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Special Features

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SEWAGE WORKS JOURNAL

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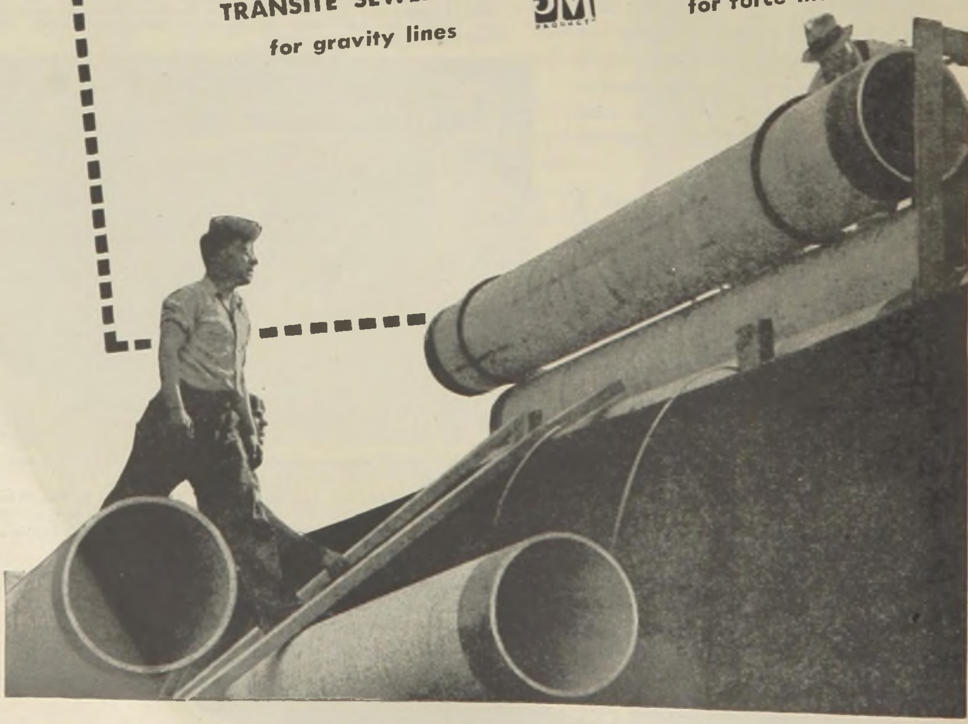

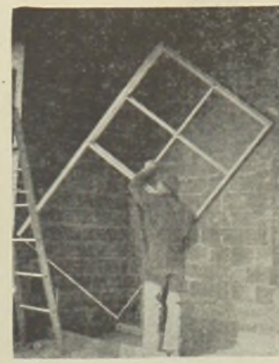

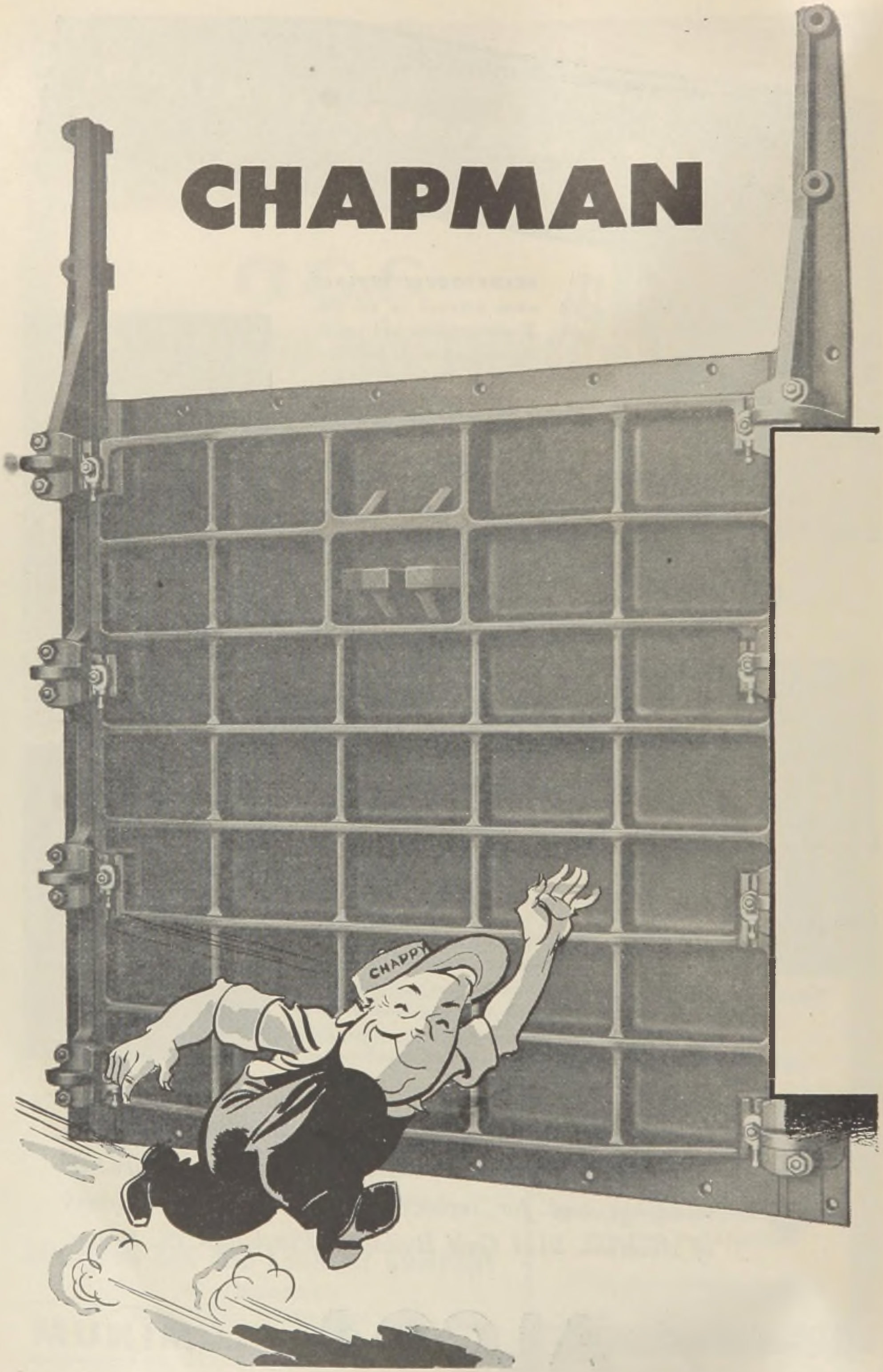
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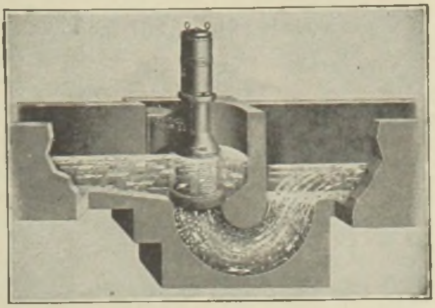

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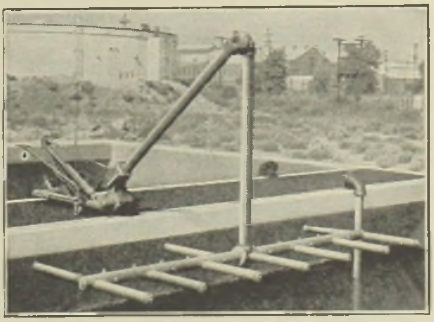

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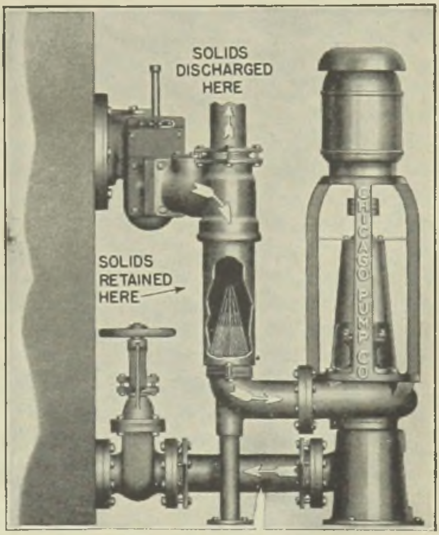

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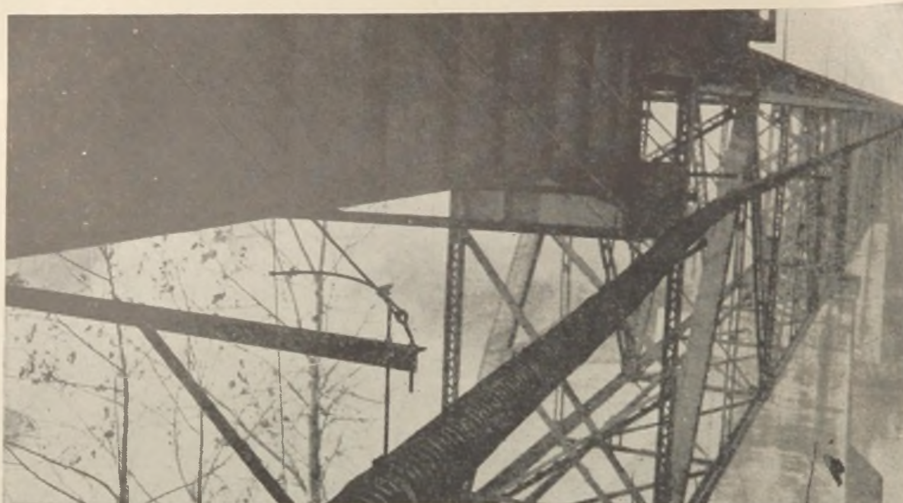

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EXPERIMENTS WITH DDT IN FILTER FLY CONTROL

By William C. Brothers

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For many years investigations have been made of the fauna and flora responsible for the biological activity occurring in rock filters of sewage treatment plants. A compilation of available information relative to these complex processes reveals a paucity of understanding of them. Before all of these activities may be properly correlated it is necessary to divide the general picture into a series of component parts which may be investigated individually. This paper is an attempt to contribute from an entomological standpoint to the knowledge of those members of the insect family *Psychodidae* which are involved in the processes occurring in a trickling filter.

These *Psychoda,* commonly referred to as "filter flies," are usually considered only as a nuisance but occasionally filter fly larvae may develop in sufficient quantity to cause clogging of the bed. In addition, when these fly larvae are excessively numerous they deplete the fungus growth essential to efficient filter operation.

This condition existed in the Aerofilters of the Camp Fannin, Texas, sewage treatment plant during the greater part of 1944. The situation became such that not only was practically all growth consumed from the rocks but the filter bed and pipe lines became clogged. The methods currently used for controlling these fly larvae were: (1) application of caustic soda to the filter, (2) addition of copper sulfate to the sewage and (3) flooding the beds at regular intervals. The latter treatment was the one most commonly used and was probably the most effective but it also had certain undesirable effects. It was noted that each flooding served in reducing the fly population only temporarily and actually contributed to the removal or injury of the remaining filter growth. As a consequence, each flooding was followed by a short period of lowered plant efficiency.

In 1945 an attempt was made to find a control method more convenient in application and less detrimental to efficient operation than the usually prescribed flooding. To this end the new insecticide (dichlorodiphenyl-trichloroethane) usually referred to as "DDT" was utilized. This report presents the information obtained in experiments conducted with DDT between April 2, 1945 and October 8, 1945.

Properties of DDT

Commercial DDT is a white crystalline substance practically insoluble in water but soluble in most organic solvents. Preliminary experimental work with DDT insecticides indicated that this poison produces a delayed toxic reaction upon the insect nervous system. DDT thus differs from most insecticides because the "knockdown" and death of the insect is more rapid where agents such as pyrethrins and rotenone are used. With most insects death does not follow instantly after contact with DDT but ranges from a few minutes to several hours. During this period the typical reaction is for the insect to have rather violent nervous spasms or tremors for short periods of time and then partially recover for a few moments. This procedure is repeated until the tremors become practically incessant, a condition which is followed by death. Thus, after contact with DDT, there usually follows a period often ranging up to several hours before death when the co-ordination of the insect is impaired to such an extent that it is not as destructive as usual. Since death does not always occur immediately after contact with the DDT, but is frequently delayed considerably, this presents a rather radical conception of insecticide reaction.

While DDT has proved to be extremely efficient when used against adult flies, thus far the use of DDT in the control of fly larvae in sludge beds and pit latrines has given rather poor results. Some entomologists attribute this to the fact that the nervous systems of these larvae are not too well developed, so that the toxicity of the DDT is reduced accordingly. Because of these apparently poor results on fly larvae it was not known what effect the DDT would have on *Psychoda* larvae in the filters.

Since DDT is so highly toxic to many insects, considerable discussion arose as to the desirability of its use by humans. It is the belief of the author that to a certain extent its danger has been over-emphasized. During the past two years he has been almost constantly in contact with it and has had many individuals under his supervision also using DDT daily. Ordinary precautions are taken not to have DDT in oil solutions or emulsions in contact with the skin for prolonged periods, but even at this late period no harmful effects have been noted on any individual. It is believed by the author that no plant operator should fear using DDT routinely if he does not permit it to remain in contact with his skin for long periods of time, and does not constantly inhale it.

Since DDT is not soluble in water it was decided that DDT in emulsified form would be most appropriate for application at trickling filters. Use of an emulsion would facilitate a more even distribution of the toxic agent throughout the entire volume of sewage than would a non-soluble powder, or an oil solution which might have a tendency to remain on the top of the water. In addition, it was felt that an emulsion would have less harmful effects on filter growth than would an oil solution.

Preliminary Considerations

The sewage treatment plant at Camp Fannin, Texas, is of a type common to the municipal field. It consists of two standard Imhoff tanks, two Halverson-Smith type Aero-filters with reaction type distributors, followed by two final clarifiers. The sewage flows by gravity through the plant. The sludge from the clarifiers is returned to the Imhoff tanks. Approximately 25 per cent of the final effluent is recirculated through the filters.

The highly toxic nature of DDT demanded that careful consideration be given to its use because of possible deleterious effects which would decrease the efficiency of the treatment plant. No information was available showing the action of DDT on the adult and larval forms of filter flies or on the filter growth, nor was information available to indicate what dosage of DDT might be needed to accomplish larval eradication. Prime consideration also had to be given to the possibility that the DDT and chemicals such as diluents or emulsifiers might reduce the efficiency of the plant to such an extent that their use would be prohibitive. In order to discover the answer to some of these unknown factors the tests were planned to be conservative and safe until more data were obtained.

The first series of experiments was performed on small areas of filters with a comparatively high dosage of DDT, the strength of DDT being governed by the total flow of sewage over the area to be treated. When this did not adversely affect the filter growth or the operation of the plant, it was felt safe to expand the treatment by application of a weak concentration of DDT to an entire filter, and then increase the dosage in accordance with the results obtained.

Characteristics of Filter Flies

Any control measure of necessity had to be governed by the characteristics of the filter flies. This resulted in a close examination of the physical features and habits of the existing larvae.

Present in the filters were two species of filter flies, namely *Psychoda alternata* Say and *Telmatoscopus albipunctatus* (Will). The former is the smaller of the two and in general is pale gray in color. Its larvae also are pale in color and are found in the well-known coarse grayish colored material resembling wet paper, which adheres closely to the filter media and is difficult to remove. As the larvae and pupae within this material develop and increase in numbers, the paper-like material gradually displaces the filter growth on the affected stone. Unmolested larval development will soon allow the larvae to denude the filter media of all growth up to the filter surface, at which point an algal growth occurs that apparently resists the invading action of the larvae. Holes have been dug in the filter media to a depth of 2½ feet and the presence of this paper-like material containing larvae was confirmed. It was noted that quite often as larval development progressed, the paper-like material appeared to advance with the larvae into the filter growth around the perimeter of a stone, leaving a patch in the center bare except for the presence of the adult flies. This condition is clearly illustrated in Figure 1.

The adults of *T. albipunctatus* are larger in size than those of *P. alternata*

FIGURE 1.—Trickling filter stone showing infestation by adult filter flies.

and are considerably darker in color. The general appearance is somewhat of a speckled blue or dark gray color. The larvae of this species differ from those of *P. alternata* both as to size, color, hardiness, and motility. In general the larvae of *T. albipunctatus* are slightly larger in size, are of a dark brown coloration bordering on black, are extremely tough and hard to kill, and are very active. These are not found in the paper-like substance common to *P. alternata.* A few larvae will appear on a stone and as they develop all of the filter growth will be eaten off, leaving the rock entirely bare. Figure 2 illustrates this condition, the white portions being those areas affected by the larvae and the darker areas being unaffected. The numerical increases evident with *T. albipunctatus* larvae were both rapid and extensive. Within a very short period of time they would be present in a large area and would completely fill all interstices. This is partially illustrated in Figure 2. In contrast to those of *P. alternata,* the larvae of *T. albipunctatus* will progress to the surface of the filter where they will even consume the algal growth. Figure 3 demonstrates this, the light areas being the result of this larval action. This discussion also emphasizes the degree to which filter flies had invaded the trickling filters at Camp Fannin.

Experimental Criteria

The determination of the results of any tests attempting to control filter flies presented a rather unique problem, the reason being that no precise information could be found in the literature which would serve as an accurate criterion. It was felt that any work done on a filter should be evaluated in accordance with any reduction in larval density, the adult population as seen on the area outside of the filters and, finally, the efficiency of the filter

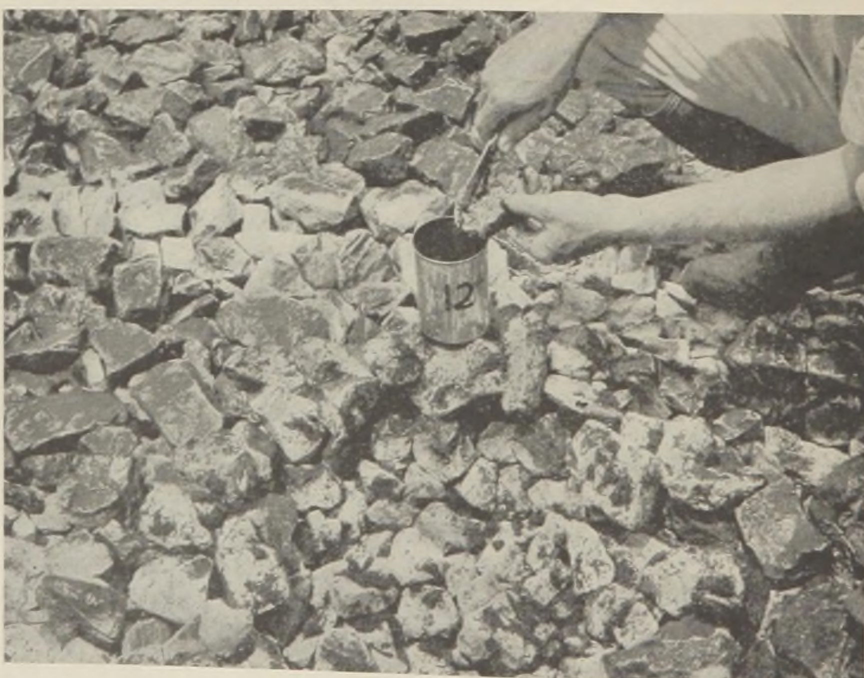

FIGURE 2.—Close-up view of trickling filter surface at Camp Fannin, Texas, showing stones denuded of growth by filter fly larvae. Note heavy infestations of larvae in foreground.

FIGURE 3.—Portion of filter surface, Camp Fannin, Texas, showing absence of growth in some areas caused by filter fly larvae.

as reflected specifically in the biochemical oxygen demand reductions. Accordingly, the overall results of this work were based on larval density within the filter, adult density outside of the filter rocks, and the biochemical oxygen demand as determined before and after treatment.

Larval Density

The absence of information relative to an accurate method of determining larval density necessitated the development of an entirely new method. As the larval characteristics and habits of the two species of filter flies varied so greatly, the problem was made still more complex.

P. alternata larvae, as illustrated in Figure 1, adhere closely to the filter media and are difficult to remove, whereas those of *T. albipunctatus,* illustrated in Figure 2, are not encased in any closely adhering material. In addition to this, it was noted that the two species were present on adjacent stones in many instances, so it would be impossible to pick an area that contained one species and then pick another area containing the other. Had both species been easy to remove, it would have been feasible to take a known quantity of filter media, wash off the larvae, and then devise a practical method of larval counting. Because this was impossible, a method was employed to compensate for the difference in larval characteristics but it was not as accurate as would be desired. This procedure should be refined or a completely new one developed by other workers. For the purpose of this work, however, it gave a sufficiently true picture of the gross increases and decreases evident in the larval population.

The theory followed was that any given weight of filter growth containing *T. albipunctatus* larvae and of the paper-like material containing *P. alternata* larvae should contain a definite number of larvae. Therefore, ten samples, each containing two grams of filter growth containing both *T. albipunctatus* larvae and the paper-like material containing *P. alternata*, were scraped from the filter media with a knife. By diluting this material with clear water and very carefully counting the number of larvae in each sample, an average number of larvae per gram was determined. An effort was made to remove only the larvae but a small amount of filter growth was always present in the samples as the two could not be completely separated. In order to check the accuracy of the ten individual samples, one final sample containing five grams of filter growth material containing both species of larvae was taken and the individual larvae counted as before. This final five gram sample, by coincidence, contained exactly the same average number of larvae per gram that the two-gram samples had contained. It was felt that the average number of larvae per gram throughout the filter would not vary greatly from that determined from the samples counted. Table I presents the data obtained from the individual samples and it will be noted from this information that an average of 301 larvae per gram was established.

