificatie van Zuren en het Opsporen van Verontreinigingen"; Pharm. Weekbl.; *57, 514 (1920)	Kk, T=?, 0.1 mol kg^{-1}
27KOL:	Kolthoff, I. M.; "Die Dissoziationskonstanten der Unterphosphorigen Saure, der Phosphorigen Saure und der Phosphorsaure"; Rec. Trav. Chim. Pays-Bas.; *46, 350 (1927)	Kk, 18 °C
49KON/LEB:	Konopík, N.; Leberl, O.; "Dissoziationskonstanten sehr schwacher Sauren. (Kolorimetrische pH-Bestimmung im Bereich 10 bis 15. III. Mitteilung)"; Monatsh. Chem.; *80, 655 (1949)	Zc, Kk, 25 °C
29KUG:	Kugelmass, I. N.; "LXVII. The determination of the tertiary dissociation constant of phosphoric acid"; Biochem. J.; *23, 587 (1929)	Kk, 20 and 38 °C
42LAN/KIE:	Lanford, O. E.; Kiehl, S. J.; "A study of the reaction of ferric ion with orthophosphate in acid solution with thiocyanate as an indicator for ferric ions"; J. Am. Chem. Soc.; *64, 291 (1942)	Kk, 30 °C, I = 0.665 mol kg^{-1}
50LAR:	Larson, W. D.; "The activity coefficients of the undissociated part of weak acids. III Orthosphosphoric acid", J. Phys. Chem; *54, 310 (1950)	Kk, Da, 25 °C
69LAR/HEP:	Larson, J. W.; Hepler, L. G.; Coetzee, J. F. (ed.); Ritchie, C.D. (ed.); 'Solute-Solvent Interactions'; M. Dekker, New York; p. 1 (1969)	Kk, 25 °C
82LAR/ZEE:	Larson, J. W.; Zeeb, K. G.; Hepler, L. G.; "Heat capacities and volumes of dissociation of phosphoric acid (1st, 2nd, and 3rd), bicarbonate ion, and bisulfate ion in aqueous solution"; Can. J. Chem.; *60, 2141 (1982)	Ql, Dm, 25 °C
38LAT/PIT:	Latimer, W. N.; Pitzer, K. S.; Smith, W. V.; "The entropies of aqueous ions"; J. Am. Chem. Soc.; *60, 1829 (1938)	Za, 25 °C
1893LOO:	Loomis, E. H.; "Ueber ein exacteres Verfahren bei der Bestimmung von Gefrierpunktserniedrigungen"; Ber. Dtsch. Chem. Ges.; *26, 797 (1893)	Px, 0 °C

1894LOO:	Loomis, E. H.; "Ueber ein exacteres Verfahren bei der Bestimmung von Gefrierpunktserniedrigungen"; Ann. Phys. (Leipzig); *51, 500 (1894)	Px, 0 °C
1894LOO2:	Loomis, E. H.; "On the freezing-points of dilute solutions. II"; Phys. Rev.; *1, 274 (1894)	Px, 0 °C
1896LOO:	Loomis, E. H.; "On the freezing-points of dilute aqueous solutions"; Phys. Rev.; *3, 270 (1896)	Px, 0 °C
1896LOO2:	Loomis, E. H.; "Ueber den Gefierpunkt verdunnter wasseriger Losungen"; Ann. Phys. (Leipzig); *57, 495 (1896)	Px, 0 °C
1897LOO:	Loomis, E. H.; "The freezing-points of dilute aqueous solutions. III"; Phys. Rev.; *4, 273 (1897)	Px, 0 °C
1897LOO2:	Loomis, E. H.; "Der Gefrierpunkt verdunnter wasseriger Losungen III"; Ann. Phys. (Leipzig); *60, 523 (1897)	Px, 0 °C
81LUF:	Luff, B. B.; "Heat capacity and enthalpy of phosphoric acid"; J. Chem. Eng. Data; *26, 70 (1981)	Ql, 25 - 367 °C
71LUF/REE:	Luff, B. B.; Reed, R. B.; Wakefield, Z. T.; "Enthalpy of dilution of superphosphoric acids"; J. Chem. Eng. Data; *16, 342 (1971)	Hm, 40 °C
78LUF/REE:	Luff, B. B.; Reed, R. B.; "Enthalpy of formation of pentaammonium triphosphate monohydrate, $(NH_4)_5P_3O_{10}\cdot P_3O_{10}\cdot H_2O$"; J. Chem. Eng. Data; *23, 192 (1978)	Hm, 25 and 40 °C
31LUG:	Lugg, J. W. H.; "Recalculations of the first dissociation constant of phosphoric acid in aqueous solution at 18°, and incidental determination of the activity coefficients of the undissociated acid molecules"; J. Am. Chem. Soc.; *53, 1 (1931)	Kk, Da, 18 °C

31LUG2:	Lugg, J. W. H.; "A study of aqueous salt solutions in equilibrium with solid secondary calcium phosphate at 40 °C"; Trans. Faraday Soc.; *27, 297 (1931)	Kk 23.5 °C
69MAC/BOY:	MacDonald, D. I.; Boyack, J. R.; "Density, electrical conductivity, and vapor pressure of concentrated phosphoric acid"; J. Chem. Eng. Data; *14, 380 (1969)	Kk, Pv, Xd, 25 to 170 °C, 77 to 102 wt. %
58MAD:	Mader, P. M.; "Kinetics of the hydrogen peroxide-sulfite reaction in alkaline solution"; J. Am. Chem. Soc.; *80, 2634 (1958)	Kk, 25 °C
58MAH/BUR:	Mahler, W.; Burg, A. B.; "The cyclopolyphosphines $(CF_3P)_4$ and $(CF_3P)_5$, and related chemistry"; J. Am. Chem. Soc.; *80, 6161 (1958)	Kk, T= ?
69MAK/KON:	Makitie, O.; Konttinen, V.; "Comparison of acid strengths of orthophosphoric acid, thiophosphoric acid, phenylphosphonic acid, and monophenyl phosphate in aqueous potassium chloride solutions"; Acta Chem. Scand.; *23, 1459 (1969)	Kk, 25 °C, $I^{1/2}$ = 0.098 to 1.401 mol kg^{-1}
72MAN/RAM:	Manning, P. G.; Ramamoorthy, S.; "Formation and stabilities of mixed-ligand (NTA and phosphate) complexes of Ca^{2+} and Cu^{2+}"; Inorg. Nucl. Chem. Lett.; *8, 653 (1972)	Kk, 25 °C, 1.0 M ($NaClO_4$)
47MAS/BLU:	Mason, C. M.; Blum, W. M.; "Activity of orthophosphoric acid in aqueous solutions at 25° from e.m.f. measurements with the lead amalgam-lead phosphate electrode"; J. Am. Chem. Soc.; *69, 1246 (1947)	Da, Kk, 25 °C, 0.001 to 0.1 mol kg^{-1}
49MAS/CUL:	Mason, C. M.; Culvern, J. B.; "Electrical conductivity of orthophosphoric acid and of sodium and potassium dihydrogen phosphates at 25°"; J. Am. Chem. Soc.; *71, 2387 (1949)	Kk, Da, 25 °C, 0.1 to 10 mol kg^{-1}
62MCD/LON:	McDougall, A. O.; Long, F. A.; "Relative hydrogen bonding of deuterium. II. Acid ionization constants in H_2O and D_2O"; J. Phys. Chem.; *66, 429 (1962)	Da, Kk, 25 °C

65MED/BER: Medvedev, V. A.; Bergman, G. A.; Gurvich, L. V.; Yungman, V. S.; Vorob'ev, A. F.; Kolesov, V. P. and others; Glushko, V. P., (ed.); 'Thermal constants of substances'; (volumes 1 to 10) VINITI, Moscow; (1965 to 1982) — Ze, Hm, 25 °C

76MEL/FER: Melardi, M. R.; Ferroni, G.; Galea, J.; "Etude Potentiometrique des equilibres d'association et de dissociation de l'acide orthophosphorique en milieu eau-chlorurew de sodium a' 25 °C, pour un taux de neutralisation compris 0 et 3"; Bull. Soc. Chim. Fr.; Part 1, 1004 (1976) — Kk, 25 °C