TABLE 1.—Larval Samples Counted to Determine Average Number of Larvae per Gram *

Sample Number	Wt. of Sample (gr.)	Total Larvae
1	2	404
2	2	387
3	2	781
4	2	743
5	2	423
6	2	614
7	2	513
8	2	977
9	2	720
10	2	466
Totals	20	6028
Average larvae per gram = 301		
Sample No. 11	5 grams	1507
Average larvae per gram = 301		

* Larval determinations made between April 10, 1945 and April 20, 1945.

After determining the average number of larvae per gram of material, the question arose as to what uniform system of taking samples would be most accurate. Because of the obvious lack of uniformity in the size of the filter media, it was not practical to take one cubic foot of media and scrape all the larvae off for counting, as some of these cubic-foot samples would contain numerous small stones and others would contain just a few large ones. The system finally adopted is also subject to errors from that cause, but is believed to be fairly representative when considered over a period of time.

A wooden frame one foot square was constructed. This square was placed on the surface of the filter and the stones within it were scraped free of larvae. The depth to which the scraping continued was determined by the presence of algal growth. In other words, all filter media within this square which contained any algal growth was removed and the larvae scraped off and weighed, the resultant larval weight being used to determine the total number of larvae within the given area. It was realized that some sections of the filter would have many small, closely compacted stones, whereas other areas would have a few large pieces. In the closely compacted sections the sunlight would not penetrate to more than an average depth of 3 to 4 in., but in the sections containing large stone the light penetration between the rocks would reach 6 to 8 in. Since it was usually found that many small stones would contain as many larvae as a few big ones, this system, when considered over a long period of time and over a large area, would compensate so that the overall averages would be about equal. Consequently, the following method was used in making larval determinations for this study:

Place the one-foot square frame on the surface, scrape the larvae from all stone inside the frame into a can (the weight of which had been predetermined), continue the scraping down to the depth at which no algal growth was evident, then weigh the larvae and determine the total number present from the data obtained earlier on the small two-gram samples. Thus, one of the methods of evaluating the result of treatment was established.

Adult Fly Density

In order to determine the density of adult flies in the areas adjacent to and outside of the filters, a standard New Jersey-style light trap was used. This trap was placed at the pump house, which is located 50 ft. below the two filters, in a position equidistant from each. The small lights at the pump house were turned off in order not to render competition to the trap. The large flood lights in the area could not be turned off, however, a factor which was constant every night and for practical purposes did not deter from the value of information obtained through use of the light trap. Since both species of filter flies were phototropic and the light factors remained constant, it was felt that any gross increases or reductions in adult density would be critically revealed when examined over a long period of time. No effort was made to determine the density of each species because of the difficulty in separating them from a collection.

Filter Efficiency

The third means used for the evaluation of results from the DDT treatment was a study of the biochemical oxygen demand removal by the filter. Since there were apparently no foreign factors except the DDT and its allied chemicals which could either favorably or adversely affect the B.O.D. reduction, it was felt that a comparison of B.O.D. values before and after the filters were treated would serve as an additional criterion for the tests.

Summarizing, the three methods employed for determining the results were: larval density as checked within a one-foot square frame, adult fly density as reflected in light trap measurements, and the biochemical oxygen demand reduction in the flow applied to the filter.

Larval Control Experiments Conducted on Selected Filter Areas

Test Methods

Considering the lack of information relative to the effect which DDT might have on a filter, it was felt that extreme caution should be exercised at the beginning. To prevent any serious damage, only a small portion of each filter was selected for treatment. In this way it was possible to treat a limited area with an unusually heavy dosage and to observe the effects without the risk of incapacitating an entire filter.

The distributing arms on the filter distributor (Figure 3) have the nozzles arranged so that in most instances the effluent from no two nozzles will fall in exactly the same place. There is usually a certain small amount of overlapping, however, or else a small amount of sewage from one nozzle will splash over onto the discharge area from the adjacent one. In first tests conducted, an attempt was made to select areas in which this overlapping or splashing was nonexistent or minimized to such a degree as to be negligible. Since the sewage flow through each nozzle could be computed quickly, it was thus possible to treat this known quantity of sewage at any desired rate.

The dispensing apparatus consisted of a 5-gal. can equipped with a household gas burner needle valve. This drip can was mounted on the distribu-

FIGURE 4.—Drip can mounted for feed of DDT emulsion in experiments involving selected areas.

tor in such a manner that all discharge from it would fall directly into the sewage being ejected from a given nozzle. This is illustrated in Figure 4. In a few cases the overlapping from another nozzle was so great that one of the nozzles had to be turned slightly. Sometimes rust prevented the nozzle from being turned to the desired position and it was necessary to adjust it so that its discharge fell in exactly the same place as that from the nozzle to be used in the treatment.

All DDT dosage rates are expressed in parts per million based on the total flow of sewage over the area under observation.

The material used in all tests was an emulsion containing DDT dissolved in Xylene, with Triton X-100 acting as the emulsifying agent. A stock solution containing 20 per cent DDT, 60 per cent Xylene, and 20 per cent Triton X-100 was employed. By dilution with water, this stock emulsion was brought to the desired strength. Previous experience with a DDT-Xylene-Triton emulsion had revealed that great difficulty is encountered in accurately dispensing small amounts of a highly concentrated emulsion through the orifices of most valves, consequently no tests were conducted with an emulsion stronger than 5 per cent DDT.

To check the effect of the treatment on larvae, at least two samples were always taken with the one-foot square frame within the treated area, with two similar additional samples being taken at random in an untreated section of the filter to serve as a control. No samples were taken less than 24 hours after treatment because the DDT was rather slow in obtaining a kill of the larvae. In addition to these samples, which presented definite figures on larval density, another manner of observing gross results was employed. This consisted in digging a hole 2 ft. deep in the selected area prior to treatment and subsequent to treatment and making observations concerning any visible effects or changes that had occurred.

Since the preliminary tests were made only on small selected areas there was obviously no noticeable effect on the total adult population. For these tests, therefore, no data are included from the light trap collections.

Results

Test Number 1

A circumscribed area located in the center of a filter at the standpipe was selected for the first test. Because of the staggered arrangement of the nozzles on the distributing arms, the sewage from only one orifice was discharged over this selected area, producing a zone 4 ft. 6 in. wide from the standpipe. This area was delineated by a wire marker.

In order to obtain two samples within the treated area, one of the checking frames was placed on the outer perimeter and the other 1 ft. from the standpipe. This one was always kept at least 1 ft. from the standpipe because very little sewage discharged right next to this pipe. Figure 5 illustrates this arrangement. Each day the two squares were moved to the next adjoining area, as indicated by the dotted lines in Figure 5. Because of the size of the area the boundaries of the two check squares did not overlap, but had at least a 1-ft. undisturbed area between them. Sixteen days were required before the outer square returned to its original starting point and 15 days before the inner had returned to its starting point. It was noticed that by the time one cycle had been completed the filter growth had returned and resumed the normal appearance seen before treatment. For a control, two samples were obtained at random each day from the untreated portions of the filter.

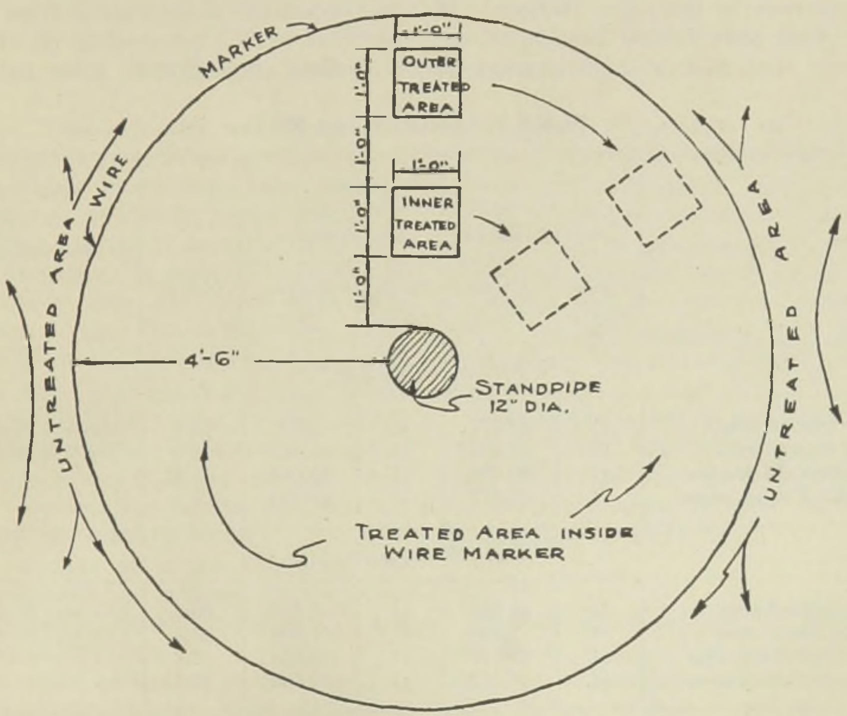

FIGURE 5.—Location of treated areas in Test No. 1.

The first test was attempted at a very high dosage to obtain information relative to any deleterious effect the chemicals might have on the filter growth as well as their effect on larvae. This test was conducted simultaneously on both filters so that the replication might nullify any unusual reduction in one filter from natural causes.

The anticipated DDT dosage rate was 3 p.p.m., based on an average sewage flow of 7.1 g.p.m. through each nozzle. Unfortunately, the valves were inaccurate and the actual quantities of 1 per cent emulsion applied over the 24-hour period were 13.2 and 8.3 quarts, thus giving an actual dosage of 3.3 p.p.m. on one filter and 2.1 p.p.m. on the other. This necessitated a duplication of this test at a later date.

The results of this test are summarized in Table 2. It will be noted that in both tests a greater larval reduction occurred in the inner areas than in the outer portion of the zone. Two conditions probably reduced the effectiveness in the outer sections. It was noted that during periods of extremely high flow a small amount of sewage from the next distal nozzle would splash over onto the treated area, thus causing a certain amount of dilution. In addition, since the immediately adjacent area contained an extremely heavy larval population it is possible that there was larval migration into the treated zone during the three-week period subsequent to treatment. Either of these factors could be sufficient to reduce the apparent effectiveness in the outer treated area.

These data also do not show that of the larvae counted in these tests, many dead ones were mixed among the live ones. In fact, on several of the checks, the ratio of dead larvae was as high as 90 per cent. Since there was no way to separate the two they were all counted, as it was believed that the dead larvae would soon disintegrate and wash out. Because of this the actual percentage reduction in live larvae would have been greater had it been possible to separate the dead ones.

Table 2 also reveals that there was an average larval decrease of from 12.6 per cent to 20.3 per cent in all of the untreated areas due to some natural

TABLE 2.—Results of Test No. 1

	Larval Counts					Observations
	Prior to Treatment		After Treatment		% Reduction	
	Number of Checks	Average Per Check	Number of Checks	Average Per Check		
Test 1*A*—3.3 p.p.m.*						
Inner treated area	11	13,671	11	2,772	79.7	Effective 32 days
Outer treated area	11	12,256	11	11,315	7.6	Effective 29 days
Untreated check area	11	20,615	11	19,660	4.6	
Untreated check area	11	26,031	11	21,105	18.9	
Test 1*B*—2.1 p.p.m.*						
Inner treated area	11	17,359	11	3,456	80.0	Effective 31 days
Outer treated area	11	2,990	11	1,798	39.9	Effective 28 days
Untreated check area	11	32,141	11	28,006	12.8	
Untreated check area	11	36,317	11	26,509	27.2	

* 24-hour dosage period.

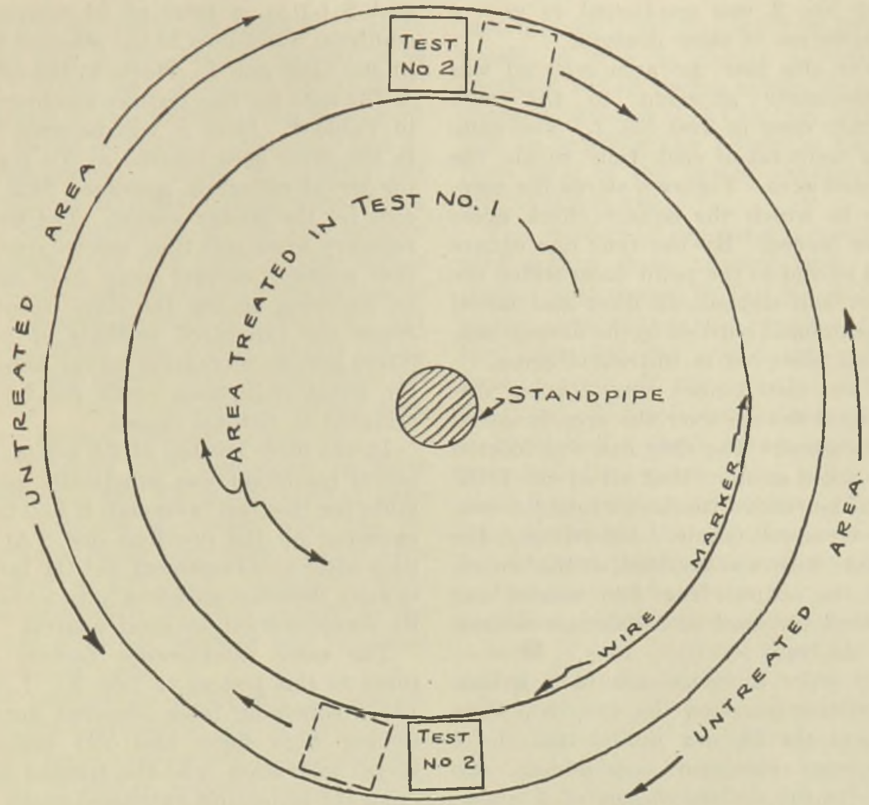

FIGURE 6.—Location of treated areas in Test No. 2.

cause. This reduction was slight compared to the 80 per cent average reduction evident in the inner treated zones.

Prior to treatment, a hole 2 ft. deep was dug within the areas to be treated in both filters. It was observed that all interstices were absolutely filled with healthy larvae. Three days after completion of the treatment additional holes were dug in undisturbed areas within the zones. At this time it was noted that not a single larva was seen down to a depth of 18 in., and from this point on down to the bottom only a very few were observed.

Five days after the treatment the filter growth had resumed a normal appearance and quality in the small areas under observation.

As stated earlier, no larval reduction was seen for 24 hours after treatment. There was a very sharp and marked reduction 72 hours after the application and this condition persisted for approximately 30 days. The resumption of larval breeding was as striking as had been its decrease and within three days time the larval population had again reached the pre-treatment level. It was considered that these dosages gave adequate control for four to five weeks.

As would be expected, no measurable effect on B.O.D. removal resulted from DDT dosage of only a small area of the filter, consequently these data are not included in Table 2.

Test Number 2

The anticipated dosage for Test No. 1 had been 3 p.p.m. but, as stated earlier, the inaccuracies of the needle valve orifices resulted in actual dosage rates of 3.3 and 2.1 p.p.m., respectively.

Test No. 2 was conducted to give a duplication of these dosages.

For this test the area selected was immediately adjacent to the wire marker used in Test No. 1. Two samples were taken each time within the treated area. Figure 6 shows the manner in which the square check areas were moved. By the time one square had moved to the point from which the other had started, all filter and larval growth had returned to the normal condition observed in untreated areas.

Two distributor arm nozzles discharged sewage over the area involved in this test. The drip can was located in such a manner that all of the DDT emulsion would discharge into the sewage from one nozzle. Accordingly, the dosage rate was doubled so that in effect the output from two nozzles was treated, but each at the dosage desired for the test.

In order to insure accuracy, a man constantly checked the two drip cans during the 24-hour period that the 1 per cent emulsion was added. To achieve the desired dosage of 3 p.p.m. and 2 p.p.m. a total of 24 quarts of emulsion was added to the selected area in one filter and 16 quarts to the other.

The data for this test are summarized in Table 3. Here it will be seen that in the filter area treated at 3.0 p.p.m. the larval reduction averaged 94.2 per cent for the 20-day period. The larval recovery after this time was so gradual that actually several more days could be included among the days counted. Since the untreated sections of both filters had an increasing larval density, the noted reductions could not be attributed to natural causes.

In the filter treated at 2.0 p.p.m. the larval reduction was practically negligible for this test, although it had been excellent on the previous one. At no time after this treatment did the larval density decrease sufficiently to warrant its consideration as good control.

The same interference factors applied to this test as to Test No. 1, viz. (1) a splashing from adjacent nozzles during high flows and (2) possible larval migration into the treated area from the adjoining untreated rocks.

TABLE 3.—Results of Test No. 2

	Larval Counts					Observations
	Prior to Treatment		After Treatment		% Reduction	
	Number of Checks	Average Per Check	Number of Checks	Average Per Check		
Test 2*A*—3.0 p.p.m.*						
Treated area No. 1	10	10,062	8	836	94.2	Perfect control for more than 20 days
Treated area No. 2	10	5,090	8	37		
Untreated check	10	25,840	8	33,927	+38.3	
Untreated check	10	20,401	8	30,025		
Test 2*B*—2.0 p.p.m.*						
Treated area No. 1	10	9,948	8	10,562	16.1	Poor control
Treated area No. 2	10	13,283	8	8,923		
Untreated check	10	21,097	8	24,881	+17.1	
Untreated check	10	23,066	8	27,229		

* 24-hour dosage period.

Prior to treatment holes 2 ft. deep were dug in the areas to be treated in both filters and it was noted that all crevices in both filters were filled with the mixed larvae of *P. alternata* and *T. albipunctatus*. Three days after the treatment additional holes were dug in undisturbed areas of the two treated sections. At this time no live larvae and practically no dead ones were seen in the area treated at 3.0 p.p.m., but in the filter area treated at 2.0 p.p.m. there was only a very slight larval reduction and none of the larvae seen were visibly affected by the DDT.

Five days after treatment the filter growth in the 3.0 p.p.m.-treated area had returned to normal and was reported as being very good. In the area treated at 2.0 p.p.m., however, there was practically no filter growth as the larvae were still present and had kept the media bare.

A comparison of the B.O.D. data on samples taken prior to and after treatment again showed that no measurable effect on B.O.D. removal resulted from the DDT dosage of only a small area of the filter.

Test Number 3

The two previous tests had indicated that DDT dosages of 2.0 p.p.m. and 3.0 p.p.m. did not have any deleterious effect on the filter growth. These dosages had resulted in an appreciable larval reduction, particularly at 3 p.p.m. In view of this, the next test was instituted to determine the effectiveness of a still lower dosage when applied to a larger area. Consequently, this test was conducted at a dosage rate of 1.0 p.p.m.

The area selected was at the distal end of the distributor arms, which was the region immediately adjacent to the outside filter wall. Since there were twelve nozzles discharging over this area the dosage was computed so that the DDT emulsion would be equivalent to a strength of 1.0 p.p.m. for each of the twelve nozzles. A drip can was then placed over the outlet from one nozzle, as seen in Figure 4, and the emulsion for all twelve nozzles was discharged through it. This was equivalent to treating the 7.1-g.p.m. output from each of the twelve nozzles at a rate of 1.0 p.p.m.

The manner of checking larval samples within these treated areas was similar to that used in Test No. 2. One square area was started on one side of the filter and the other was started from a point on the opposite side of the filter. The peripheral distance was so great that a check square never approached the point from which the other had started; thus there was no time at which the sampling was obtained from previously scraped media.

The material used was a 1 per cent emulsion, added over a 24-hour period. A total of 48.7 quarts of emulsion was added to the treated area.

Table 4 shows that in Test No. 3*A* there was only a 3.2 per cent overall larval reduction during the period of the test. Actually there was a noticeable larval reduction on the fifth day after treatment but within three days time the larval density had returned to normal. The 69.6 per cent average reduction in Test No. 3*B* was adequate for consideration as good control for 13 days subsequent to treatment.

No visible change occurred in the filter growth after Test No. 3*A* but the growth in the filter used in Test No. 3*B* improved markedly by the fifth day subsequent to treatment. This improved condition persisted until the larval density caused the filter media to become denuded approximately 15 days after treatment.

This test was subject to the same limiting factors noted in the two previous tests, viz., migration of larvae from untreated areas into the treated sections and splashing of sewage onto the treated area from adjacent untreated nozzles. Despite these factors the control in one filter was adequate but there

TABLE 4.—Results of Test No. 3

	Larval Counts					Observations
	Prior to Treatment		After Treatment		% Reduction	
	Number of Checks	Average Per Check	Number of Checks	Average Per Check		
Test 3*A*—1.0 p.p.m.*						
Treated area no. 1	9	9,557	6	10,419	3.2	Not effective
Treated area no. 2	9	25,731	6	23,723		
Untreated check	9	22,391	6	29,558	+27.5	
Untreated check	9	24,180	6	29,829		
Test 3*B*—1.0 p.p.m.*						
Treated area No. 1	9	29,103	6	8,152	69.6	Effective 13 days
Treated area No. 2	9	26,878	6	8,859		
Untreated check	9	27,252	6	47,814	+81.2	
Untreated check	9	19,916	6	37,650		

* 24-hour dosage period.

was only a negligible control evidenced in the other treated area.

Larval Control Experiments Involving Entire Filter Area

Based upon the results of the first three tests, it was decided to dose an entire filter with DDT emulsion. The previous tests had established to a degree the effect which high dosages of DDT would have on the larvae of both *P. alternata* Say and *T. albipunctatus* (Will), as well as upon the filter growth, so the following tests were begun at relatively low dosages.

The method employed was to compute the amount of DDT emulsion required to give the desired dosage for a 24-hour period. This material was then added to the influent of a filter at the headbox. In this manner it was possible to treat one entire filter and use the other as a control check. This would eliminate any possible migration of larvae from an untreated section of a filter onto the treated area and would also prevent any untreated sewage from splashing over onto the treated areas.