74MES/BAE: Mesmer, R. E.; Baes, C. F., Jr.; "Phosphoric acid dissociation equilibria in aqueous solutions to 300 °C"; J. Solution Chem.; *3, 307 (1974) — Kk, 0 to 300 °C, up to 1.0 M KCl

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78MES/HER: Mesmer, R. E.; Herting, D. L.; "Thermodynamics of ionization of D_2O and $D_2PO_4^-$"; J. Solution Chem.; *7, 901 (1978) — Kk, 50 to 300 °C, 0.2 M KCl

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14MIC/GAR: Michaelis, L.; Garmendia, T.; "Die zweite Dissoziationskonstante der Phosphorsaure"; Biochem. Z.; *67, 431 (1914) — Kk, 25 °C

21MIC/KRU: Michaelis, L.; Kruger, R.; "Weitere Ausarbeitung der Indikatorenmethode ohne Puffer"; Biochem. Z.; *119, 307 (1921) — Kk, 16 to 20 °C

25MIC/MIZ: Michaelis, L.; Mizutani, M.; "Die Dissoziation der schwachen Elektrolyte in wasserig-alkoholischen Losungen"; Z. Phys. Chem.; *116, 135 (1925) — Da, Kk, 16 and 19 °C

78MIL/DUE: Millero, F. J.; Duer, W. C.; Shepard, E.; Chetirkin, P. V.; "The enthalpies of dilution of phosphate solutions at 30 °C"; J. Solution Chem.; *7, 877 (1978) — Kk, Hm, 30 °C, 0.1 to 1.0 mol kg^{-1}

78MON/AMI: Monk, C. B.; Amira, M. F.; "Electromotive force studies of electrolytic dissociation. Part 12. Dissociation constants of some strongly ionising acids at zero ionic strength and 25 °C"; J. Chem. Soc. Faraday Trans. I; *74, 1170 (1978) — Kk, 25 °C

30MOR:	Morton, C.; "Glass electrode studies: I. Some oxy-acids of phosphorus"; Q. J. Pharm. Pharmacol.; *3, 438 (1930)	Kk, 18 °C, 0.1 M
33NIM:	Nims, L. F.; "The second dissociation constant of phosphoric acid from 20 to 50°"; J. Am. Chem. Soc.; *55, 1946 (1933)	Kk, 20 to 50 °C, I = 0.0 to 0.166 mol kg^{-1}
34NIM:	Nims, L. F.; "The first dissociation constant of phosphoric acid from 0 to 50°"; J. Am. Chem. Soc.; *56, 1110 (1934)	Kk, 0 to 50 °C, I = 0 to 0.1 mol kg^{-1}
10NOY/MEL:	Noyes, A. A.; Melcher, A. C.; Cooper, H. C.; Eastman, G. W.; "The conductivity and ionization of salts, acids, and bases in aqueous solutions at high temperatures"; Z. Phys. Chem.; *70, 335 (1910)	Ze, Kk, 18 to 156 °C
65PAA/ROB:	Paabo, M.; Robinson, R. A.; Bates, R. G.; "Reference Buffer solutions for pH measurements in 50% methanol. Dissociation constants of acetic acid and dihydrogen phosphate ion from 10 to 40°"; J. Am. Chem. Soc.; *87, 415 (1965)	Kk, 10 to 40 °C
78PAV/KRY:	Pavlyuk, L. A.; Kryukov, P. A.; "Spectrophotometric determination of the first and of the second ionization constants of phosphoric acid from 25 to 175 °C"; Izv. Sib. Otd, Akad. Nauk SSSR, Ser. Khim. Nauk; *No. 6, 88 (1978)	Kk, 25 to 175 °C
69PEA/NIC:	Peacock, C. J.; Nickless, G.; "The dissociation constants of some phosphorus (V) acids"; Z. Naturforsch.; *24A, 245 (1969)	Kk, 0.2 to 50.0 °C, 0.5 mol L^{-1}
1893PET:	Petersen, E.; "Uber die Dissociationswarme einiger Sauren"; Z. Phys. Chem. (Leipzig); *11, 174; (1893)	Hm, 21 °C
71PET:	Pettersson, L.; "Multicomponent polyanions. I. On yellow and colourless molybdophosphates in 3 M $Na(ClO_4)$. A determination of formation constants for three colourless pentamolybdodiphosphates in the pH-range 3-9";. Acta Chem. Scand.; *25, 1959 (1971)	Kk, 25 °C, 3 M $Na(ClO_4)$