The operational procedures for an Aero-filter are well known to all plant operators. In the Camp Fannin plant approximately one-fourth of the sewage passing through the final clarifiers is returned to the filters. All DDT dosages were computed on the basis of this total sewage flow over a filter. It can be seen that after the DDT emulsion was initially added, approximately one-fourth of it was possibly returned to the filter with the recirculated clarifier effluent. Within a period of a few hours time, however, the continuous addition of raw sewage would cause this small amount of DDT to be diluted to the point of being negligible.

For these tests a 5 per cent DDT-Triton-Xylene emulsion was used, the addition being made at the influent headbox for each filter.

Results

Test Number 4

The object of this test was to determine if the amount of DDT emulsion required for a 24-hour treatment could be added to a filter in a "batch" dose and still result in larval control. This test was conducted at a 0.25-p.p.m. dosage, this being the anticipated minimum dosage necessary for larval kill.

The total average daily flow to one filter during the preceding month had been 946,000 g.p.d., which would require 4.73 gallons of 5 per cent emulsion if added over a 24-hour period. This amount of emulsion was taken to the influent headbox of a filter and poured in all at one time. When subsequent larval checks revealed that all effects from the treatment had disappeared, the test was repeated on the other filter, with the first one now being used as a control check to see if any unusual reductions might appear from natural causes. It is obvious that the period in which the DDT remained in contact with any larvae was extremely short because the continuous addition of sewage over the filter tended to wash the emulsion through. It was estimated that the majority of the DDT was in contact with the larvae from 5 to 15 minutes at the most.

The data for this test are presented in Table 5, where the "Treated Area" represents random samples taken from the treated filter and the "Untreated Area" refers to random samples from the control filter.

Prior to treatment a hole was dug 2 ft. deep in the filter to be dosed. It was noted that practically every crevice between the stone was filled with larvae. Seven days after treatment another 2-ft. hole was dug in an undisturbed part of the filter and no larval reduction whatsoever could be seen, the tremendous density still extending to the very bottom of the hole. Later

TABLE 5.—Results of Test No. 4. Entire Filter Dosed

	Larval Counts			Adult Fly Counts†						Ave. 5-Day B.O.D. (p.p.m.)[2]			Observations
	Prior to Treatment, Ave. per Check[1]	After Treatment, Ave. per Check[1]	% Reduction	Prior to Treatment, Ave. per Night[1]	After Treatment, Ave. per Night[1]	% Reduction	Prior to Treatment, Ave. per Brick	After Treatment, Ave. per Brick	% Reduction	Filter Influent	Filter Effluent	% Reduction	
Test 4A*													
Treated													
Area No. 1	29,387	29,759	0.6	23,391	23,433	+0.1	15	25	+66.6	62	76	+22.5	Not effective for the 7-day period.
Area No. 2	27,305	26,573											
Untreated													
Area No. 1	21,230	30,765	+64.4										
Area No. 2	17,729	33,295											
Test 4B*													
Treated													
Area No. 1	30,765	26,133	13.8	23,433	15,737	37.1	5	1	80.0	62	53	14.5	Poor control for 7-day period.
Area No. 2	33,129	28,931											
Untreated													
Area No. 1	29,759	41,407	+33.6										
Area No. 2	26,573	33,872											

* 0.25 p.p.m. with 12.7 m.g.a.d. flow-batch dosage.
† Standard N. J. style light trap operated 10 hours per night.
[1] Each check based on six samples.
[2] Each check based on three samples.

when the other filter was treated at the same dosage, exactly the same observations were made prior to treatment and six days after treatment, and again no larval reduction whatsoever was evident.

It can be noted from Table 5 that in one filter there was a negligible larval reduction of 0.6 per cent; however, in the second filter, also treated at 0.25 p.p.m. in the same manner, an overall reduction of 13.8 per cent resulted. For both of these tests there was a very substantial larval increase in the untreated check areas, thus ruling out the possibility that natural factors had caused the reductions after treatment.

Table 5 also indicates that after the first test the adult density as determined by the nearby light trap increased 0.1 per cent but during the 6-day period after the second filter was treated a 37.1 per cent decrease was obtained. Similiarly, the number of adults seen on the bricks of the filter wall increased 66.6 per cent during the first test but decreased 80.0 per cent during the last test.

The 5-day B.O.D. determinations on the filter influent and effluent revealed an average increase of 22.5 per cent for the first test, but the fact that there was a 14.5 per cent reduction during the second test would indicate that causes other than the DDT could have been in effect during the first trial.

Test Number 5

Because of the poor larval control obtained from the 0.25-p.p.m. "batch" dosages of Tests 4*A* and 4*B*, it was felt desirable to attempt a test with this same dosage but using a longer contact period. Tests 5*A* and 5*B* were conducted at the 0.25-p.p.m. dosage rate, with the emulsion being applied over a 24-hour period.

Again all additions were made at the influent headbox to the filters, the drip can previously described being used for dispensing the emulsion. A total of 4.75 gallons of 5 per cent emulsion was added, this being computed from an average daily flow of 946,000 g.p.d. to each filter.

The results obtained are summarized in Table 6, where the "Treated Areas" represent random samples taken from the treated filter and the "Untreated Areas" refer to random samples from the control filter. It will be observed that in Test No. 5*A* the overall larval reduction amounted to 59.7 per cent, but in Test No. 5*B* there was a 49.0 per cent larval increase. Since the general trend was upward during the period of both of these tests, the reason for the larval control failure is not known. It was considered significant, however, that in one filter the larval kill was much greater than any obtained when the emulsion was added in a batch dosing.

Two-foot deep holes dug in the filters prior to and after treatment revealed that in Test No. 5*A* there was a larval reduction of approximately 50 per cent down to the 2-ft. level, an indication that the DDT can give a kill at a reasonable depth below the surface.

After both tests the adult density increases of 92.0 per cent and 41.8 per cent as determined by light trap collections indicated that the 0.25 p.p.m. dosage had not as yet affected the adult population. Observations on the filter wall revealed that there was a 98 per cent decrease after the first test and a 33.3 per cent increase after the second. This dosage rate was therefore considered inadequate for proper adult control.

The effect which the two tests had on the filter effluent B.O.D. is considered interesting. It is noted that in Test No. 5*A* there was a rather negligible decrease, indicating no unfavorable action. Test No. 5*B*, on the other hand, presented a 20.8 per cent increase in the 5-day B.O.D. for the filter involved. As this was somewhat unfavorable, a check was made to see if any unusual action had occurred in the untreated filter used as a control for this test.

TABLE 6.—Results of Test No. 5. Entire Filter Dosed

	Larval Counts			Adult Fly Counts†						Ave. 5-Day B.O.D. (p.p.m.)[2]			Observations
	Prior to Treatment, Ave. per Check[1]	After Treatment, Ave. per Check[1]	% Reduction	Prior to Treatment, Ave. per Night[1]	After Treatment, Ave. per Night[1]	% Reduction	Prior to Treatment, Ave. per Brick	After Treatment, Ave. per Brick	% Reduction	Filter Influent	Filter Effluent	% Reduction	
Test 5A*													
Treated													
Area No. 1	41,407	17,006	59.7	15,737	30,229	+92.0	5	1/10	98.0	64	60	6 2	Effective 8 days.
Area No. 2	33,872	14,277											
Untreated													
Area No. 1	26,133	38,733	+33.0										
Area No. 2	28,931	34,504											
Text 5B*													
Treated													
Area No. 1	38,277	65,587	+49.0	30,229	42,891	+41.8	75	100	+33.3	48	58	+20.8	No control for 7 days.
Area No. 2	36,034	45,192											
Untreated													
Area No. 1	24,049	22,304	+9.4										
Area No. 2	16,073	21,606											

* 0.25 p.p.m. with 12.7 m.g.a.d. flow—24-hour dosage.
† Standard N. J. style light trap operated 10 hours per night.
[1] Each check based on six samples.
[2] Each check based on three samples.

Examination of the plant operator's records revealed that during this same period the B.O.D. in the untreated filter effluent increased 14 per cent, a fact suggesting that the emulsion was not altogether responsible for the reduction in B.O.D. removal.

Again no damage was evident on the filter growth, filter media, or efficiency of the plant as a whole.

Test Number 6

The information derived from Tests No. 4 and 5 suggested that the degree of larval kill might be dependent upon the length of time the DDT was in contact with the larvae, as well as upon the strength of the emulsion. Test No. 6 was performed to check the validity of that hypothesis.

The dosage rate for Test No. 6 was established at 0.5 p.p.m., with a 30-minute contact period. The method of application was to take the amount of emulsion that would be required for a 24-hour treatment and pour it all into the influent headbox of a filter. As soon as any of the white emulsion began to appear in the nozzle discharge on the filter all sewage flow into that filter was cut off and the emulsion thus allowed to trickle slowly through the filter without being washed out.

Since all sewage flow into this filter was cut off for 30 minutes, the DDT could theoretically be in contact with larvae during all of that time. Actually, however, there were many larvae in protected places on the under surface of rocks which would not come in contact with the DDT unless they crawled out to exposed positions. At the completion of this 30-minute period the normal sewage flow was diverted back into that filter.

A total of 9.5 gallons of 5 per cent emulsion was added to the influent of each filter, this amount being based on the average daily flow of 946,000 g.p.d. per filter. One filter was treated and the other used as a control. When the normal larval density had returned in the treated filter the other one was then treated. This system was adopted both to provide a control for the treated filter as well as to prevent the possibility of any harmful effects on the B.O.D. removal from upsetting the efficiency of the plant.

When Test No. 6 *A* was conducted it was noticed that there was no appreciable larval reduction for four days, despite the fact that literally hundreds of dead larvae were seen 24 hours after treatment. Since the subsequent reductions showed the somewhat "spotty" larval condition characteristic of all the tests, the actual daily larval counts are presented in Table No. 7 as a typical example of these tests. When it is remembered that 1,000 larvae represent just slightly over 3 grams of material and that these larvae came from many stones in a one-square foot area, the degree of control can be appreciated.

From a knowledge of undesirable larval densities and daily observations in the filter, it was felt that the delayed control began on August 11 and

TABLE 7.—Larval Counts in Test No. 6*A*

Date (1945)	Treated Area No. 1	Treated Area No. 2	Untreated Check Area	Untreated Check Area
Before DDT application				
August 1	74,558	63,872	35,638	30,281
August 2	64,565	34,856	15,592	39,040
August 3	91,444	47,558	13,425	11,197
August 4	55,866	49,725	14,418	16,826
August 6	41,508	29,950	32,448	10,686
DDT applied from 10:30 A.M. to 11:00 A.M. on August 6				
August 7	49,785	18,903	28,023	30,281
August 8	26,519	22,786	34,344	1,926
August 9	23,779	37,535	12,160	20,197
August 10	21,943	32,659	56,227	10,114
August 11	10,816	2,950	24,833	9,993
August 13	8,548	7,375	18,722	23,779
August 14	1,415	2,619	22,063	25,525
August 15	8,037	1,716	40,846	34,013
August 16	1,445	903	38,709	14,267
August 17	843	933	30,521	35,669
August 18	1,746	1,656	33,832	13,425
August 20	0	0	20,889	31,485
August 21	0	692	18,120	22,033
August 22	0	3,341	24,261	17,217
August 23	0	0	32,659	28,896
August 24	3,161	0	34,766	9,331
August 25	0	0	27,542	21,281
August 28	0	0	15,712	17,940
August 30	3,221	602	18,180	25,374
September 1	0	0	21,070	28,866
September 4	2,707	4,726	42,772	25,766
September 5	5,027	2,739	30,100	22,816
September 6	5,388	8,468	34,013	35,970
September 7	692	9,722	17,518	25,615
September 8	5,809	12,793	26,488	46,324
September 10	1,054	16,043	27,421	30,100
September 11	24,140	20,137	45,692	32,237

was terminated by September 8. Consequently, in computing the larval reduction, the figures between these dates were used.

Several interesting observations were made during the 30-minute treatment periods. In both filters it was noted that many adults and larvae of both *P. alternata* and *T. albipunctatus* which were near the surface became violently active and died within 20 minutes time. The death of some larvae was attributed partially to their crawling into the sunlight and drying out, but this would not have affected the adults. Twenty minutes after the DDT had first come in contact with them, those larvae of both species which were as much as one foot under the surface had become violently agitated, displaying constant movement with tremors that were not seen in the larvae from an untreated filter, and many were dead. As soon as the sewage flow was again diverted onto the filters, observations made at the clarifier influent revealed tremendous masses of larvae and pupae, many being dead and many being still alive. It was believed that the emulsion had affected the larvae and caused them to release their hold on the rocks, thus allowing them to be washed out. This condition was so much more pronounced in a treated filter than in an untreated one that it was believed to be indicative of the effect of the emulsion on larvae.

The complete data for Tests 6*A* and 6*B* will be found in Table 8, where the "Treated Area" represents random samples taken from the treated filter and the "Untreated Area" refers to random samples from the control filter. It will be noted that in Test No. 6*A* the average larval reduction was 95.4 per cent, the light trap reduction of adults was 66.5 per cent and the number of adults on the filter walls decreased 96.6 per cent. In Test No. 6*B* the average larval reduction was 44.3 per cent, the light trap collection increased 50.8 per cent, and the number of adults on the filter wall decreased 60 per cent. These figures were clearly indicative of good larval control, but revealed that this larval reduction had not materially reduced the total adult population by the end of the test.

Holes dug down 2½ ft. in the treated filters prior to treatment revealed that there was absolutely no filter growth and all crevasses were filled with larvae. Approximately four-fifths of all larvae had disappeared a week after treatment and most of the few remaining ones were dead.

Five days after the filters were treated it was noticed that a filter growth was appearing. Prior to these treatments there had been absolutely none, the media being either completely bare or covered with larvae. By the eighth day after treatment the filter growth had become very good and all media had at least a thin covering. Definitely no damage had occurred as a result of the DDT.

It is noted in Table 8 that there was a 13.7 per cent increase in the filter effluent B.O.D. in Test No. 6*A*. This undesirable increase was expected due to operational procedures in the plant. One week after that filter had been treated, all sludge from the clarifier was pumped back over that filter. Immediately the B.O.D. increased in this filter and remained high for the week that this practice was in operation. As soon as the operator discontinued pumping this sludge back to the filter, the B.O.D. returned to normal. That one week's increase, however, was sufficient to upset the average for this test.

In reviewing these two tests it will be seen that the average larval reductions were 95.2 per cent and 44.3 per cent. The adult density as reflected in light trap collections decreased 66.5 per cent during the first test but increased 50.8 per cent after the second. The number of adults seen on the filter walls decreased 96.6 per cent and 60.0 per cent.

TABLE 8.—Results of Test No. 6. Entire Filter Dosed

	Larval Counts					Adult Counts								5-Day B.O.D. (p.p.m.)					Observations
	Prior to Treatment		After Treatment		% Re-duc-tion	†Prior to Treatment		After Treatment		% Re-duc-tion	Prior to Treat-ment	After Treat-ment	% Re-duc-tion	Filter Influent		Filter Effluent		% Re-duc-tion	
	Num-ber of Checks	Ave. per Check	Num-ber of Checks	Ave. per Check		Num-ber of Nights	Ave. per Night	Num-ber of Nights	Ave. per Night		Ave. per Brick	Ave. per Brick		Num-ber of Samples	Ave.	Num-ber of Samples	Ave.		
Test No. 6A*																			
Treated area No. 1 . .	5	65,588	20	2,652	95.4	6	42,891	30	14,341	66.5	3	1/10	96.6	3	58	10	66	+13.7	Excellent larval reduction for 32 days
Treated area No. 2 . .	5	45,192	20	2,422															
Untreated check	5	22,304	20	27,356	+13.4														
Untreated check	5	21,606	20	23,463															
Test No. 6B*																			
Treated area No. 1 . .	7	32,000	16	17,495	44.3	10	6,788	15	10,242	+50.8	10	4	60.0	3	89	10	57	35.9	Good larval reduction for 27 days
Treated area No. 2 . .	7	31,261	16	17,698															
Untreated check	7	6,402	16	36,821	+405.1														
Untreated check	7	8,234	16	37,109															

* 0.5 p.p.m. with 12.7 m.g.a.d. flow. Thirty-minute contact period.
† Light trap collections.

No deleterious effects from the DDT were revealed by the B.O.D. samples of the filter influent and effluent. The filter growth improved considerably approximately 6 days after the filters were treated.

Adult Fly Control by Sprayed Residues on Resting Surfaces

In the early spring of 1945 considerable annoyance was being encountered at the treatment plant by adult filter flies. The plant operators urgently requested and insisted upon immediate attempts to alleviate the almost unbearable condition. Since the author had just been assigned to Camp Fannin, it was impossible to obtain the desired pretreatment data on the first test. Certain observations and results were obtained, however, which were considered noteworthy.

A standard N. J. style light trap was placed at the pump house, located equidistant from the two filters, to obtain the numerical density of the flies after treatment. The operation hours were from 7:00 P.M. until 7:00 A.M., daily. It was felt that if the spraying of adult resting places was a very effective means of control, the light trap data obtained after treatment would reflect to some extent the degree of control.

In addition to this, observations were made prior to treatment as to the average number of adults seen resting on the first two courses of brick above the water line on the filter wall. This was compared to the same observations made after treatment. Obviously, this method was subject to errors due to climatic conditions but, nevertheless, gross differences could be noted.

A third means of determining the long-range value of sprayed residues was by observation of the larval density within the filters subsequent to treatment. It was believed that if the adults were returning to the filter beds to oviposit there would be a substantial reduction in the larval population after a reasonable period of time. In this respect it was also unfortunate that for the first test no pretreatment data could be obtained, but the larval densities determined three weeks after the residues had been sprayed were noteworthy and interesting.

All exposed surfaces of the following units were treated: filter walls, effluent and inspection wells for both filters, pump house, raw sewage influent headbox, and the meter house. These constituted practically every available surface upon which adults could rest. The total surface area sprayed was 4,373 sq. ft.

A total of 15 gallons of 5 per cent DDT in kerosene was deposited on these surfaces with an ordinary five-gallon knapsack sprayer commonly used in mosquito control work. The rate of application was therefore 645 mg. of DDT per sq. ft. of surface area. Previous work done by the author and other entomologists had indicated that a dosage rate of 300 mg. per sq. ft. is ample for the control of adult house flies and mosquitoes, but this unusually heavy application was made to abate the filter fly nuisance.

The data for the daily light trap collections and larval sampling will be found in Table 9. It was interesting to note that for the 40-day period after DDT was applied to the resting surfaces, a daily average of 6,113 adults were collected from the light trap.

The effect which lowered temperatures and relatively high winds had on the adult collections can be clearly noted in Table 9. Warmer weather with calm nights no doubt would have raised the average adult density considerably.

Three weeks after treatment the larval population was so high as to be considered uncontrolled, a condition also persistent through the 40-day period. The thirty samples taken in each filter during that period presented averages of 23,041 and 35,814 larvae per check.

TABLE 9.—Effect of DDT-Sprayed Residues on Adults and Larvae. Surfaces Treated April 2, 1945

Date (1945)	Total Adults*	Min. Daily Temperature (° F.)	Ave. Larvae Per Check†	
			Filter No. 1	Filter No. 2
April 3	7,600	54	—	—
April 4	110	44—Windy	—	—
April 5	0	30—Windy	—	—
April 6	0	32—Windy	—	—
April 7	0	36	—	—
April 8	6,000	42	—	—
April 9	11,100	54—Windy	—	—
April 10	5	61—Windy	—	—
April 11	250	66	—	—
April 12	4,275	57	—	—
April 13	7,125	72	—	—
April 14	1,900	70—Windy	—	—
April 15	1,900	66—Windy	—	—
April 16	200	48—Windy	—	—
April 17	321	44—Windy	—	—
April 18	2,130	48—Windy	—	—
April 19	4,750	50	—	—
April 20	21,850	56	—	—
April 21	15,200	60	—	—
April 22	4,000	58	—	—
April 23	4,540	55	—	—
April 24	19,950	56—Windy	15,366	45,426
April 25	50	48—Windy	17,081	27,571
April 26	2,850	46—Windy	25,540	30,356
April 27	1,900	50—Windy	27,331	42,049
April 28	9,025	56	25,494	34,028
April 29	5,000	48		
April 30	5,450	44	31,108	55,474
May 1	8,075	61		
May 2	16,150	58—Windy	15,050	46,429
May 3	475	52—Windy	28,745	24,501
May 4	23	40—Windy	16,435	37,098
May 5	1,425	42—Windy	20,212	27,045
May 6	9,950	52—Windy		
May 7	10,000	58—Windy	17,879	28,716
May 8	239	52—Windy	24,065	37,805
May 9	11,875	62	20,242	36,210
May 10	29,450	63—Rain	36,632	30,566
May 11	475	62—Rain	24,441	33,938
May 12	19,000	86		

* Light trap operated from 7:00 P.M. to 7:00 A.M. This includes both *P. alternata* and *T. albipunctatus* in approximately equal numbers.

† Based on two samples each day from each filter.

Whereas the light trap collections and larval samples revealed that the excessively heavy sprayed residues did not eliminate or substantially reduce the total fly population, the picture presented by counting the average number of adults resting on the filter wall was entirely different. The average of four adults per brick prior to treatment was reduced to an average of $\frac{1}{10}$ per brick eight days after treatment. As the weather was comparable for the two tests, it seems possible that the solution had exerted a slight repellency.

Since the larval experiments were being conducted during the remainder of the summer and the light trap data used in that work, this sprayed residue test could not be repeated until fall. This same experiment was at that time duplicated, however, using exactly the same amount of DDT solution, applied in the same manner to the same surfaces. In this connection it should be noted that there undoubtedly were many DDT crystals still present on the surfaces from the first test. This would result in a DDT deposit greater than 645 mg. per sq. ft.

TABLE 10.—Effect of DDT-Sprayed Residues on Adults and Larvae

Date (1945)	Total Adults*	Min. Daily Temperature (° F.)	Ave. Larvae Per Check†	
			Filter No. 1	Filter No. 2‡
Before Treatment				
September 11	14,500	69	22,138	—
September 12	14,000	64	3,492	—
September 13	30	66	23,869	—
September 14	76	44	33,727	—
September 15	7	43	27,461	—
September 16	20	47	—	—
September 17	27	56	18,944	—
September 18	53	50	41,583	—
September 19	475	50	30,883	—
September 20	7,600	66	27,827	—
September 21	19,000	70	32,944	—
September 22	28,500	70	32,192	—
September 23	20,000	68	—	—
September 24	19,900	67	28,467	—
September 25	29,450	72	38,829	—
After Treatment—All Surfaces Sprayed with DDT at 645 mg. per sq. ft.				
September 26	19,000	65	—	—
September 27	15,200	66	38,299	16,299
September 28	20,900	64	51,937	21,416
September 29	256	66		
September 30	255	62		
October 1	250	58	34,178	23,447
October 2	475	58	49,304	16,766
October 3	3	52	45,526	21,491
October 4	7	58	32,914	23,207
October 5	14	59	—	—
October 6	122	68	40,906	24,862
October 7	22,325	60	—	—
October 8	22,300	60	46,188	17,518
October 9	66	46	—	—
October 10	—	42	51,712	32,132
October 11	11	42	36,015	33,452
October 12	10	42	47,829	40,830
October 13	11	44	38,769	32,402
October 14	22	46	—	—
October 15	27	54	46,173	24,983
October 16	23	41	46,504	37,098
October 17	30	39	33,907	36,752

* Light trap operated from 7:00 P.M. until 7:00 A.M. Both *P. alternata* and *T. albipunctatus* in approximately equal numbers.

† Based on two samples each day from each filter.

‡ Filter No. 2 was under effect of larval control test until Sept. 26.

In Table 10 it will be noted that three days after the resting surfaces were sprayed there was a sharp decrease in adult density outside of the filters, due apparently to the DDT. Despite this, however, there was an average daily collection of 4,824 adults for the 3-week period following the application. This decrease was followed by a rather marked lowering of the temperature, a factor which had affected densities during the previous adult and larval tests. It was interesting to note the sharp adult increase evident after the rise in temperature on October 6. Since low temperatures are unfavorable for the collection of large numbers of adult filter flies, it was felt that consideration should be given to this in analyzing the results of the test.

Military duties prevented daily larval sampling but, as seen in Table 10, thirty samples were taken in each filter during a 3-week period following the treatment. The averages of 42,677 and 26,843 larvae obtained in the 3-week period after treatment, suffice to show the complete lack of larval control.

During this test observations revealed literally thousands of dead and affected larvae on the ground surrounding the filter walls. In warm and favorable weather undoubtedly many adults would live long enough to invade the pump house. When all factors from both tests were weighed carefully it was the belief of the author that the degree of adult filter fly control obtained from sprayed residues was not sufficient to prevent annoyance from these insects during periods of warm weather. In fact, the unusually heavy dosage applied on the first test did not itself afford more than a negligible amount of relief from them.

Both tests clearly showed that larval reduction or eradication was not accomplished by depositing DDT on adult resting surfaces. Close study of the habits and characteristics of filter flies led to the conclusion that many adults remain in the filter bed during their life span and oviposit there without ever migrating to the open air.

If this is true, sprayed residues on adult resting areas would naturally never be able to eliminate the problem completely because the majority of the adults hatching in a filter would never come in contact with the DDT but would continue to reproduce beneath the stone. Since the filter flies are phototropic, many of those hatching near the filter surface would be attracted to the lights of the pump house during favorable weather, thus accounting for the influx which caused annoyance.

Summary and Conclusions

Larval control experiments conducted on selected areas of filter bed were limited by the deposition of the DDT in relatively narrow strips, the dilution of this material during high flows by splashing of untreated sewage from adjoining nozzles, and the possible migration into the treated zones by larvae from the adjacent untreated bed. Despite these considerations the following results were obtained in the application of a 1 per cent DDT emulsion by means of a drip can, to selected areas of filter bed over a 24-hour period, for control of the larvae of *P. alternata* and *T. albipunctatus:*

1. A 3.3 p.p.m. dosage accomplished an average larval reduction of 45.7 per cent, whereas a 3.0 p.p.m. dosage effected a 94.2 per cent average larval reduction. Both dosages were considered adequate for effective control.

2. Dosages of 2.1 p.p.m. and 2.0 p.p.m. resulted in average larval decreases of 74.1 per cent in one filter and 16.1 per cent in the other. Rather poor control was therefore indicated.

3. Two tests with an application rate of 1.0 p.p.m. disclosed only 3.2 per cent and 69.6 per cent larval reductions. The length of the effective periods for this dosage was slightly over one week,

which rendered it inadequate for proper control.

4. Dosages ranging from 1.0 p.p.m. to 3.3 p.p.m. of DDT did not adversely affect the filter growth in the small areas involved in these tests but actually improved this growth by eliminating the excess larvae.

5. A comparison of the 5-day B.O.D. samples taken from the filter influent and effluent disclosed no ill effects attributable to the application of DDT and its allied chemicals to selected areas of the filter bed.

Larval control experiments involving entire filter bed areas were free from the undesirable limiting factors present in the previous tests, therefore the data obtained were considered more informative and reliable. All treatments were accomplished by the addition of a 5 per cent DDT emulsion to the influent headbox of the filters, with the following results being obtained:

1. The application in a batch dosage at a rate of 0.25 p.p.m. presented negligible larval reductions of 0.6 per cent in one filter and 13.8 per cent in the other, both of which were considered inadequate for control. Holes 2 ft. deep in both filters revealed no larval reduction at that depth. It should be recalled, however, that the DDT applied in this manner probably was in contact with the exposed larvae for not more than a very few minutes. The alternate treatment of the two filters did not give clear-cut indications of desirable adult reductions.

2. The application of DDT at this same rate of 0.25 p.p.m., but added to an entire filter over a 24-hour period, gave an average larval reduction of 59.7 per cent in one test. This was offset by a 49.0 per cent increase when repeated on the other filter. For both 24-hour tests 50 per cent larval decreases were noted at a depth of 2 feet in the filter beds. It was considered significant, however, that the larval kill was much greater than any obtained when the emulsion was added in a batch method. This indicated that possibly the length of contact period influenced the degree of larval kill. Again the alternate treatment of the filters did not favorably affect the adult populations.

3. Effective control was obtained when a DDT dosage of 0.5 p.p.m. was applied in a batch dose and the sewage flow diverted so as to allow the DDT to trickle slowly through the filters for a 30-minute period. Larval reductions of 95.4 per cent and 44.3 per cent were obtained in the two tests, with an 80 per cent overall decrease at a depth of 2 ft. in the filter bed. Within 20 minutes of the application a very substantial initial kill had been obtained on both adults and larvae of *P. alternata* and *T. albipunctatus*. This dosage with its 30-minute contact period gave effective larval control for approximately thirty days, and resulted in such adult filter fly reductions as to warrant its consideration as an adequate control measure.

Several general observations relating to this phase of the work should be mentioned at this point as they have a direct bearing on the solution of the filter fly problem.

As noted in the tables, there was a general upward trend in the larval densities of untreated filters. Because of this it is felt that the favorable results obtained from the treatments were produced by the DDT and not by some unknown natural causes.

No difference could be seen in the speed or completeness with which the DDT reduced the larval population of *P. alternata* Say and *T. albipunctatus* (Will). This indicated that their susceptibility to DDT is approximately equal, so control measures directed against one need not be especially altered to control the other.

It was not known whether the lethal action of the DDT was due to toxicity to the insect's nervous system or whether it acted as an intestinal poison. The methods of application employed in these tests would possibly indicate, however, that death was caused by the DDT acting as a contact poison. In this respect attention is invited to the fact that the length of the contact period had a definite effect upon the mortality rate. When a dosage of 0.25 p.p.m. was applied in a batch dose practically no control was evidenced but when the same amount of emulsion was added over a 24-hour period an appreciable reduction occurred. Also, when a 0.5 p.p.m. dosage was employed with a 30-minute contact period, a large number of both adults and larvae were seen to be dead and dying a half-hour after this contact with the DDT. Thus, it appears that the degree of kill could be increased considerably by extending the contact period to perhaps two hours.

During no test was damage ever produced upon the filter growth, but quite definite improvements were seen in all tests. DDT appears to be specific for insects and its activity in these experiments indicated that it was not a fungicide. Although there are many other solvents and emulsifiers which can be used to good advantage, it is possible that certain ones might in themselves prove to be fungicides, a fact which would emphasize the need for caution in any attempted large scale work.

Throughout this work no deleterious effects attributable to the DDT and its allied chemicals were evident in the 5-day B.O.D. samples taken from the filter influent and effluent. It is believed by the author that considerably higher dosages of this material could be used before the efficiency of the filter would be impaired.

The experiments conducted to determine the value for adult control of DDT-sprayed residues on resting surfaces disclosed several interesting facts. Although complete pretreatment data could not be secured, the figures obtained after the application of 645 mg. DDT per sq. ft. indicated that poor adult control was accomplished with this method. During the 40-day period following the first test, a daily average light trap collection of 6,113 adults was obtained, with a daily average of 4,824 for the 3-week period following the second test. During both of these tests there were many days of lowered temperature, which condition would limit the number of adults subject to collection.

Observations made as to the number of adult flies resting on the bricks of the filter wall would indicate that excellent adult control had been obtained. Since the light trap collections definitely revealed that considerable adults were not only present, but flying at night, the value of relying upon a count of adults seen resting on a surface was questioned.

The application of sprayed residues on adult resting surfaces did not eliminate or materially reduce the larval population within the filter beds. Thirty samples were taken in each filter during the 40-day period following the first test, with the average number of larvae per check being 29,427. In the 3-week period following the second test thirty samples were again taken in each filter and the average number of larvae per sample remained high, this time being 24,760. These figures clearly indicated the complete lack of larval control accomplished by the treatment.

It is believed by the writer that the reduction or elimination of adults which are outside of the filter beds will not effect any appreciable larval control. The basis for this assumption lies in the fact that during the course of this study it was noted that thousands of adults were always found present even at a depth of 2 ft. in the filter media. It is believed that many, if not the majority, of these adult filter flies remain within the bed during their entire life span and oviposit there without ever leaving the filter. Thus many would never come in contact with the sprayed residue of DDT. Also it is questionable how many *Psychoda* adults will return to the filter beds after they have once left.

The materials and methods of application employed both in the treatment of an entire filter for larval control and in the deposition of sprayed residues of DDT for adult control of *P. alternata* and *T. albipunctatus* were such that these procedures can be easily and quickly performed by any plant operator.

For the benefit of any operators who might desire to utilize this method of controlling filter flies, the following suggestions are offered as an aid in preparing the emulsion and applying it to a filter:

1. Obtain an open container which will hold 10 gal. of solution. Mark the 10-gal. point by scratching the container or using a non-soluble paint (to prevent the Xylene from removing the mark).

2. Place 17 lb. of commercially pure DDT in the container and add 6 gal. of Xylene. Stir until all the DDT is dissolved. This may require 30 minutes or more. Then add 8½ quarts of Triton (or any other good emulsifying agent), and stir well for 10 or 15 minutes. Add enough Xylene to this mixture to bring the total amount of solution up to the 10-gal. mark on the container. This solution will then contain 20 per cent DDT, 20 per cent Triton and 60 per cent Xylene. As the Xylene evaporates rapidly, this material should not be left uncovered for long periods of time, and should be stored in tightly closed containers.

3. Dilute this 20 per cent DDT stock solution to 5 per cent by adding three parts of water to one part of stock solution. The resultant product will be milky in appearance.

4. Compute the amount of DDT (by weight) required to treat the actual sewage flowing through the plant. It is suggested that for practical work this dosage be such that one part of DDT is applied to one million parts of sewage. For example, on the experiments described in this work, 19 gal. of 5 per cent emulsion would have been needed to treat the sewage flow of 946,000 g.p.d. at a rate of one part per million. (*Editor's Note*—See editorial on page 330 of this issue.)

5. It is further suggested that the 5 per cent emulsion be taken to the influent headbox (dosing tank) of a filter and poured in. As soon as the milky emulsion begins to appear in the nozzle outlet, slowly begin to cut off the sewage flow so that by the time all of the emulsion has drained from the pipes no untreated sewage will flow over the bed. It is recommended that the DDT emulsion be allowed to trickle through the filter for one hour before any untreated sewage is turned back onto the bed.

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CONTROL OF TRICKLING FILTER FLIES WITH DDT

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The sewage works operator has known for many years that man-made "improvements" often create new problems sometimes more difficult to solve than those responsible for the improvements. One of these unsolved problems has been the "filter fly" that has shown its appreciation of man's works by multiplying in tremendous numbers around sewage treatment plants and, more especially, in that ideal habitat, the trickling filter. Many control methods for this unwelcome guest have been tried in the past thirty years. None has proven more than partially successful. The most practical method, where feasible, has been flooding of the filter, but at the cost of temporarily lowered filter efficiency.

The success of DDT [2,2-bis (p-chlorophenyl) 1,1,1-trichloroethane] for the control of lice, house flies and mosquitoes by the armed forces following the experimental work by the Department of Agriculture, Bureau of Entomology and Plant Quarantine at Orlando, Florida, naturally led to attempts to apply this substance in the control of the "filter fly" at sewage treatment plants.

There are many flies that breed and live in and around sewage filters in relatively large numbers but those that have come to be called "filter flies" belong to the Order *Diptera;* Family *Psychodidae* (Moth-Flies). The family includes at least six genera, *Phlebotomus, Sycorax, Maruina, Pericoma, Telmatoscopus* and *Psychoda.* The last three named are the ones of interest to a sewage works operator and, of these, the last two are the most common. Del Rosario lists 24 American species as belonging to the genus *Psychoda,* and 48 synonyms that have been given to these species in the literature.

There is considerable confusion in generic and specific names for the *Psychodidae* because entomologists have not devoted much study to the family until comparatively recently. The only reason for pointing out the large number of species is that they vary in their resistance to DDT and when work on this family is reported, the species, or at least the genus, should be mentioned.

O. A. Johannsen's keys deal with larvae of American species and A. L. Tonnoir's 1940 publication is limited to British species of the *Psychodidae* family so that F. del Rosario's work as published in the 1936 *Philippine Journal of Science* remains the most useful paper available on the American species.

The two most common "filter flies" are *P. alternata* Say and *P. albipunctata* Williston (*Telmatoscopus albipunctatus* Edwards). *P. alternata* is lighter in color, smaller, less hairy and the wings more "roof-shaped" than *P. albipunctatus.* They exist concurrently in filters, but usually, one or the other continues to be much more numerous in any particular filter for long periods of time. *P. albipunctatus* thrived from April to October, 1945, at the Intrenchment Creek sewage treatment plant, Atlanta, Georgia, and *P. alternata* inhabited the filters in enormous number during the same period at the South River sewage treatment plant, Atlanta, Georgia.

Laboratory Work

Rearing Psychoda Flies

Both species were grown in the Fourth Service Command Medical

Laboratory, Fort McPherson, Georgia. The first attempts to rear *Psychodidae* in the laboratory failed. When larvae were taken from the filter and placed in petri dishes in distilled water, tap water, tap water plus yeast, tap water plus dog food, tap water plus scrapings from filter rock or filter influent, practically all the larvae died within several days. The larvae placed in filter influent, however, died much sooner than in the other media. Placing small stones from a trickling filter and only a small amount of water in the dishes was more successful. The most successful method discovered, however, was placing the larvae in animal jars containing about 1/16 in. of filter stone washings in which clumps of muslin cloth were partially submerged. Water lost by evaporation was replaced with tap water and small amounts of yeast and ground dog food were added from time to time. The larvae pupated in the muslin. A few filter stones protruding well above the liquid surface formed sites for adult resting and breeding areas. The jars were covered with gauze to prevent the escape of adults. In this way we reared a number of generations of both *P. alternata* and *P. albipunctatus*.

Laboratory Tests

DDT was tried against both reared and captured adults in the laboratory. Tests for adult kill were performed in two ways. The first method consisted of placing a 10 × 10 in. glass plate, coated on both sides with DDT at any desired dosage, in a large cage containing *Psychoda* flies. The flies were observed through cleared X-ray film that formed two sides of the cage. This method was not satisfactory because flies sometimes would not contact the coated glass plate immediately. The second method was to place the flies in a dismountable glass box, 10 in. on a side. Each interior side of the box was coated with DDT. "Knockdown time" was the time in minutes from the insertion of a *Psychoda* until it fell and was unable to co-ordinate sufficiently to fly. Death always followed a "knockdown" though movements continued for sometime thereafter. The results of these trials are shown in Table 1.

TABLE 1.—Per Cent Knockdown of DDT on Adult *Psychodidae* Flies

(Rate of application of DDT = 1/5 lb. per acre)

	Time of Exposure in Minutes																			
	11	12	13	14	15	16	23	24	28	29	30	31	35	39	49	58	62	75	85	90
Aedes aegypti (1 hour*)	10	30	100																	
P. albipunctatus (1 hour*)											20	40	70		100					
P. alternata (1 hour*)		20	50	70	100															
P. alternata (4 hours*)	10		30	60		100														
P. alternata (24 hours*)							10	40	60	80			90	100						
P. alternata (48 hours*)																20	30	50	90	100

* Time since contact surface was treated.

It is evident that the adult *P. albipunctatus* is much more resistant to DDT than *P. alternata* and that a DDT coated surface gradually loses its ability to kill these flies.

Tests for larval kill were performed by placing the larvae in petri dishes containing muslin clumps and a known concentration of DDT in filter stone washings. Controls containing no DDT but Triton and Xylene and controls free from all three substances were run concurrently. Twenty larvae were placed in each of five petri dishes for each test plus the two control dishes. Table 2 presents the average results of these tests.

TABLE 2.—Effect of DDT on *Psychodidae* Larvae

Species	P.P.M. in Tap Water of			Per Cent Kill 48 Hours
	DDT	Triton	Xylene	
P. alternata	0.1	0.1	0.3	40
P. alternata	1.0	1.0	3.0	100
P. alternata	5.0	5.0	15.0	100
P. alternata	10.0	10.0	30.0	100
P. alternata	20.0	20.0	60.0	100
P. alternata	50.0	50.0	150.0	100
P. alternata	0.0	50.0	150.0	10
P. alternata	0.0	0.0	0.0	0
P. albipunctatus	0.1	0.1	0.3	0
P. albipunctatus	1.0	1.0	3.0	30
P. albipunctatus	5.0	5.0	15.0	100
P. albipunctatus	10.0	10.0	30.0	100
P. albipunctatus	20.0	20.0	60.0	100
P. albipunctatus	50.0	50.0	150.0	100
P. albipunctatus	0.0	50.0	150.0	0
P. albipunctatus	0.0	0.0	0.0	0

From the above table it is evident that DDT will kill the larvae of both *P. alternata* and *P. albipunctatus.* The latter, as was noted in the adult stage, is more resistant to DDT.

Field Tests

Spraying DDT on Surface of Filter

The control of psychodid flies was attempted at the South River sewage treatment plant, Atlanta, Georgia, by spraying 5 per cent DDT in kerosene on the walls and the surrounding grass of four 175-ft. rotary type trickling filters. The DDT was applied at the rate of 30 lb. per acre. Many adult flies were killed but the flies continued to emerge and breed in enormous numbers in the filters.

The surface of the filters in addition to the walls and surrounding grass were then sprayed at the rate of 30 lb. of DDT per acre and the filters rested for 2 hours. Many flies and larvae were killed but myriads of flies continued to leave the filter. Flooding, four days after the DDT application, brought wheelbarrow loads of live larvae and pupae to the surface. This procedure has been repeated several times. The kerosene solution evidently did not penetrate beneath the surface layer of rock and then was washed through the filter too quickly to produce lasting results.

Emulsifying DDT in Filter Influent

The city of Atlanta constructed a 30-in. diameter 6-ft. deep filter next to one of the large fixed spray trickling filter units at its Intrenchment Creek plant. Sewage from one of the fixed nozzles was piped to a small rotary distributor mounted over the model filter. Stones from the plant filter were used in the experimental filter and it soon ripened. *P. albipunctatus* larvae became abundant in about 10 days.

DDT, as a Triton-Xylene emulsion, was applied to this filter for 24 hours at the rate of 1.0 p.p.m. based upon the 24-hr. flow. But because of mechanical limitations the DDT was actually applied for about 30 seconds at the beginning of each filter dosing cycle. The average strength per application was probably in the neighborhood of 30 p.p.m. The filter therefore received a shot of DDT for 30 seconds at the beginning of each dosing cycle throughout the 24-hr. period.

The results were remarkable. The filter, which at the beginning of treatment contained millions of psychodid larvae, contained only 50 larvae at the end of the treatment. Four days later no large larvae were found but some immature stages began to appear. This appearance of young larvae three to four days after treatment, was noted upon the second trial of this method. Psychodid larvae again became abundant within 15 days after the treatment.

The third treatment consisted of two 24-hr. applications at 1.0 p.p.m. of DDT with a 3-day interval between applications. All larvae were killed and did not again appear for five days. If it is remembered that within five feet of the experimental filter psychodid flies were breeding prolifically in the standard filters and that the adults had free access to the experimental filter, the re-infestation of the experimental filter in a relatively short time is easily understood.