37PIT:	Pitzer, K. S.; "The heats of ionization of water, ammonium hydroxide, carbonic, phosphoric, and sulfuric acids. The variation of ionization constants with temperature and the entropy change with ionization"; J. Am. Chem. Soc.; *59, 2365 (1937)	Hr, Kk, 25 °C, 1 M HCl
79PIT:	Pitzer, K. S.; "Theory: Ion interaction approach"; Pytkowicz, R. M. (ed.); 'Activity coefficients in electrolyte solutions'; CRC Press, Boca Raton; *Vol. 1, p. 198 (1979)	Zr, Da, Kk, 25 °C
76PIT/SIL:	Pitzer, K. S.; Silvester, L. F.; "Thermodynamics of electrolytes. VI. Weak electrolyes including H_3PO_4"; J. Solution Chem.; *5, 269 (1976)	Ze, Da, Kk, 25 °C, 0 to 6 M
75PLA:	Platford, R. F.; "Thermodynamics of aqueous soltuions of ortho-phosphoric acid from the freezing point to 298.15 K"; J. Solution Chem.; *4, 591 (1975)	Da, 273.15 and 298.15 K, 10^{-4} to 15 mol kg^{-1}
76PLA:	Platford, R. F.; "Thermodynamics of the system H_2O-NaH_2PO_4-H_3PO_4"; J. Chem. Eng. Data; *21, 468 (1976)	Da, Dx, 273.15 and 298.15 K, 0 to 9 mol kg^{-1}
33POP/SKU:	Popoff, M. M.; Skuratoff, S. M.; Feodossjeff, N. N.: "Bestimmung der spezifischen Warme wasseriger Losungen der Phosphorsaure"; Z. Phys. Chem. Abt. A; *167A, 42 (1933)	Ql, 22 to 100 °C
79PRE/ADA:	Preston, C. M.; and Adams, W. A.; "A laser raman spectroscopic study of aqueous orthophosphate salts"; J. Phys. Chem.; *83, 814 (1979)	Kk, T = ?, 0.005 to 6 M
24PRI/WAR:	Prideaux, E. B. R.; Ward, A. T.; "The dissociation constants of phosphoric acid"; J. Chem. Soc.; *125, 423 (1924)	Za, Da, Kk, T = ?
59ROB/STO:	Robinson, R. A.; Stokes, R. H.; 'Electrolyte solutions'; Second edition revised, Butterworths, London; 520 (1959)	Ze, Kk, 25 °C