Algae on the surface of the filter rock faded somewhat for a day or two after each application of the DDT-Triton-Xylene emulsion but soon recovered. Snails became more abundant after each treatment. Sewage filter bacteria are not killed by DDT in concentrations up to 100 p.p.m. Triton at 1,000 p.p.m. kills these bacteria when grown on Tryptose-phosphate agar and they are somewhat inhibited at 100 p.p.m. of Triton.

Conclusions

1. DDT applied at the rate of ⅕ lb. per acre under laboratory conditions will kill adult psychodid flies.

2. DDT applied at the rate of 1.0 to 5.0 p.p.m. will kill filter fly larvae.

3. DDT applied at the rate of 30 lb. per acre over the surface of trickling filter will *not* materially reduce the psychodid larvae population.

4. DDT applied as a Triton-Xylene emulsion to the influent of a trickling filter will control psychodid larvae and therefore the adults. The amount that was successful was 1.0 p.p.m. based on the total 24-hr. flow but was actually applied at a greater concentration at the beginning of each dosing cycle.

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SLUDGE DISPOSAL PRACTICES AT DETROIT *

By Clarence W. Hubbell

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Sludge disposal is the enigma of sewage treatment.

Every engineer interested in health and sanitation problems knows that sewage can be collected and treated to any extent needed to meet modern requirements for health, recreation, and safe living. No two cases are alike, and in each case the degree and type of treatment given are determined by the local conditions to be met, sometimes modified by the ability of the benefitted parties to pay the cost.

The liquid effluent from a treatment plant must of necessity be discharged into a waterway or lake, or into the ocean itself. By trial and error, we have come to know that our rivers are limited in their capacity to assimilate sewage pollution. The plight of the city of Chester, Pa., located on the Delaware River, is a good example (1). Los Angeles, where raw sewage is pumped directly into the ocean, is seriously considering remedial measures to insure the continued purity of its attractive beaches.

The disposal of sewage sludges, which sometimes include garbage, presents, if anything, a more difficult problem than that of the liquid effluent. We have long outgrown the ancient customs of using human wastes for direct fertilization of crops, as still practiced in parts of China. To come nearer home, some of our own cities still maintain noisome dumps which everybody avoids if possible; some have gone into the business of manufacturing fertilizers; and some, like Detroit, believe in purification by fire, and burn their sludge. In short, the question of what to do with residual sludges is about the most serious problem connected with the whole field of sewage treatment.

Instead of attempting to give a pretentious resume of the various methods practiced by many cities, it is the purpose of this paper to concentrate on what Detroit has done with its particular sludge disposal problem.

Detroit was made conscious of her problem something over thirty years ago, when the United States and Great Britain entered into a treaty agreement that neither should pollute boundary waters to the detriment of the other. This led to an intensive study of the pollution of the Detroit River which brought home to the city the fact that she was not only the greatest offender but also the greatest sufferer from the huge volume of pollution discharged directly into the river from her homes and factories. Detroit at that time was just beginning to suffer from growing pains of expansion which, in the next few years, made it necessary to spend over $40,000,000 for sewers alone to prevent flooding of basements.

World War I intervened and was followed by postwar prosperity which added further to the problems of a rapidly growing city. In 1925, the plans recommended by the consulting engineers employed by the city involved the construction of a plant located downriver beyond the city limits. There were serious objections to this location, which resulted in legislation prohibiting the construction of such a plant by any municipality outside its own boundaries except with the consent of the municipality encroached upon. The plans had to be revised, but then the depression of the early 30's

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interfered with the financing and accomplishment of the project. Finally, in 1939, after more than thirty years of effort, Detroit succeeded in completing and putting into service an up-to-date sewage treatment plant suitable for its needs.

This plant, now in operation for the past five years, is one of the world's largest, both as to population served and the amount of sewage treated (2).

To summarize briefly the description of this plant which has appeared in the form of articles by the writer and others (3), the design is for an ultimate population of 4,000,000, and an estimated average flow of 175 gal. per capita per day. The interceptors bringing sewage to the plant have a capacity of 1,292 m.g.d. which is equivalent to a maximum flow of 324 gal. per capita per day. The treatment consists essentially of plain sedimentation, sludge incineration, and chlorination of the effluent. This degree of treatment was recommended by the consulting engineers and approved by the Michigan State Board of Health as adequate to meet the present situation, both as to local need and treaty obligations. The units installed to accomplish sedimentation and incineration are of sufficient capacity to treat the sewage from a population of 2,400,000, which capacity it was assumed would be reached by 1950, when additional units could be added. The present population served (1945) is estimated at approximately 2,200,000. For the year ended June 30, 1945, the average flow of sewage entering the plant was 315 m.g.d. with a maximum day of 472 m.g.

The plant also includes one experimental digestion tank and one elutriation tank with a design capacity for a population of 500,000, or one-eighth of the ultimate plant capacity.

The usefulness of elutriation under existing conditions has been seriously questioned. A careful 3-month test ending September 8, 1944, resulted in an actual increase in operating costs without any reduction in the chemicals required; and so far as could be determined, no corresponding benefit. The use of the unit as an elutriation tank has been discontinued. The tank is advantageously used, however, for mixing raw and digested sludge prior to filtration of sludge. The digestion unit has proved very satisfactory, not for complete digestion of sludge but for the production of gas, for which purpose it is fed sludge at the rate of thirty tons of volatile solids per day from which it produces 20,000 cu. ft. of gas per hr., having a heat value of 650 B.T.U. per cu. ft. The partially digested sludge from this unit, mixed with the raw sludge from the sedimentation tanks together with the grit and scum, forms a satisfactory filter cake which burns well in the incinerators.

Table 1 shows the annual amount of sludge fed to the incinerators and the

TABLE 1.—Incineration Data. Years Ended June 30

Year	Wet Solids		Tons Dry Solids	Per Cent Volatile	Per Cent Ash	Tons Ash	Ash (% of wet solids)
	Tons	% Moist.					
1941	—	—	55,071	53.3	46.7	25,703	—
1942	164,787	67.9	52,927	55.4	44.6	23,600	14.3
1943	164,414	68.9	51,169	54.7	45.3	23,169	14.1
1944	202,840	68.8	63,388	58.6	41.4	26,261	12.9
1945	167,488	66.3	56,431	58.5	41.5	23,400	13.9
Total	—	—	278,986	—	—	122,133	—
Average	—	—	55,797	55.1	43.9	24,427	13.8

resulting ash for the period of the five years during which the plant has been in operation.

The dry ash produced is normally about 14 per cent of the total wet sludge cake sent to the multiple hearth incinerators. The ash is sluiced into a lagoon. There are two of these lagoons, which are used alternately. Each lagoon has sufficient capacity to hold approximately one year's production of ash. As soon as one lagoon is full, it is permitted to dry for a time, and a contract is then let for removing the ash to the nearest available dump. Steam shovels and trucks are used for this purpose. Four such contracts have been let since the plant was placed in operation, and one lagoon is now ready for letting the fifth contract which will cost about $40,000. The total expenditure of $184,000 in five years to dispose of a total of 122,133 tons of ash averages $1.51 per dry ton.

Eventually, dumping grounds for 2,000 tons a month may become difficult to find within reasonable hauling distance and some other method of disposal may be necessary. If necessary, ash can be disposed of by barge, in Lake Erie, without injury to health and at a cost somewhat less than is involved by the present method. This, however, is not looked upon with favor and will be avoided if possible.

The most hopeful development, looking to the future disposal of ash, is in the use of this material for manufac-

TABLE 2.—Summary of Operation Data, Detroit Sewage Treatment Plant, for Year Ended June 30, 1944

Operation Item	Year 1943–44
Sewage pumped, total for year (m.g.)	119,751
Per day (m.g.)	327
Rainfall, total for year (in.)	29.37
Electric power, total used (100 kw. hr.)	182,593
Purchased (100 kw. hr.)	169,800
Generated (100 kw. hr.)	12,793
Used for pumping sewage (100 kw. hr.)	137,797
Kw. hr. per m.g. pumped	115
Auxiliary power (100 kw. hr.)	44,796
Screenings removed (tons wet)	1,289
Moisture (%)	79.9
Volatile (% of dry solids)	78.5
Grit removed (tons wet)	14,428
Moisture (%)	49.4
Volatile (% of dry solids)	38.3
Skimmings removed (tons wet)	594
Moisture (%)	34.9
Volatile (% of dry solids)	90.1
Primary sedimentation detention period (hr.)	1.51
Suspended solids removed (tons dry)	53,797
Volatile (%)	78.8
Sludge to digesters (1,000 gal.)	31,845
Dry solids (tons)	12,229
Solids (%)	9.1
Volatile (%)	65.8
Digested sludge withdrawn (1,000 gal.)	31,510
Dry solids	9,100
Solids (%)	6.8
Volatile (%)	54.3
Digester gas production (1,000 cu. ft.)	115,149
Cu. ft. per lb. volatile added	7.2
Sludge to vacuum filters (1,000 gal.)	141,006
Solids (%)	8.7
Volatile (%)	64.1
Conditioning chemicals:	
CaO (%)	7.6
$FeCl_3$ (%)	2.2
Filter rate (lbs. per sq. ft. per hr.)	6.1
Sludge cake solids (%)	30.3
Volatile (%)	59.7
Incinerator feed (tons wet cake)	202,840
Dry solids (tons)	63,388
Volatile solids (tons)	37,127
Feed rate (wet tons per hr. per unit)	8.9
Fuel oil per wet ton burned (gal.)	0.19
Chlorination (tons applied)	3,914
Chlorine demand (p.p.m.)	7.35
Dosage (p.p.m.)	7.85
Demand satisfied (%)	106.8
Analytical data:	
Suspended solids, influent (p.p.m.)	222
Effluent (p.p.m.)	113
Removal (%)	49.3
5-Day B.O.D., influent (p.p.m.)	116
Effluent (p.p.m.)	71
Removal (%)	38.8

turing purposes. It contains some 17 per cent calcium, together with aluminum and other chemicals which are of value in manufacturing. One experiment along this line has been made in connection with a nearby cement plant, which resulted in the production of a trial output of 1,500 barrels of cement. In this particular experiment, the ash contained too much organic matter due to the fact that the grit from grit chambers had been by-passed without incineration. This defect could be remedied easily; and the outlook is favorable for the profitable disposal of ash in the future.

An operation summary of the sewage treatment plant, as compiled for the year 1943–44, is given in Table 2.

For the same fiscal year ended June 30, 1944, the operating expense, exclusive of depreciation, totalled $1,082,220.14, as shown in detail in Table 3.

At Detroit, incineration of sludge has been satisfactory. The sludge has practically burned itself, requiring only 0.19 gallons of oil per wet ton; it has been reduced from a troublesome, noisome material to an innocuous ash; it has been reduced in volume by about 86 per cent. For a plant the size of Detroit's, however, the disposal of the ash, primarily due to the amount, is still a major operation, though minor in comparison to the problem that would be involved if it were necessary to dispose of the sludge without incineration.

TABLE 3.—Cost Data, Detroit Sewage Treatment Plant, Year Ended June 30, 1944

General plant	$ 114,638.14
Pumping station	143,657.75
Rack and grit	34,753.50
Sedimentation	44,265.12
Chlorination	170,334.49
Digestion and elutriation (net)	6,530.26
Filtration and chemical	150,517.94
Incineration and ash handling	282,870.46
Boiler plant	39,627.48
Interceptors and regulators	2,360.66
Unallocated	57,362.31
General administration	35,302.03
Total operating expense	$1,082,220.14

REFERENCES

1. Harvey, Holman, "America's Dead and Dying Rivers." *Reader's Digest*, October, 1945.
2. Hubbell, Clarence W., "Detroit's Sewage Treatment Plant." *Civil Engineering*, July, 1938, and October, 1938.
3. Thompson, G. R., and Morrill, A. B., "Detroit's Answer to a 30-Year Pollution Problem." *Sewage Works Engineering*, November, 1939.

DISCUSSION

By L. V. Garrity

Assistant General Superintendent, Department of Water Supply, Detroit, Michigan

Mr. Hubbell made brief reference to the use of sewage sludge as a fertilizer, to the fact that we have questioned the usefulness of the elutriation process under Detroit conditions and to our researches in the use of the incinerator ash as a raw material for the manufacture of portland cement. It is believed that these subjects may be of sufficient interest to warrant development to the limits of this discussion.

Sludge Disposal as Fertilizer

We are faced with the ever recurring question, from members of the profession and from the laity, of why the sewage sludge cannot be disposed of as fertilizer. In our answers to these questions, we attempt to point out that there are several important requirements that sewage sludge must meet to be considered as suitable material for fertilizer. To be applicable as fertilizer, the sludge should contain certain components, in suitable proportions and essential to plant growth, it must be free from constituents detrimental to consumer's health and to plant growth, and it should have a texture that lends itself readily to blending with the soil. Of the many elements drawn from the soil for plant growth, some are replaced by the processes of nature. The elements of nitrogen, phosphorus and potassium, however, essential to all plant growth, are drawn upon so heavily that they must be replaced through fertilization if the land is continually worked. These three elements must be present, in proper proportions, in any material before it should be considered as a fertilizer or fertilizer filler, on a competitive market.

The desirable amounts and proportions of the three essential elements may be arrived at by comparison of the analysis of the sludge with that of successful commercial fertilizers used on the soils in the areas which will provide the probable markets. Much can be determined, also, from actual field tests.

A typical analysis of the filter cake produced at the Detroit plant follows:

Constituent	*Per cent by wt.*
Total nitrogen	1.66
Available phosphoric acid	1.71
Water soluble potash	0.11
Insoluble material	16.80
Calcium oxide	12.00
Grease content (ether soluble)	18.00
Oxides of iron and alumina	11.00

In comparison, one activated sludge fertilizer produced on a commercial scale contains, from the latest analysis available to the writer, between 6 and 7 per cent ammonia (NH_3) and about 2.5 per cent of available phosphates (P_2O_5) with a moisture content of less than 7 per cent. The ether soluble matter (grease) in this product will run in the neighborhood of 6 per cent as compared with 18 per cent in the Detroit sludge cake. The sludge cake from the filters at our plant is quite fibrous and has a relatively high sand content, which characteristics detract further from its potential fertilizer value.

It is difficult to establish, generally, the amount and proportions of the desirable components fertilizers should contain because of the wide differences in the requirements of the various crops and because the nature of soil varies so widely. The most conclusive test of the fertilizing value of a given material for any crop is perhaps afforded by experimental cultures on various types of typical soils in the potential area in which the fertilizer may be economically marketed. Small scale cultural experiments at the plant site, in sandy soil, have indicated that there may be a slight increase in the yield of corn when the ground is fertilized or conditioned with filter cake. The results obtained thus far, however, are not conclusive, and there are some indications that the use of the cake tends to make the ground impervious.

From the foregoing considerations it is concluded that the raw sludge cake produced at the Detroit plant fails to meet the essential chemical and physical requirements of a desirable fertilizer or filler, and because of the present state of knowledge (or lack of knowledge) of the viability of some of the sewage borne organisms, we would not recommend its use for that purpose, particularly for root crops.

Perhaps in the future it may be necessary to refine the present processes by the addition of secondary treatment, and if that occurs it is possible that we may produce a sludge which may be economically utilized as a safe fertilizer or fertilizer filler. In the meantime, as Mr. Hubbell pointed out in his paper, we are confronted with the problem of the disposal of almost 200,000 tons of unstable wet solids each year. From experience to date at the Detroit plant, it has been concluded that the safest and most economical operation will obtain if the sludge from the sedimentation tanks is filtered and then incinerated, without intermediate digestion to any degree.

Digestion and Elutriation

As Mr. Hubbell stated, the present plant includes one digester with two elutriation tanks designed to serve one-eighth of the ultimate planned capacity. The digester has been operated continuously since 1941, and the sludge therefrom mixed, without elutriation, with the raw sludge from the sedimentation tanks and the mixture has been vacuum filtered, after conditioning with both ferric chloride and lime, and then incinerated. The gas produced has been used to operate a 240 kw. gas engine-generator and as fuel to fire the plant heating boilers.

Elutriation of the digested sludge was abandoned, after a test of three months in duration demonstrated that the process increased rather than decreased our operating costs. The digested sludge, during the period of the test, averaged 7.32 per cent solids and 49.8 per cent volatile. A total of 5,691,400 gal. of sludge, containing 1,890 tons of dry solids, was removed from the digesters and elutriated during the test run. Of this total 1,690 tons were filtered, indicating a solids loss in the elutriation wash water of 200 tons, or 10.6 per cent. As these solids are principally soluble and collodial material it would be expected that the filtration process should benefit by the removal. This was not the case.

During the test run the digested sludge was elutriated by operating the two tanks in series with two volumes of wash water used to one volume of sludge. The sludge was washed twice, using the spent wash water from one tank for the initial wash, after which the sludge was transferred to the second tank and again washed with two volumes of fresh city water.

The filter cake produced over the entire test period was much darker in color and thinner than that normally produced. It was spongy and would not strip and discharge well from the filters and the filter production rates, therefore, were only 45 per cent of those obtained in normal practice. The chemical and water costs increased the average cost of conditioning almost 50 per cent. No attempt has been made to evaluate further additional costs involved in the elutriation operation. It was found necessary, however, to have additional personnel in attendance at the elutriation tanks while the system was operated. Filter cloth life was materially lowered when in the elutriated sludge service and when ferric chloride alone was used for conditioning.

Our experience indicates that, for Detroit conditions, it is safer and more economical to reduce the raw sludge to a stable ash by incineration and, therefore, our present plans do not contemplate the addition of more digesters, but rather improvements in incinerator performance, reclamation of heat, and utilization of the incinerator ash.

Proposed Improvements to Incineration Facilities

The filter cake normally produced at the Detroit plant has a moisture content just under 70 per cent, and about 60 per cent of the solid content is combustible. The combustible portion has the relatively high heat value of about 11,500 B.T.U. per lb.

We have incinerated as much as 500 tons of this cake in 24 hours. With that load there is a total heat release in 24 hours of approximately 2,070,000,000 B.T.U., or the equivalent of that obtained from burning about 80 tons of coal per day, of the quality we are now receiving at our various plants. This sludge cake normally sustains combustion without auxiliary fuel and the 0.19 gal. of fuel oil per wet ton, cited in Mr. Hubbell's paper, is consumed mostly in the warming periods of no production, when units are taken out or placed into service, and when the fires get out of control.

When the incinerators are fed at the rate of 500 tons per day there are normally about 700,000 pounds of water to be evaporated daily from the wet feed. In this and with the heat absorbed by the water of combustion and in superheating all of the steam to the gas outlet temperatures, approximately 58 per cent of the total heat release is required. Another 19 per cent is lost through absorption by the dry gases, radiation, and in the ash, leaving a potential waste heat recovery of about 23 per cent of the total.

We have in preparation plans for the further improvement of the present incinerators, as well as plans for a different type of incinerator with waste heat recovery equipment. It is proposed to drive turbo-generator equipment with steam produced from the recovered heat. The plans contemplate that the installation may be made when the wet solids load reaches a rate of 720 tons per day. At that time, it is conservatively estimated that about 1,000 kw. can be produced from the waste heat and, with the 240 kw. production of the presently installed sewage gas engine-generator set, the total generating capacity will lie between 1,200 and 1,300 kw. It is estimated that with a favorable power exchange arrangement with the municipally owned Public Lighting Commission, it will then be possible to produce 75 per cent of the electrical energy requirements at the sewage plant.

Ash Disposal

The ash from the incinerators is stable and presently is in demand for fill material. A typical analysis of the dry ash follows:

	Per cent by wt.
Volatile and combined H_2O	8.0
Silica (SiO_2)	50.0
Iron and alumina (R_2O_3)	23.0
Calcium Oxide (CaO)	15.0
Magnesium Oxide (MgO)	2.0
Phosphates (P_2O_5)	2.0

As Mr. Hubbell pointed out, it may eventually be difficult to find dump sites for the large quantities produced. For this reason, and in our constant search for means of reducing operating expenses, we have explored several possibilities of ash utilization.

The most encouraging possibility to date is the use of the ash as a raw material in the manufacture of portland cement. In 1940, a large scale experiment was conducted in one of the large cement mills in Detroit, in which 660,000 lb. of incinerator ash, taken from the lagoons, was used as raw material for the manufacture of portland cement. The ash was mixed with other raw materials and the average amount used was about 3 per cent of the total. A total of 34,500 bbl. of clinker was produced from which some 1,500 bbl. of cement were ground, meeting all the requirements of the standard specifications, and sold to the trade.

Several things were learned relative to the use of the ash for this purpose, as a result of this experiment, the most important of which were: (1) the necessity for holding down the organic matter in the ash and (2) the desirability of maintaining a ratio of silica to the iron and alumina content of between two and three, and preferably around three.

At the time the experiment was in progress, utilizing the plant facilities as designed, as much as 50 per cent of the grit received at the plant was sluiced directly and without incineration to the ash lagoon. This procedure was necessary because the plant as designed made no provision for leveling off the grit load to the incinerators and in time of storms the full amount of grit received, if taken to the incinerators, would have smothered the fires.

Ordinarily the grit received at the plant contains about 30 per cent organic matter. This additional organic matter in the ash raises the water requirement when mixed in the slurry and thereby increases the coal consumption in the cement kiln. This detracts from its desirability as a raw material for cement manufacture.

Plans were made to correct this condition by providing a grit storage hopper, from which the grit may be fed by screw conveyors at the proper rate to the incinerators, where it will be burned and free of the undesirable organic matter. These plans were interrupted by the war and the resultant lack of necessary material, but we are now in a position to proceed with the installation. With the control offered through the grit storage bin installation it is believed we may also be able to maintain the optimum silica to iron-alumina ratio.

In closing, it is to be emphasized that this discussion is limited only to the operation of the Detroit sewage treatment and, as everyone concerned with sewage treatment knows, our findings under Detroit conditions may not be indicative of what may be expected in the similar treatment of sewage in other communities.

DISCUSSION

By R. A. Greene

Chemist, Sewage Treatment Plant, Jackson, Michigan

It has been said many times that if the solution to the problem of sludge disposal could be found, the major headache in the whole field of sewage treatment would be solved. This is probably true in the majority of plants, but it is also noted that in some plants sludge disposal is a lesser problem than in others. This might be due to a more advantageous location or to better facilities provided at some plants.

Plants that are not bothered particularly with the sludge disposal problem are the few that take the raw sludge by barge to sea and dump it. Another fortunate group, also relatively small, includes the plants having ample lagoon capacity for all of their digested sludge. In both the above cases disposal of the sludge provides little trouble in so far as plant operation is concerned and the expense involved is considerably less than in the greater number of plants in which additional handling of sludge is required before final disposal is accomplished.

The problem is also considerably lessened if there is a place available for disposition of the processed sludge. If there is a ready sale for the sludge either from drying beds or from vacuum filters, it will do away with incineration and disposal of the ash content. Use of the sludge for fill purposes also eliminates the incineration problem.

Plants that have to process (digest, vacuum filter, dry on beds) the sludge are the ones that have the most difficulties. It is in these plants, and most plants fall in this category, that the disposal of the sludge is most likely to affect the operation of the plant as a whole. Where the raw sludge is dumped at sea and where there are lagoons to receive the digested sludge, there are not strict requirements as to the quality of the sludge. But where the sludge is vacuum filtered or dried on beds, the sludge should have those qualities which make it most economically processed. Consequently, in most plants digestion is the step in the processing of sludge for disposal around which many of the troubles arise.

Lack of digester capacity is often found, and in such cases a poor draining or poor filtering sludge is unavoidable. A poor supernatant or no supernatant at all is produced, which more often than not deteriorates the quality of the plant effluent. This is especially true if the plant includes secondary treatment by activated sludge. Complete treatment plants that have 3 cu. ft. or less of digester capacity per capita are almost always deficient in this element. This has probably been caused partly by the inconsistencies in computation and expression of digester loadings. The statement of digester loading in pounds of solids per cubic foot of digester capacity per month is a term that is often misleading; no one would expect to digest the same amount of raw solids per unit volume and time with a volatile content of 70 per cent as with a volatile content of 60 per cent. It is suggested that a more accurate statement of digester capacity would be in pounds of *volatile* solids added per cubic foot of digester capacity per month, and that the best expression of digester accomplishment is in pounds of volatile solids digested per cubic foot per month. The latter would be a measure of the actual amount of solids destroyed in a given length of time per unit of volume. Data in these units would provide a much better basis of comparison with other plants.

Experience at Jackson, Michigan, over a long period of time has been that not much more than 0.5 pounds of volatile solids can be digested per cubic foot of total digester capacity per month and still produce a fair supernatant. This is when the digesters are operated at 85° F. At higher loadings the sludge from the digester will not concentrate satisfactorily and will not dewater well on the drying beds. At this loading the concentration of the digested sludge is about equal to that of the raw sludge pumped into the digester. It seems that such a concentration of the digested sludge should be the minimum and in most cases a concentration exceeding that should be attained.

It has been known for some time that very rapid digestion would occur at thermophilic temperatures, but the digested sludge had always been difficult to dewater. Multi-stage digestion with only the primary digester being heated to thermophilic temperatures produces a sludge that can be readily dewatered. The second stage and also the third stage, if available, need not be heated at all. There may be some physical change that takes place when raw sludge is heated to thermophilic temperatures and kept there until it is completely digested. Even though the sludge was concentrated and low in volatile content, the dewatering qualities were poor. The drop in temperature through the second and third stages restores this quality to a great extent. Certainly a well digested thermophilic sludge will dewater better than an incompletely digested mesophilic sludge. By using multi-stage thermophilic digestion, about 1.6 times as much volatile solids may be digested as with mesophilic digestion and still produce a good filtering sludge.

The use of thermophilic digestion as an aid to those plants lacking in digester capacity would be limited. Thermophilic digestion requires about twice the quantity of heat as does mesophilic digestion at 85° F., so there would have to be sufficient gas or waste heat available. Thermophilic digestion is also more difficult to operate; a quick change in temperature of five to ten degrees can completely upset the digestion process. The above mentioned drawbacks would limit its use to medium sized and large plants.

Whether the lack of digester capacity be remedied by use of thermophilic digestion or by an increase in digester capacity, the production of a sludge that dewaters readily would help in many plants to overcome the sludge disposal problem.

INCINERATION OF FINE SCREENINGS AT NIAGARA FALLS, N. Y.

By Edward J. Smith

Superintendent, Sewage Treatment Plant, Niagara Falls, N. Y.

The established and formerly satisfactory method of operating the screenings incineration process at Niagara Falls was seriously upset by changed conditions deriving from wartime industrial activities and, consequently, it has been necessary to revise operating procedures and equipment to meet the new requirements. These improvements were made following a long period of experimentation and have resulted in a successful solution to the problem.

The Niagara Falls sewage has always been largely of industrial origin, there being in 1940 about 12 volumes of industrial wastes to one of domestic sewage. Wartime activities nearly doubled the volume of industrial wastes and the tributary population has increased about one-third since 1940. Table 1 presents data illustrating the increased volume and suspended matter content of the sewage.

TABLE 1.—Effect of Wartime Activities on Sewage Flow *

Year	Ave. Susp. Solids in Plant Influent (p.p.m.)	Percentage Increase Over 1940				
		Flows to Plant		Dry Solids		Total
		Domestic Sewage	Ind. Wastes	Domestic Sewage	Ind. Wastes	
1940	245	—	—	—	—	—
1941	295	12.5	29.5	12.5	11.3	11.4
1942	311	27.2	30.1	27.2	20.8	21.4
1943	313	39.5	62.0	39.5	46.3	45.6
1944	477	33.3	42.0	33.3	102.5	97.5
1945	369	25.0	64.0	25.0	87.5	81.5

* Based on dry weather flow periods of May to September, inclusive, of each year.

The effect of this overload early in the war period was to create intermittent odors of obnoxious character during the incineration process. It is believed that the change in the quality of the sewage, brought about by the increased flows of industrial origin, was mainly responsible for the difficulty.

Original Method of Screenings Incineration

Sewage treatment at Niagara Falls consists of fine screening with disc screens followed by chlorination of the screened sewage. The screenings are disposed of by incineration.

The original plans included facilities for the dehydration of the screenings before incineration, but the dehydration process was omitted due to failure of the contractor to furnish adequate equipment. Provision was made, however, for the installation of the dehydration process at such time as it might prove necessary. Until recently, therefore, the screenings were incinerated in a wet state as removed from the screens and, as would be expected, auxiliary fuel was required to effect

* Presented at meeting of Western Section, New York State Sewage Works Assn., held at East Aurora, N. Y., September, 1945.

incineration since there was not sufficient fuel value in the wet screenings to evaporate the 85 per cent moisture content. The additional fuel is in the form of coal or fuel oil, but coal is used whenever possible because it is the most economical.

The burning of wet screenings, with incidental evaporation of large amounts of moisture, may appear to be unduly expensive at first thought. Careful analysis, however, of the increased wet screenings incineration cost as compared to the savings in equipment, materials, and labor effected by the omission of the dehydration equipment indicated the former procedure to be most economical. This analysis was based upon fuel and labor price levels that existed before the war.

Another item leading to the original adoption of incineration of the screenings in a wet state was the fact that burning temperatures in the incinerators could be reduced to a minimum without danger of odor nuisances as a result of such low temperature operation.

It became evident in the summer of 1942, when numerous complaints of obnoxious odors were received, that modifications were necessary in the incineration process. A series of experiments and tests were begun immediately to investigate the cause of the odors and to determine a remedy.

There are two types of odors resulting from incineration in this plant. One is the distinct chemical or metallic type of odor that is prevalent throughout the city as it comes directly from the stacks of the industrial plants or from their processes of manufacture. Trade wastes from these industries are removed by the fine screens at the sewage treatment plant and, when incinerated, they produce the same odors as are emitted from the industrial plants themselves. These odors, while not pleasant, prevail generally through the city and it is not possible to eliminate them at the screenings incinerator.

The second type of odor derives from the burning of the organic matter in the screenings. This organic matter is of both industrial and domestic origin but the odors produced in burning it are about similar to those resulting from the incineration of ordinary domestic sewage sludge.

Effect of Increased Temperature

The incinerator used at Niagara Falls is of the vertical multi-hearth type with drafts arranged in such a manner as to perform the evaporating and burning functions but not to subject the exhaust gases to the high temperatures essential to eliminate organic odors.

It was promptly determined by experiment that organic odors were eliminated from the stack gases if the exhaust gases were subjected to temperatures from 1,600 to 1,800° F. following the evaporation and burning processes. For immediate relief, therefore, the exhaust gas circulation system was rearranged in so far as it could be without disturbing incineration efficiency, and temperatures were increased to the above range.

This method of operation proved to be very expensive because of the increased requirement for auxiliary fuel to maintain the high temperatures. Both coal and oil were necessary war items and, upon occasion, were not available at all. There was also an appreciable advance in the price of both fuels.

In order to reduce fuel requirements to a minimum, temperatures sufficient to control the organic odors were maintained only when necessary during the hours that the odors might be most objectionable. The attempt to carry variable temperatures at the incinerators resulted in expansion and contraction of the brick hearths and they soon showed distinct signs of permanent damage.

The above complications in incinerator operation and the inability to obtain positive control of odors at all times clearly indicated that more radical changes were required. It was then decided to install the screenings dehydration facilities and to make radical changes in the incinerator so as to effect a complete solution to the problem. At the same time, it was decided to incorporate other improvements in regard to the waste heat boiler, feeding and storage of sludge and in the conveyance equipment.

Development of Improvements

The decision to install dehydration equipment was based on the following reasons, listed in their order of importance:

(1) To make it possible to control odors completely, which could not otherwise be done unless the incinerator was entirely rebuilt.

(2) To effect economy in auxiliary fuel requirements.

(3) To conserve critical war supplies of coal and fuel oil.

(4) To utilize the waste heat boiler for heating of the building, without the use of auxiliary fuel.

(5) To make it possible to maintain a constant high temperature in the incinerators, without undue use of auxiliary fuel, in order to eliminate damage to the structure from expansion and contraction.

Considerable time was spent in the selection of the dehydration equipment. Inspection trips were made to several cities throughout the country and the merits of the various types of equipment thus observed were studied with the special requirements and limitations of the Niagara Falls problems in mind. The equipment finally selected was a sludge press having a capacity of 2,600 lb. of dehydrated sludge per hour. This same type of unit has been in service at Milwaukee for a number of years and is said to have given satisfactory results. Conditions at Milwaukee are quite similar to those prevailing at Niagara Falls. The simplicity, low maintenance cost and ease of operation of the equipment were other factors that lead to its selection.

The other improvements (Figure 1) which were planned to be made to existing facilities at the same time the dehydration equipment was installed, were intended to accomplish the following:

(1) The provision of better discharge facilities at the large wet screenings storage tanks was expected to make possible the use of these tanks to advantage. These storage units, each having a capacity of 1,400 cu. ft., are a part of the original plant but they were not usable on account of design deficiencies.

(2) Conversion of the present conveying equipment in such a manner as to make it possible to eject pneumatically the dehydrated screenings to either incinerator.

(3) The provision of better feeding facilities from the small dry sludge storage tanks to the incinerator. This change includes the improved provision for discharge of wet screenings from these tanks when they might be used for storage purposes. There is one of these 700-cu. ft. tanks serving each incinerator.

(4) The rebuilding of the incinerator so as to omit three evaporating hearths and thus reduce maintenance costs on plows and rabble arms by one-third.

(5) The elimination of the bucket elevator now used for feeding sludge from the dry storage tank to the incinerator, made possible by the above change, effects a further reduction in maintenance costs.

(6) The installation of a small coal pocket of measured capacity and a feed device that would make it possible to fuel the incinerator constantly at a very low rate, thus eliminating temperature variations resulting from intermittent discharges of coal at high rates.

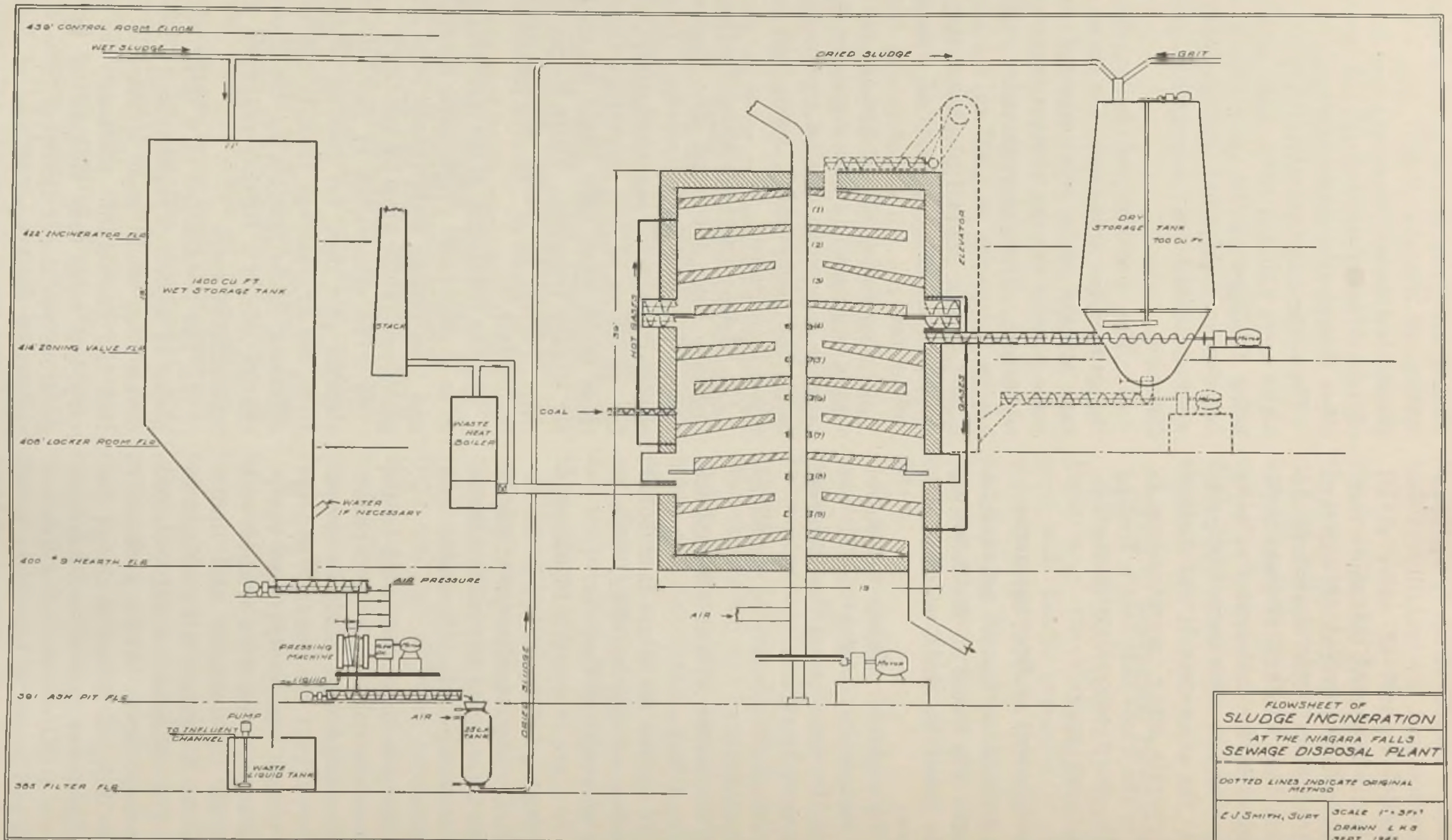

FIGURE 1.—Diagrammatic section of screenings dewatering and incineration process at Niagara Falls, N. Y. Original process indicated by dotted lines.

(7) Revamping of the drafts and exhaust gas passages in the incinerator for the accomplishment of better temperature control, odor elimination, improved utilization of the waste heat boiler and general improvement of efficiency.

The equipment was finally ordered in January, 1944, after a long delay occasioned by priorities. Due also to war conditions, delivery was not made until 11 months had elapsed. Installation was performed entirely by regular plant mechanics. Parts of dismantled items of equipment were utilized throughout the job wherever possible.

Provisions for Future Needs

Care was taken to install equipment that not only would be sufficient for present needs but that would fit in with about any future condition, even to a complete restoration of the former method of operation. One complete incineration unit has not been changed. This can, of course, be equipped similarly to the revised unit or it can be used as a spare incinerator in case it becomes necessary to remove the rebuilt unit from service.

At present there is no standby dehydration equipment; the equipment selected, however, is very simple. There is now liberal available storage for both wet and dry sludge and there should be ample time to make even quite extended repairs without having to revert to the original system of operation. There are, moreover, several other operation procedures and combinations that can be resorted to in emergency. If other dewatering units are to be added they can be of larger or smaller capacity.

Present Method of Operation

Each shift operates the dehydrating equipment and dewaters the material accumulated during the previous shift. This, if possible, is retained in the ejector pots and not stored in the large storage tank. The wet screenings are still likely to arch and lodge in the large storage tanks, and remedial measures have not yet been worked out entirely.

The screenings are discharged from the ejector pot into the large tank and pass slowly through the sludge press. From the sludge press, after dehydration, the cake is elevated by the pneumatic system to the dry sludge storage tank that feeds the incinerator. Each storage tank has a screw feed with stirring paddles to preclude any arching of the tank contents. The screw feed and conveyor are equipped with an adjustable drive and deliver the material to the proper point.

The incinerator is charged at a slow rate in order to avoid disturbance of the heat balance in the incinerator between the several hearths. The dehydrated cake is almost dry enough to burn without the use of auxiliary fuel. The sludge burning cycle, however, covers less than one-half of the total shift so that coal must be fed in small amounts at least to maintain temperatures and to keep the fires intact. Auxiliary coal is fed from the storage bunkers at a constant rate, consistent with the requirements of the incineration process.

There was a waste heat boiler furnished with the original equipment and this boiler was expected to furnish the heat for the building in winter. This was a successful installation provided that the incinerator was operated at very high temperature, but this involved a high consumption of coal and was too expensive. In order to cut down on the auxiliary fuel and to run the incinerators at lower temperatures, the waste heat boiler was disconnected and converted to an ordinary boiler fired with coal and entirely separate from the incinerator system. This accomplished the purpose at a saving of considerable coal, but a waste heat boiler is not adapted to efficient service as an individually fired unit.

The original provision for circulation through the incinerator was never right as far as odor control was concerned. It was the intent of the manufacturer to effect evaporation by passage of the hot gases from the burning hearths over the evaporating hearths in such a manner as to utilize heat from combustion to assist in the evaporation. By so doing, however, the gases lost their heat and then were partly reheated and mixed with other spent gases, which passed through the waste heat boiler (when used as such) and then up the stack.

Without going into too much detail concerning the various circulation paths of the hot gases in their functions of evaporating and incineration, it is sufficient to state that while the gases might at certain points in their circulation attain the temperature required for the destruction of organic odors, there always was a part of the discharged gases that contained evaporated vapor. This was the fundamental weakness of this particular incinerator that had to be overcome before positive control of odors could be achieved.

With the new revisions the entire evaporating function of the incinerator was eliminated. The hot gases are now circulated in such a manner that, after burning at the critical temperature necessary, they are not allowed to perform any evaporating functions before exit to the stack and must pass over the hot hearths, thus insuring perfect elimination of organic odors as far as possibly can be done.

While it is expensive and costly to raise the gases to this temperature by use of auxiliary fuel, for at least six months in the year such fuel is not wasted, since it can be credited to building heat. Thus, in the modified path of circulation of gases, the waste heat boiler is now located between the hot hearths and stack. The stack is sufficiently large to furnish the required draft, no matter how low the temperature of the gases entering the stack, as long as only one incinerator is being used.

Dehydration Results

Data representing the moisture content of the screenings, after dewatering in the filter press, are presented in Table 2. The initial moisture content of the wet screenings as delivered to the press averaged about 85 per cent, ranging from 82 to 88 per cent. The indicated reduction of the moisture content from 85 to 60 per cent represents a percentage removal of water from the screenings of 73.5 per cent.

TABLE 2.—Per Cent Moisture in Pressed Screenings, May to August, 1945

Day of Month	May	June	July	August
1	60.2	59.6	69.8	57.6
2	56.2	57.2	65.0	57.0
3	61.8	57.8	59.0	59.2
4	55.4	56.8	60.6	58.6
5	57.4	55.8	56.4	70.2
6	65.8	56.8	62.6	70.2
7	65.4	57.4	62.6	63.6
8	56.2	56.4	—	64.4
9	55.8	54.0	—	58.6
10	54.8	63.2	—	58.6
11	62.6	58.4	—	66.0
12	57.2	52.4	—	68.0
13	61.0	53.6	—	67.8
14	62.8	56.6	—	48.8
15	57.6	45.0	—	62.6
16	64.8	—	61.4	72.2
17	53.0	—	58.4	60.4
18	52.0	58.4	56.6	58.2
19	54.0	59.6	62.2	59.6
20	62.8	66.6	56.4	70.6
21	61.6	66.0	61.2	59.6
22	61.4	56.6	59.4	61.6
23	57.4	50.8	67.6	61.6
24	52.8	58.6	61.6	65.6
25	53.4	62.6	62.6	58.8
26	58.4	60.0	60.6	60.2
27	64.0	61.2	57.6	74.0
28	68.4	60.6	56.0	61.4
29	56.4	57.2	66.0	56.4
30	58.4	64.0	66.6	60.8
31	62.6	—	59.8	64.0
Average	59.1	58.0	61.3	62.5

The data contained in Table 2 cover only the summer period of May to August, 1945. It is in these summer months that the odor problem is most critical.