03ROT/DRU:	Rothmund, V.; Drucker, K.; "Uber die elektrolytische Dissociation der Pikrinsaure"; Z. Phys. Chem.; *46, 827 (1903)	Px, 0 °C
07RUM:	Rumelin, G.; "Uber die Verdunnungswarme konzentrierter Losungen"; Z. Phys. Chem. (Leipzig); *58, 449 (1907)	Hm, 25 °C
69SAL/HAK:	Salomaa, P.; Hakala, R.; Vesala, S.; Aalto, T.; "Solvent deuterium isotope effects on acid-base reactions. Part III. Relative acidity constants of inorganic oxyacids in light and heavy water. Kinetic applications"; Acta Chem. Scand.; *23, 2116 (1969)	Kk, 25 °C
64SAL/SCH:	Salomaa, P.; Schaleger, L. L.; Long, F. A.; "Solvent deuterium isotope effects on acid-base equilibria"; J. Am. Chem. Soc.; *86, 1 (1964)	Kk, 25 °C
70SCH:	Schmalz, E. O.; "Bestimmung der Dampfdrukkurven von Wasser uber Phosphorsauren"; Z. Phys. Chem. (Leipzig); *245, 344 (1970)	Pv, 30 to 170 °C, 85.7 to 103.4 wt % H_3PO_4
36SCH/EPP:	Schwarzenbach, G.; Epprecht, A.; Erlenmeyer, H.; "Uber Dissoziation-skonstanten in Wasser und Deuteriumoxyd. Messungen mit der Deuteriumelektrode"; Helv. Chim. Acta; *19, 1292 (1936)	Kk, 20 °C
63SCH/GEI:	Schwarzenbach, G.; Geier, G.; "Die Raschacidifierung und -alkalisierung von Vanadaten"; Helv. Chim. Acta; *46, 906 (1963)	Kk, 20 °C, I = 0.1 M $NaClO_4$
74SCH/PRO:	Schumm, R. H.; Prosen, E. J.; Wagman, D. D.; "Enthalpy of formation of phosphorus pentachloride; derivation of the enthalpy of formation of aqueous orthophosphoric acid"; J. Res. Natl. Bur. Stand. Sect A; *78A, 375 (1974)	Ze, Hr, 25 °C
60SCH/VAN:	Schmulbach, C. D.; Van Wazer, J. R.; Irani, R. R.; "Structure and properties of the condensed phosphates. XVI. Pyrophosphate formation in concentrated orthophosphate solutions and its biological implications"; J. Am. Chem. Soc.; *81, 6347 (1960)	Da, Kk, 25 to 110 °C

27SEN/HAS:	Sendroy, J.; Hastings, A. B.; "Studies of the solubility of calcium salts. II. The solubility of tertiary calcium phosphate in salt solutions and biological fluids"; J. Biol. Chem.; *71, 783 (1927)	Za, Kk, 38 °C
69SHA:	Shatkay, A.; "Activity of phosphate ions measured with phosphate electrodes of the second kind"; Anal. Biochem.; *29, 311 (1969)	Da, 20.5 °C
26SHE/NOY:	Sherrill, M. S.; Noyes, A. A.; "The inter-ionic attraction theory of ionized solutes. VI. The ionization and ionization constants of moderately ionized acids"; J. Am. Chem. Soc.; *48, 1861 (1926)	Kk, 18 °C, I = 0.0 to 1.0 mol kg^{-1}
39SHI:	Shima, K.; "On the numerical value of the second dissociation exponent of phosphoric acid and factors influencing upon it. I. Experimental studies on the dissociation constant of phosphoric acid"; J. Biochem. (Tokyo); *29, 121 (1939)	Kk, 18, 25 and 37 °C
67SIG/BEC:	Sigel, H.; Becker, K.; McCormick, D. B.; "Ternary complexes in solution. Influence of 2,2'-bipyridyl on the stability of 1:1 complexes of Co^{2+}, Ni^{2+}, Cu^{2+}, and Zn^{2+} with hydrogen phosphate, adenosine 5'-monophosphate, and adenosine 5'-triphosphate"; Biochim. Biophys. Acta; *148, 655 (1967)	Kk, 25 °C, I = 0.1 mol kg^{-1}
64SIL/MAR:	Sillen, L. G.; Martell, A. E.; 'Stability constants of metal-ion complexes'; Special Publication No. 17, The Chemical Society, London; 180 (1964)	Zr, Kk, 0 to 156 °C
76SMI/MAR:	Smith, R. M.; Martell, A. E.; 'Critical stability constants'; Plenum Press, New York; *Vol. 4, p. 56 (1976)	Zr, Kk, 25 °C
69SMI/MAT:	Smirnova, E. P.; Matveichuk, N. L.; Mikhailin, A. D.; Illarionov, V. V.; "The heat capacity of polyphosphoric acid and its relationship to its structure"; Dokl. Akad. Nauk SSSR; *189, 344 (1969)	Ql, 25 to 100 °C
44STE:	Stephenson, C. C.; "The entropies of some aqueous ions"; J. Am. Chem. Soc.; *66, 1436 (1944)	Za, Kk, 298.1 K