Economies Effected

The cost of fuel for use in the Niagara Falls plant is a relatively minor item, amounting to only about 5 per cent of the total operation expense. By converting the gallonage of fuel oil used in the period November 1, 1939, to October 31, 1944, to the equivalent tonnage of coal, and adding this value to the actual tonnage of coal also used in the same 5-year period, it is determined that the average daily rate of coal consumption prior to the changes reported here was 2.86 tons. The present rate of feeding coal to the incinerators is 2.25 tons per day, an indicated reduction of 0.61 ton per day or 21.3 per cent. Auxiliary fuel consumption at this time is about the same as it was in the early years of operation when loadings were much lighter.

Although it is too early to furnish precise data, it is believed that maintenance requirements of the equipment now in use will be appreciably less than previously. It has already been mentioned that the present uniform incinerator temperatures will lengthen the life of the linings, which will be a heavy replacement item when the time comes. The new rabble installations are simplified and will involve less expense for labor and repair parts. The bucket elevators, now dismantled, were a source of expense for replacement parts and required a good deal of the mechanic's time that now may be employed to advantage on other work.

The labor needed to operate the sludge press is no more than was required to feed the wet screenings formerly. This operation, once completed, releases the men for duty elsewhere.

Conclusions

It is too early to tabulate completely all of the benefits and savings that should result from the plant improvements and revised operation procedures. It will be evident that continuing maintenance costs and long term expenses for renewal of equipment are involved in addition to fuel and labor costs. Observations to date indicate clearly, however, that the following aims have been realized:

1. The odor problem has been solved in highly satisfactory fashion without increasing operation expenses.

2. General operation of the plant has been vastly improved, both in efficiency and economy.

3. The present solution of the problem has entailed a moderate outlay and the plant changes made may be readily incorporated into an ultimate program to be carried out at a later date when cost and labor conditions are more favorable.

THE DETERMINATION OF SUSPENDED SOLIDS IN SEWAGE

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The accurate determination of suspended solids is a very important operation in sewage works practice, since frequently by government regulations final effluents must not contain more than 30 p.p.m. of suspended matter as discharged into streams or otherwise released from the sewage treatment plant. In addition, the measurement of suspended matter is usually required regularly as an indication of changes in the characteristics of the sewage, of the load imposed on percolating filters, and of the efficiency of sedimentation or flocculating processes throughout the various operations of sewage purification. In standard references on water and sewage (1, 2, 3) the determination of suspended solids is carried out by filtering a measured volume through a Gooch crucible with suction, followed by drying and weighing the crucible in the usual manner.

The filtration of many types of sewage effluents by this procedure is an exceedingly time-consuming operation. The colloidal or semi-colloidal nature of part of the suspended matter results in rapid clogging of the asbestos mat in the crucible, and strong suction seems to merely aggravate the condition. Decreasing the thickness of the mat from the recommended 2 to 3 mm. allows more of the finer particles to pass through the filter and gives an increasingly turbid filtrate.

Some determinations of suspended solids in effluents from Imhoff tanks receiving sewage from a large native compound at Rhokana Corporation, Nkana, Northern Rhodesia, prompted the writers to try modifications of existing procedures. These effluents appeared to be particularly difficult to filter, probably owing to their high carbohydrate content derived from the predominantly maize diet of the African.

It was hoped that a centrifuge could be used to effect a separation of the effluent into a large volume of clear, rapid filtering liquid and a very small quantity of solids which would require a minimum of wash water in transferring from the centrifuge vessel to the Gooch crucible. Centrifuging, however, at speeds up to 2,000 r.p.m. with a precipitating force exceeding 1,000 times that of gravity, failed to give any observable decrease in turbidity of the sample. It is possible that a super centrifuge would have given a satisfactory separation, but this equipment is rarely available in sewage works laboratories.

The addition of a reagent to induce flocculation of the effluent, and hence speedier filtration, is fraught with many difficulties. In the first place such a reagent must be water-soluble and have no effect, either by direct chemical action or by an alteration in the pH of the liquid, on the effluent. For instance, the addition of aluminum sulfate to an alkaline or neutral solution, with the resultant precipitation of aluminum hydroxide, would increase the suspended solids of the effluent. Secondly, the addition of a neutral salt or other water-soluble substance having an electrical charge opposite in sign to that of the fine particles is not effective in flocculating effluents, owing to their complex nature and the presence of protective colloids like soaps and starches.

Attention was then directed to filtration in a Gooch crucible and a number of variations in suction, depth of asbestos mat, use of sintered glass crucibles, etc., were attempted. The procedure finally developed, which dispensed with both asbestos and suction, is given below. It is believed that this method may be applied successfully for the filtration of other obstinate solutions than effluents.

Suggested Procedure

Prepare a Gooch crucible in the customary manner, using slight suction, with a 6- to 8-mm. layer of best quality filter paper pulp. Dry at 105° C. and weigh. Place a short length of rubber tubing provided with a pinchcock over the end of the stem of a 75-mm. diameter long-stemmed glass funnel. Fill the funnel about ¼-full of water and place the Gooch crucible in the funnel. Carefully pour filter paper pulp around the space between crucible and funnel, being careful to avoid spilling any pulp into the crucible. This can be done by temporarily fitting a stopper in the Gooch crucible.

Drain out a portion of the water, by opening the pinchcock at the bottom of the stem, each time more pulp is added until a good layer is present. Tamp the pulp with a glass rod into a continuous, compact layer between the crucible and the funnel. Water must not drain below the bottom of the crucible, otherwise air is admitted and the continuous water layer between crucible and funnel stem, on which the rapidity of the filtration process depends, is broken.

Remove the rubber tubing and pinchcock from the funnel stem. If the paper pulp has been properly packed around the crucible, water will drip slowly from the funnel and an airtight column will be maintained. Place the funnel containing the Gooch in an ordinary funnel stand and filter the effluent through the crucible in the usual manner. Wash off any adhering paper pulp from the outside of the crucible, dry at 150° C., and weigh. Before filtering the effluent pass about 25 ml. of distilled water through the crucible to allow the filter paper to resume its original bulky pulped form. If the first few milliliters of the filtered effluent come through turbid, refilter.

Discussion

It has been found that this procedure gives excellent results in both clarity of filtrate and rapidity of filtration for suspended solids in effluents which were formerly exceedingly troublesome. For instance, 100 ml. of the Imhoff tank effluents, referred to above, could be filtered clear in this way in 45 minutes compared with 8 hours required when using asbestos in a Gooch crucible with suction. It appears that there are two factors responsible for this improvement. The large volume of paper pulp probably provides a better filtering medium than a thin dense pad of asbestos, which rapidly becomes choked with a relatively impervious layer of fine suspended solids. The very gentle downward pull induced by the unbroken column of water in the funnel does not bind the fine particles of the effluent into a tight mass on the paper pulp. That the latter is an important factor is shown by poor filtration secured when ordinary suction, even at a very low rate, is applied to a Gooch crucible provided with a thick layer of paper pulp in place of the conventional asbestos mat.

In the procedure given for suspended solids by some authorities (2) it is indicated that a slight turbidity may be found after filtration of certain effluents, but this is disregarded on the assumption that such finely divided suspended matter will not settle within a reasonable time after its discharge into a stream. We believe that a neglect to obtain a clear filtrate may lead to wide variations in values for suspended solids obtained by different workers on the same sample. It should be recalled that precipitation of the finely divided particles of an effluent may occur shortly after its discharge into a stream, through the influence of many factors such as changes in pH, composition of the water, trade wastes, etc. Even a slight turbidity in a filtered effluent may exceed the low limit of 30 p.p.m. suspended matter insisted upon by some regulatory bodies. We believe that the procedure outlined above will enable clear filtrates to be obtained in a reasonable time.

Summary

A modified technic for the filtration of suspended solids in sewage effluents is described. This procedure has proved very satisfactory for obtaining clear filtrates from an exceptionally difficult effluent in much less time than was formerly required for this determination.

References

1. American Public Health Association, "Standard Methods for the Examination of Water and Sewage," 8th ed., New York, American Public Health Association (1936).
2. Ministry of Health, "Methods of Chemical Analysis as Applied to Sewage and Sewage Effluents," London, H. M. Stationery Office (1929).
3. Suckling, E. V., "The Examination of Waters and Water Supplies," London, J. and A. Churchill, Ltd. (1944).

DISCUSSION

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We have tried the paper pulp method suggested by Messrs. Young and Liebowitz, using 50 ml. of mixed activated sludge liquor (90 mg. of sludge on the mat), and find that the material will filter easily in less than 15 min. using a 25-ml. Gooch crucible. The success of the method seems to be due to two factors: (1) the "fluffing up" of the mat before starting the filtration and (2) the use of a very mild vacuum, *i.e.*, a 6- to 8-in. negative head of water in the stem of the funnel.

There are two disadvantages to the proposed method: (1) the determination of volatile matter in the filtered solids is difficult and (2) the technic described of matting the crucible into the funnel is time-consuming. This latter difficulty, however, is easily overcome. Instead of the funnel, place a glass tube about 6 or 10 in. long in a No. 5 rubber stopper and attach to the rubber stopper a piece of 118 by 4-mm. rubber hose, into which the base of the Gooch crucible fits snugly. At the bottom of the glass tube a short piece of rubber tubing with a stopcock is fitted and operated as described by the authors. The length of the glass tube can be varied to secure the amount of suction desirable for the particular material being filtered.

The poor quality of the asbestos presently available for Gooch determinations has made the filtration of sewage and sewage effluents a problem. We have found that the asbestos must be washed free of "fines" until the usual mat, when wet, draws a vacuum of about 6 in. of mercury under our conditions. The asbestos requires from 2 to 10 washings by decantation to remove the "fines" which clog the pores of the mat.

* Chairman, F.S.W.A. Committee on Standard Methods of Sewage Analysis.

CERTIFICATION OF SEWAGE TREATMENT PLANT OPERATORS *

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An action by the government delegating the exclusive right to a particular group of individuals to perform a specific activity, by a process such as licensing or certification, involves a fundamental rule of life and restriction of freedom that may not properly be lightly undertaken. For by the very act of licensing, the use of full governmental authority is at least implied in denying to the remaining individuals the right to make a living in the particular field concerned. It may very properly be asked by what right and for what purpose the authority of government may be so invoked to limit the action of individuals. The argument that the lot of the individual so licensed will be improved by such governmental action is poor justification indeed for such limitation of individual freedom. Only in so far as this action can be shown to protect the public interest can there be any justification for such interference by the government in the life and activity of the individual.

So, if licensing or certification of operators of sewage treatment works is a proper activity of government, then it may properly be done only if certification will in one way or another clearly benefit or protect the public interest. This criterion would appear to make mandatory a showing that by the procedure, the public interest is better protected by reason of improved pollution control, by better protection of public property, by elimination of conditions of nuisance, and by obtaining the optimum return in service per unit of expenditure of public funds.

Justification for Licensing

It cannot be shown that licensing will of itself insure, unfailingly, that all of these criteria will be fully realized. For at best, licensing can only reasonably insure that the holder has the capacity to do the work involved, and less accurately, that he has the disposition to do the work, but cannot guarantee that he will actually perform. It can be shown however, that individuals unqualified by knowledge, training, aptitude, and experience, will fail to operate facilities in a manner which will secure optimum performance. It can be shown that incompetence, whatever the cause, will result in increased depreciation of equipment. It can be shown that neglect, whether occasioned by indifference or ignorance, will result in creation of a public nuisance at a facility intended for public protection. It can be shown that intelligent appraisal of available facilities will point the way to securing maximum performance from these facilities, and direct the way toward appropriate correction of existing limitations. It can be shown that replacement of skilled and experienced personnel with men inadequately trained and with limited or no experience in the field will result disadvantageously to the public interest. So it would seem that the case for exercise of the authority vested by the people in their government can be sustained in this instance.

The Licensing Authority

Accepting that premise, how then should this authority be exercised? In one form or another, the people have generally expressed their determination to have streams and public water-

* Presented at Twelfth Annual Convention, The Canadian Institute on Sewage and Sanitation, held at Windsor, Ont., Canada, on November 5–6, 1945.

courses protected from pollution, and to have the liquid wastes of the communities properly collected, treated, and disposed of in a satisfactory manner. They have, in a variety of forms, delegated authority to certain governmental agencies for execution of this policy. This in many instances, takes the form of requiring that plans for collection and disposition of such wastes receive the sanction of some specific agency, most often a health organization. It seems logical, therefore, that whatever agency is charged with this duty and responsibility might well be the agent through which this additional and complementary function of government should be exercised. This is not exclusively an interest of government representing the public, however. The individual or the group of individuals who are to be so licensed have, properly enough, a specific and personal interest in the execution of such policies. So it is quite proper that they too have a voice and opportunity for action in the administration of such a plan. The employers of the licensed individuals, the cities and villages, might properly claim that they too are directly concerned, for the licensed individual becomes, finally, one of their employees, whose salary they must pay and upon whose competence they must rely, and for whose actions they are responsible. So it might well be that in one form or another, recognition should be given to these three interests in adopting any plan of licensing or certification.

Licensing in Michigan

Responsibility for the control and supervision of sewage treatment works at a state level in Michigan has been vested in the State Commissioner of Health since the passage of Act 98, P.A. 1913. No specific authority was written into this act giving the commissioner power to certify or license sewage treatment plant operators. It was felt, however, that the general health laws of the state, together with the specific authority granted in this Act were broad enough to sanction such procedure. After a committee representing the Michigan Sewage Works Association had investigated the matter and it had been given consideration by the association for several years, a resolution requesting the commissioner to adopt such a plan was unanimously adopted. Rules and regulations covering a certification plan were then prepared and adopted by the State Advisory Council of Health as required by law. The matter was also discussed with the Michigan Municipal League before the rules and regulations were adopted.

After the plan had been put into effect for several years, the question of the validity of the regulation was raised in connection with the certification of an operator for one of our municipalities. The Attorney General's advice was sought and his formal opinion stated that authority for such certification or licensing could not be inferred, and in the absence of specific authorization by statute, the regulation in question was not, in his opinion, enforceable. In view of that opinion and pending action by the legislature delegating such specific power to the Commissioner of Health, that portion of the regulations making certification mandatory was abandoned and a plan of voluntary certification was adopted. This plan provides for a Board of Examiners, at least one of whom shall be an operator. No fees are charged for examination. The place and time of examinations are not fixed and in practice have been given simultaneously at three locations most convenient for the operators. No examinations have been held during the war. Provision is made for revocation of a certificate, after a hearing, for the practice of fraud or deception in the examination, or for negligence in the discharge of duty.

Classification of Plants

Under this plan, the plants in the state are subdivided into four classifications designated by the letters "A," "B," "C," or "D." The classifications are made by the Board according to population served, type of plant, character of sewage treated, and the use and nature of the body of water receiving the effluent. Plants serving 40,000 or over are designated as Class A, between 10,000 and 40,000 as Class B, between 2,000 and 10,000 as Class C and less than 2,000 as Class D. Plants below Class A in population served may be classified in a higher group by reason of having special features of design or characteristics more difficult to operate than is usually found in plants of smaller size, or by reason of particular stream conditions or combinations thereof. Plants including mechanical devices and methods of treatment such as aerators, recirculating filters, and chemical precipitation, are classified not lower than Class B, except where populations less than 2,000 are served. Corresponding certificates are recommended for a person who demonstrates to the satisfaction of the Board that he possesses the necessary "knowledge, skill, training, and personal characteristics to satisfactorily operate" plants of that classification or lower, except that no certificates are issued in the Class D group.

Examinations

The examinations for determining the qualifications of an applicant for certification are divided into four major sections:

1. The educational qualifications of the applicant.
2. The experience qualifications of the applicant.
3. The personal characteristics of the applicant.
4. The technical knowledge of the applicant on the general subject of sewage treatment plant operation in any or all of its phases.

Applicants are required to submit statements of their educational and experience qualifications and the names of four character references. A candidate must attain a minimum grade of at least 60 in each part of the examination and a weighted average grade of 70 in the four sections to become eligible for certification. This weighted grade is calculated by adding 10 per cent of the grade in Section 1, 30 per cent of the grade in Section 2, 10 per cent of the grade in Section 3 and 50 per cent of the grade in Section 4.

In determining the rating for an applicant's education and experience qualifications, a schedule was worked out as follows:

SCHEDULE FOR DIVISION I—EDUCATIONAL QUALIFICATIONS

(Total credit may not exceed 100)

BASIC GRADE

(Credit awarded for one item only, not additive with other items in basic grade schedule)

	Class A	Class B	Class C
Grade School	10	30	50
Graduation from high school	40	60	70
College—Sanitary Engineering graduate	90	90	90
College—Graduate engineering other than sanitary	80	85	85
College—Graduate, other than engineering	70	80	80

ADDITIONAL

(Credit additive to basic grade credit)

Advanced degree in sanitary engineering	10	10	10
Short course work in sewage treatment	10	20	30
Other work (correspondence courses, uncompleted high school and college course, trade schools, special courses, etc. Credit as determined by Board)	—	—	—

SCHEDULE FOR DIVISION II—EXPERIENCE QUALIFICATIONS

(Total credit may not exceed 100. Credit awarded for any single item from any single group may be added to credits awarded for items in other groups in determining total but not more than one item in a single group may be used.)

GROUP A

	Class A	Class B	Class C
1. Responsible charge of operation of Class A plant for two years	60	80	80
For each year of 8 additional years add	×5=	×2=	×2=
Total			
2. Less than two years in responsible charge Class A plant, or subordinate but position requiring some responsibility, direction of others, some technical knowledge, or responsible charge Class B plant for two years	30	60	70
For each year of 3 additional years add	×15=	×12=	×5=
Total			
3. Position of minor responsibility at Class A or B plant involving only execution of directions given by others, or responsible charge Class C plant, for two years	20	30	60
For each year of 3 additional years add	×5=	×20=	×10=
Total			

GROUP B

1. Responsible position in engineering design of sewage treatment works for five years	40	60	70
For each year of 4 additional years add	×5=	×5=	×5=
Total			
2. Subordinate position in engineering design requiring technical knowledge of art of sewage treatment for two years	15	30	60
For each year of 3 additional years add	×5=	×10=	×10=
Total			

GROUP C

	Class A	Class B	Class C
1. Responsible charge of operation of water purification plant for at least 3 years	25	30	50
2. Position of responsibility involving direction of others in fields other than sewage treatment for 5 years	20	30	50

GROUP D			
1. Employment with State or Federal Departments of Sanitary Engineering on assignment relating to municipal water purification, sewage treatment, stream pollution investigations, etc., for two years..........	20	60	70
For each year of 5 additional years add..........	×10=	×8=	×5=
Total..........			
2. Technical positions with manufacturers of sewage treatment plant equipment, requiring knowledge of design, processes and procedures in sewage treatment work for five years.....	60	80	80
3. Research work in sewage treatment or industrial wastes. (Credit to be determined by Board)..........	—	—	—
GROUP E			
Unlisted activities. (Credit to be determined by Board).......	—	—	—

Experience in the use of this schedule indicates that it is reasonably satisfactory and appears to give a fairly accurate representation of an applicant's qualifications.

The written examination occupies a day's time. A typical examination embraces a list of 50 "true and false" type questions which cover a wide range of items. Probably this is the most effective way of covering a wide range of knowledge in a short time. In an attempt to compensate for a grade an applicant might attain by the law of chance, a credit of one point is given for a correct answer, a point is deducted for an incorrect answer, and a grade of zero is given for no answer. A second group of 25 questions is of the form requiring the applicant to fill in blanks with a few words, generally not more than three and frequently only one. This also affords a rapid method of measuring the applicant's general knowledge of the field. A third group of questions is of the problem and essay type and is designed to determine the applicant's knowledge of plant processes, operating procedures, methods of calculations, and so on. Some latitude is allowed in these questions by the use of optional selection, to give the applicant an opportunity to take advantage of special knowledge of a particular type of plant and to avoid penalizing him for not possessing detailed information about a process with which he may not have had opportunity or occasion to become acquainted. This is particularly true in the lower group classification. These questions are also weighted so that the applicant has full knowledge of the relative importance given each question.

All applicants are given every opportunity to become fully acquainted with the nature of examinations. When available, copies of previous examinations have been given out upon request. Reference to texts has not been permitted in the past. Slide rule calculations have been accepted, although in questions involving calculations, it is required that the calculations be shown. Reasonable latitude in grading is allowed where common practice in the topic question varies.

All papers are graded individually by each member of the Board and the final grade determined by averaging the values given by the individual examiners.

Evaluation of Personal Qualifications

The evaluation of an applicant's personality and character is probably the most inaccurate and unsatisfactory phase of the examination, for to evaluate properly the statements of references given, the examining board would first need to evaluate the individual making the statement, which is of course impossible. From the statements actually received in reference to previous applicants, it would seem that, collectively, they are a most exceptionally high grade group, certainly far above the standard which would be attained by a similar number of actual operators selected at random, whose qualifications are personally known to the Board. Nevertheless, judging from the writer's experience with a good many operators covering a long period of time, these personal qualifications—the integrity, the loyalty, the resourcefulness, the perseverance, the diplomacy, the energy, the thought habits—are worth infinitely more than an ability to do certain mathematical exercises, or the acquisition of several key bits of information, or even possession of a good understanding of the art of sewage treatment. Certainly some attempt at weighing these characteristics is in order. Recognizing the inherent difficulty of measuring an individual's aptitude, knowledge, and ability by any form of examination, short of actual trial, the system described seems to have worked with reasonable accuracy and satisfaction. Criticisms that the examinations are too difficult or too easy seem to be rather well proportioned, with the first objection outnumbering the second, as would be expected.