57THA:	Thamer, B. J.; "Spectrophotometric and solvent-extraction studies of uranyl phosphate complexes"; J. Am. Chem. Soc.; *79, 4298 (1957)	Kk, 24 to 25 °C, I = 1.06 and 1.07 mol kg^{-1}
1883THO:	Thomsen, J.; 'Thermochemische Untersuchungen'; Band III, J. A. Barth, Leipzig; (1883)	Hm, 18 °C
08THO:	Thomsen, J.; 'Thermochemistry'; Longmans, Green & Co., London; p. 495 (1908)	Ze, 18 °C
76TOS:	Tossidis, I.; "Ueber die Dissoziation von Phosphor- und Arsensaeure in Waessrig-organischen Loesungsmitteln"; Inorg. Nucl. Chem. Lett.; *12, 609 (1976)	Kk, 25 °C, I = 0.1 M KCl
78VAL/STA:	Valcu, R.; Staicu, L.; "Determinarea unor marimi termodinamice prin metoda titrarii calorimetrice"; Rev. Chim. (Bucharest); *29, 218 (1978)	Hr, T = ?, 0.01 M
58VAN:	van Wazer, J. R.; 'Phosphorous and its compounds'; Interscience Publishers, New York; (1958)	Ze, T = ?
61VAN/QUI:	Vanderzee, C. E.; Quist, A. S.; "The third dissociation constant of orthophosphoric acid"; J. Phys. Chem.; *65, 118 (1961)	Kk, 25 °C, I = 0.015 to 0.507 mol kg^{-1}
77VAS/KOM:	Vasil'eva, T. V.; Komar, N. P.; "Determination of the activity coefficients of phosphoric acid and the dihydrogen phosphate ion"; Zh. Fiz. Khim.; *51, 985 (1977)	Da, Kk, 25 °C, I = 0.2 to 3.0 mol kg^{-1}
68WAG/EVA:	Wagman, D. D.; Evans, W. H.; Parker, V. B.; Halow, I.; Bailey, S. M.; Schumm, R. H.; 'Selected Values of Chemical Thermodynamic Properties', Nat. Bur. Stand. (U.S.) Tech. Note; 270-3; U. S. Government Printing Office, Washington, DC; 264 pp (1968)	Ze, Hm, Kk, 25 °C
82WAG/EVA:	Wagman, D. D.; Evans, W. H.; Parker, V. B.; Schumm, R. H.; Halow, I.; Bailey, S. M.; Churney, K. L.; Nuttall, R. L.; "The NBS tables of chemical thermodynamic properties"; J. Phys. Chem. Ref. Data; *11, Suppl No. 2, 392 pp. (1982)	Ze, Hm, Kk, 25 °C

72WAK/LUF:	Wakefield, Z. T.; Luff, B. B.; Reed, R. B.; "Heat capacity and enthalpy of phosphoric acid"; J. Chem. Eng. Data; *17, 420 (1972)	Hm, Ql, Qh, 25 to 200 °C, 0 to 100 % P_2O_5
26WAS:	Washburn, E. W., (ed.); 'International critical tables of numerical data physics, chemistry and technology'; McGrawHill, New York; *1, (1926)	Zr, Px, Kk, T=?
29WAS:	Washburn, E. W., ed.; 'International critical tables of numerical data, physics, chemistry and technology'; McGraw Hill, New York; *1 and 6, (1929)	Ze, Px, Kk, 15 to 156 °C, I= 0.1 to 0.0002 mol kg^{-1}
42WEL:	Wells, R. C.; "The third dissociation constant of phosphoric acid and its variation with salt content"; J. Washington Acad. Sci.; *32, 321 (1942)	Kk, 27 °C, 0.04 to 0.64 M
75WOO/PLA:	Wood, R. H.; Platford, R. F.; "Free energies of aqueous mixtures of NaH_2PO_4 and $NaClO_4$: evidence for the species $(H_2PO_4)_2^{-2}$"; J. Solution Chem.; *4, 977 (1975)	Kk, 25 °C
39YUD:	Yudin, I. D.; "The behavior of phosphoric acid solutions as ideal concentrated solutions"; Zh. Fiz. Khim.; *13, 1346 (1939)	Hm, 25 °C

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