Scope of Program

In Michigan, the effort has been directed toward certifying the superintendent or person in actual operating charge of a plant, although certificates of competency are issued to others. This practice is open to criticism particularly in larger plants where a considerable measure of responsibility rests with several individuals, for example, foremen or assistant superintendents in charge of various shifts, or in a few cases, where individuals may be in charge of operation of certain plant functions, such as the individual in charge of chlorination, or sludge incineration, or primary sedimentation. It might well be that some provision should be made for certifying these men.

Another debatable procedure is the rather fundamental one of certifying or licensing by plant classes, as described above. From experience, it is known that there are operators giving perfectly satisfactory performances in a plant with which they have become thoroughly acquainted, perhaps in a rule-of-thumb way or perhaps by working under previous administrations, who do not possess and would find it most difficult to acquire knowledge to qualify them for certification in the general class in which their plant lies. Nevertheless, they are competent in their individual plants and are entitled to recognition, and perhaps, in a qualified way, to whatever benefits such a plan offers to the individual. Possibly certifying individuals to specific plants might offer a solution to this phase of the problem, yet it would undoubtedly be more difficult to administer.

Conclusion

It is interesting to note how nearly past procedure in Michigan parallels the recent recommendations of the F.S.W.A. Committee on Qualifications of Sewage Treatment Plant Operators. Very little change would be required in our basic procedures to bring them into complete conformity with these recommendations.

It seems probable that there will be a material increase in the number of plants operating, once the decks are cleared for construction in the postwar era. Many existing plants are due for enlargements and alterations, and some are badly in need of better operation. Standards of performance seem likely to be raised. All of these things point to the need for more and better operators, for in the last analysis it is upon the plant operators that dependence for adequate pollution control must finally rest. Licensing or certification can only be justified as it serves to improve the competency of that profession and gives to the public the protection and service to which it is entitled.

SEWAGE PUMPING STATIONS *

By W. S. Lea

Consulting Engineer, Montreal, Quebec, Canada

Both the design and the operation of sewage pumping stations are governed by a number of factors, among which may be mentioned:

1. Whether the sewerage system is separate or combined;
2. Whether the sewers are laid on self-cleansing slopes for dry weather flow or, in the case of a combined system, for storm water flow only;
3. The character of manufacturing wastes and whether such wastes constitute a small or large proportion of the dry weather flow;
4. Whether the discharge is to a sewage treatment plant or directly into a body of water and, if the latter, whether or not it is permissible to discharge any solids the pumps can handle or if solids of obvious sewage origin must be comminuted or shredded;
5. Whether the head is high or low and the degree to which the head varies;
6. Whether the station is automatically controlled or is constantly attended.

It is scarcely necessary to state that the factors listed above can be considerably extended, particularly to meet special conditions.

This paper will be confined mainly to a discussion of the pumps and piping used in sewage lift stations; no reference will be made to prime movers or standby equipment and limited reference will be made to details of station design. It is further proposed to deal only with comparatively small installations serving a population of say 25,000 or less, but most of the comments will probably apply quite as well to plants of much greater capacity. It will be assumed that the territory served by the station is drained by a combined system of sewers; also that operators are in attendance and that the pumps are motor driven.

Suction Well

Where three or more pumps may be running together most of the time, some attention should be given to the design of the junction between the supply sewer and the suction well.

If the sewer naturally joins the well more or less at right angles, and at or near its center, the approach channel should be gradually flared out on both sides and training walls installed to direct the flow toward each suction, to the end that the load may be more equitably shared by each unit. This is somewhat more easily achieved if all the pumps are of the same capacity.

When the sewer joins the well at one end, whether or not on its longitudinal axis, the problem is much more difficult of solution. It is the writer's opinion, however, that with several units involved, proper distribution of the flow to the pumps can be more satisfactorily attained by continuing the inlet sewer alongside the well with a branch to each suction.

It is believed to be somewhat better, where the sewer joins the suction well at or near one end, to locate the dry weather flow pumps at this end, the storm water pumps being installed in the other end of the suction well on the more or less direct line of the sewer. The whole well can be divided by a low wall between the small and large

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pumps and a gate provided which would be kept closed during dry weather and opened when the flow exceeds the capacity of the dry weather pumps. The latter units could be shut down during the storm and the flow handled by the large pumps only, particularly during the spring when considerable silt may be contained in the sewage. The gate could be automatically controlled but that is hardly necessary with operators in attendance.

It is desirable to keep the suction well clean. To this end, slotted pipes can be provided around the walls just above the highest possible water level in the well, into which water under pressure can be supplied to flush down the walls. It may be advisable also to provide for hosing the suction well floor between the suction pipes to prevent an objectionable accumulation of solids there. It is also a good idea to install a fan for changing the air in the suction well when the operator must enter it. The fan is also useful for changing the air when objectionable odors develop due to washing of the walls or flushing out of accumulations of solids.

Horizontal vs. Vertical Pumps

It is very desirable but not imperative so to locate the pumps that they will be self-priming at least at the higher sewage levels in the suction well. With a dry pump pit alongside the well, this can be accomplished by using either horizontal or vertical units, irrespective of the range of the level in the well.

Although small horizontal units are cheaper than vertical, and more convenient to service, this is a situation where vertical units are believed well worth considering. They can be accommodated in a smaller pump pit; the motor gets better ventilation and perhaps better attention when located at ground floor level; there is always some risk of inundation of the motors of horizontal units when installed at the bottom of the pit, due to accidental flooding.

In comparing vertical and horizontal pumps, it may be pointed out that where there is a suction lift, it is the same over the whole face of vertical pump impellers, but increases from the bottom to the top of the impellers of horizontal pumps. This is probably of minor importance but it is certainly not an advantage in favor of the latter.

The writer has been responsible for the design of one or two small plants with submerged vertical pumps, the motors being installed on the floor above. These are cheap self-priming installations but are not considered entirely satisfactory.

In two other designs, horizontal pumps were placed on the floor over the suction well. This is also less expensive than installing the pumps in a dry well alongside the suction well and is, of course, permissible only when the supply sewer is not laid very deep. There are, however, several disadvantages to this arrangement. In the first place, priming facilities must be provided and there is usually some trouble from objectionable odors on the operating floor. Moreover, there may be some risk eventually of the floor being flooded by surge from the supply sewers, due to sudden failure of power.

Presumably, if the drainage area tributary to the plant is completely sewered and built up, it should be practicable to determine the surge fairly closely. But granting this, and it is a great deal to take for granted, how can one be sure about the future with probable changes in the character of the watershed and in the arrangement of the trunk sewers?

Raising the pump room floor, thereby increasing the suction lift, is not always a satisfactory solution. It has been the writer's experience that trouble with pumps due to pitting, noise or vibration is usually associated with comparatively high suction lifts.

As already intimated, where the suction lift is too high to locate the pumps at ground floor level, vertical units set in a separate dry pit with their motors on the ground floor are preferred over horizontal pumps. Horizontal units can be used but they require a larger pit and ventilation is not as good. The pumps should preferably be set low enough to be self-priming at the higher permissible levels in the suction well. If the pumps and piping will drain back into the well at about the lowest level therein, so much the better. A sump should be provided in the pump room floor into which all leaks and drips are piped. The sump can best be cleared by a small sump pump or, as second choice, by a small pipe from the suction of the main pumps.

Provision for Pumping Tests

If economically feasible, provision should be made in the design of the station for measurement of flow. A constant record of pumpage data is indeed valuable and, in addition, the metering facilities are useful for the determination of capacities and over all efficiencies of the pumps when installed and periodically thereafter. In low head plants, a V-notch or other type of weir will suffice; where the head is high, a venturi meter is best. If a meter is used, it should be of a type that is conveniently maintained, as grease or other foreign matter may interfere with its operation. There is no better way to check the service being given by pumps than by measurement of capacity and by occasional efficiency tests.

As it is usually difficult to maintain a constant head during tests, a series should be run at different heads to permit plotting of at least part of the head-capacity characteristic. Where it desired to run for some time at constant head, this can be closely attained by providing for the return of part of the discharge to the suction well, controlled either by hand or by a float operated valve, or in low head plants, by a hinged weir. In most layouts it is easier to conduct such a test during a moderate rain.

Sewage Pumps

The pumps themselves are, of course, of primary importance. The first sewage pumps in the writer's experience were of the open impeller type and not only were they low in efficiency, but they were subject to very frequent clogging when handling unscreened sewage. These pumps were vastly improved so far as the elimination of clogging was concerned when the client had new impellers cast with fewer vanes and they worked fairly well with screens having openings of 2½ in. ahead of them.

Montreal has been pumping sewage for a lifetime at several plants, and the sewage from the downtown manufacturing districts is difficult to handle. The writer has had quite a lot to do with Montreal sewers and has learned a good deal about pumping sewage from Mr. Frank Dowd, who had charge of the old open impeller pumps in these stations. Mr. Dowd practically rebuilt these pumps and, old-fashioned as they were, eventually made them practically non-clogging when handling unscreened sewage.

Fifteen or twenty years ago, the installation of one 20-in. and three 14-in. Woods trash pumps, or pumps of this type, was recommended. It is considered that these pumps have done a satisfactory job handling unscreened sewage. The rated capacity of the 20-in. unit is 40 c.f.s. at 25 ft. and, although it has done well in the intermittent service required of it, the velocity head is really excessive.

The city has since that time installed many pumps of this type for comfort stations and subways.

There is considerable doubt in the mind of the writer as to the best way of handling some features of pump specifications. At any rate, the usual characteristics are requested when pumping clear water. These characteristics apply also when pumping storm water and closely enough when pumping sewage of any kind so long as no clogging occurs.

Although a high efficiency is desirable it is, of course, not nearly so important as reasonable freedom from clogging, because the first duty of the plant is to give continuous service. It is difficult to define freedom from clogging in a specification at all definitely, because the pump manufacturer naturally expects full information on the character of the sewage before he will guarantee uninterrupted service. The writer's practice is to supply prospective bidders with full particulars of the contributing system of sewers and of the tributary area and all that is known about the sewage.

The bidders are required to give, in effect, a guarantee of the performance of the pump with respect to freedom from clogging in terms of the number of cloggings during the first year's service. The clogging must be sufficiently serious that the pump must be opened up to correct it. There is also a clause covering rejection if the frequency of clogging is excessive during the first two months.

One can, of course, make a pretty good guess at what the pump will do from a careful examination of the details of its design. Usually records are available of pumps in service under somewhat equivalent conditions and it is best, if there is doubt, to check in detail on such operating installations.

Be sure to examine the tributary area carefully because there is a great difference in the character of sewage from different areas sewered on the combined plan. As for sewage from purely residential areas compared with that from some manufacturing districts, they differ so vastly from the point of view of pumping that it seems scarcely in order to apply the same name to them.

Single suction pumps are preferable for comparatively small capacities because of the larger passages through the pumps.

As to wearing rings, the writer insists on plain rings set in finished recesses in the casing. The clean pressure water supply is piped to small channels cored out of the casing behind the stationary rings, and when the pressure is turned on the water passes through one or more small holes in the stationary ring to clear the space between the stationary and moving rings. The water should be turned on when starting up, occasionally while running, and for several minutes after shutting down. Such flushing water supply should not involve a cross connection with any drinking water supply.

The efficiency of some open impeller pumps is surprising, at least when they are new. The pumps referred to have bronze impellers with their edges running close to smooth bronze side plates. In such pumps it is possible that stringy materials and other solids are thrown against the side plates and cut up there by the edges of the vanes. The good efficiency is no doubt due to the very close clearances between the edges of the impeller and the side plates, which reduces the slip, and to the low friction at the smooth side plates. The side plates, moreover, are replaceable and therefore a good idea where the sewage carries considerable silt.

Some less important details of pump specifications follow:

1. Impellers should be machined smooth on the outside, and where inaccessible for machining, made smooth by filing or otherwise. Bronze impellers are usually best but cast iron impellers often give good service.

2. Shaft sleeves may be of bronze or stainless steel.

3. Where exposed to the sewage, a cast iron stationary sleeve should be

installed to keep stringy material from wrapping around the shaft.

4. Exterior of bearing shells should be ground to fit the bearing brackets or pedestals.

5. Large handhole plates should be required to permit inspection of the interior of the pump and to permit cleaning at the suction and at the impeller if and when required. These access ports are rarely large enough or placed to the best advantage.

6. The pump bearing pads should be machined to rest on machined surfaces on the bedplate.

7. Starting screws should be provided to break the casing from its seat, at least when the pumps are fairly large.

8. The seats of bolt heads, nuts and washers should be machined.

9. Nuts used in ordinary dismantling should be hexagonal and machine finished.

10. The pump casing should be able to withstand at least 150 per cent of the shutoff pressure of the pump.

Suction and Discharge Piping

It is desirable to carry the suction pipes down as close to the floor of the well as possible without creating unreasonable entrance losses. Obviously, the longer the periphery of the suction inlet, the closer it can be to the floor. A bell mouth is the best way to accomplish this end.

Where neither screens, comminutors, nor shredders are used ahead of the pumps, however, or where screens of fairly coarse openings (2½ in. or more) are adopted, some provision should be made to minimize the risk of long, partially waterlogged sticks being carried into and up the suction, possibly to damage the impeller. Such a risk is, of course, not great but the writer has known of a 48-in. and a 54-in. pump being damaged in this way.

Whether or not the pumps are self-priming, foot valves should not be used. For that matter, the fewer the valves the better. Where valves must be used, it may be worth while to tap the bottom of them for pressure water pipe connections to clean out the recess for the seats if and when required. The same provision can be adopted for swing check valves.

There is some advantage to allowing sewage to run back through the pump for a short time when it stops. Where the discharge line is short, and the head low, this can quite often be arranged by installing a so-called siphonic discharge. That is to say, by installing the discharge pipes with their crowns above the high water level of the receiving conduit or body of water but with the actual discharge openings below the low water level. To prevent back siphonage, a solenoid operated valve is installed on the crown of each discharge, which valve is electrically opened when the power is shut off the pump, and closed when it is turned on. Soon after stopping, the pump will reverse its direction of rotation for a short time, which helps to clear the impeller, particularly if of the open type, of such things as rags. This arrangement has been found quite worth while, particularly in automatic stations. Obviously, the design of the arrangement should insure against too high a reversal speed.

Where for any reason check valves are necessary or desirable on the discharge of each pump, and there is an operator in attendance, the same scheme can be adopted by providing a hand operated gate on a by-pass around the check.

The writer has always used discharge pipes of such a size that the velocity is high enough to keep the crowns clear of air, expanding gradually at the pipe outlets to recover most of the velocity head. The pipe crowns can be positively kept free from air, of course, by connecting them to a tank freed by an automatic air pump.

When the pumps are connected to a

common discharge and where horizontal units are set on a floor over the suction well, piping losses may be minimized by using bottom suction, side discharge pumps with their shafts at 45 degrees to the longitudinal axis of the room. The main discharge line can be laid on the floor against the wall and each pump discharge run straight into it at 45 degrees. This affords plenty of room to expand gradually the individual discharges before the junctions, and permits the use of 45-degree bends and Y branches instead of elbows and tees.

Where horizontal units are used in a chamber alongside the suction well, if end suction, side discharge pumps are adopted, their discharge piping can be arranged in the same way, and their suctions run straight through the wall into the well. This of course, necessitates a walkway over the suctions with steps to the floor between the units. The piping of many vertical units can, of course, be arranged in the same way as for horizontal units.

The writer has been informed, on what is believed to be good authority, that where an elbow has to be placed immediately on the pump discharge, and it is desired to increase the pipe size, the loss will be less if the elbow is kept the same size as the pump nozzle and an increaser used, instead of employing an increasing elbow to dispense with the increaser.

A pump should not be fixed in its permanent position before the flanged joints on the suction and discharge nozzles have been made up. This precaution should be observed because otherwise careless pipe fitters may spring the casing enough to bind the shaft, in attempting to bring piping into alignment. This admonition does not apply, of course, if a Dresser or Victaulic coupling intervenes.

A CRITICAL REVIEW OF THE LITERATURE OF 1945 ON SEWAGE AND WASTE TREATMENT AND STREAM POLLUTION

By W. Rudolfs, *Chairman,* H. E. Babbitt, D. E. Bloodgood, C. P. Edwards, H. A. Faber, A. L. Genter, H. Heukelekian, H. J. Miles, F. W. Mohlman, C. C. Ruchhoft, C. N. Sawyer, L. R. Setter, L. W. Van Kleeck

Committee on Research, Section A, Federation of Sewage Works Associations

The anticipated increased volume of research literature as a result of the termination of the war in 1945 is naturally not yet reflected in this review. The number of references has remained surprisingly constant in recent years.

The large numbers of papers dealing with construction during the earlier war years have been replaced by operation reports, while papers and reports on basic research have continued to be published to a limited extent. Although considerable discussion has taken place regarding diseases caused by sewage, the number of papers published does not reflect many studies.

The effect of war production plants discharging large volumes of wastes to the receiving waters and sewage treatment processes remained noticeable. The greatly increased industrial activities, together with a general relaxation of enforcement agencies, has left the streams in a generally poorer condition than before the war. These conditions are well recognized by officials and the public at large. This is indicated by the large number of new and revised stream pollution laws introduced into the federal and state legislatures. A survey shows that new legislation and changes in enforcement acts or changes in rules and regulations to tighten up existing laws, were introduced in 38 states during 1945. Similar activities and considerable discussion took place in England, reflecting the attitude in that country. Perhaps one of the most significant developments has been the awakening of industries in connection with stream pollution. Co-operation between various industries to solve common problems, special programs to abate pollution, the recognition of needed research in many instances, and the working together with enforcement agencies rather than against them, should eventually result in cleaner streams. During the year an unusually large number of papers pertaining to stream pollution were published, particularly surveys of streams.

The simple sedimentation of sewage solids still requires basic work. Several papers have appeared which summarize existing knowledge and emphasize the effect of turbulence encountered in various types of tanks.

Studies on standard and high rate filters include work on the flora and fauna present and comparisons of the biochemical and biological characteristics of such filters. In general, it appears that the organisms responsible for purification and the biochemical changes taking place during purification are of the same type, no matter whether the purification occurs in a stream, standard or high rate filters or activated sludge process, but that the numbers of organisms and their activities are modified by changing the environmental conditions. Changes in environmental conditions in turn affect the degree and rate of purification. The remarkable renewal of interest in biological treatment processes will undoubtedly result in further progress.

The published results indicate the direction these improvements will take within the next few years.

More information on the prevalence and numbers of organisms in high rate filters, as compared with standard filters and those occurring in activated sludge, have aided in obtaining a clearer picture of the complex phenomena involved. Descriptions of operation and results obtained by the activated sludge process serve as an aid to operators.

The renewed interest in biological treatment has forced chemical treatment still further into the background. The studies reported are primarily in connection with operation. Although mechanization of sewage treatment processes continues, apparently there will be no radical changes in the immediate postwar era. Mechanization of treatment plants is not a question of short-time development, but is brought about gradually and depends frequently upon trends in treatment as well as upon new processes and variations of existing processes. Nevertheless, improvements which may not be considered radical changes continue to appear.

Papers on sludge digestion have been concerned mainly with operation. The investigations of benefits and disadvantages of thermophilic digestion on a plant scale are of interest, particularly to existing overloaded plants. Methods of obtaining supernatant liquor of good quality and special treatment of supernatant liquor continue to be of interest.

Sludge treatment other than by digestion has followed previous procedures. No information has been published showing that sludge conditioning other than by chemicals and elutriation are to be expected in the near future. There seems to be a trend towards simplified sludge disposal and a renewed interest in disposal of sludge together with garbage.

Chlorination for disinfection, odor control, reduction of B.O.D. and, to a limited extent, for process control, has been continued. No studies on basic principles and specialized applications have been noted. It is understood that before long a series of fundamental studies will be undertaken by various laboratories.

The treatment and disposal of industrial wastes remains of paramount importance. The population equivalent of pollution caused by industrial wastes has rapidly increased, without equivalent progress in treatment. Several very good and illustrative papers have appeared during the year, indicating progress, but much research and experimentation remains to be done before the problem is solved. The various trade organizations, by sponsoring research and co-operating with governmental bodies, can be important factors in the solution, provided the interest of these trade organizations is maintained in solving the pollution problems for which the industries are responsible.

Analytical procedures for the examination of sewage and industrial wastes are important for determining the efficiency of treatment processes and enforcement of the laws. The new edition of "Standard Methods," which is to appear in 1946, will undoubtedly aid the laboratory worker. There is, however, a continuing need for improved and simplified methods to be used by plant operators and a need for workable methods in connection with various industrial wastes. The papers published during the year are principally concerned with modifications of existing methods. The development of micro-analytical methods for sewage analysis is of interest to research workers.

In presenting the annual review, the Research Committee wishes to call attention to the fact that the review is not a complete enumeration of all papers published during the year on the subject, but a more or less critical review of the science and progress of the art. The committee welcomes comments, criticisms and suggestions for improvement of the review.

General

Sewage and Disease

A residual of 0.4 to 0.5 p.p.m. of chlorine after 10 min. of contact was insufficient to inactivate certain strains of poliomyelitis virus according to Trask, Melnick and Wenner (207).

Some risks of transmission of disease during treatment, disposal and utilization of sewage, sewage effluent and sewage sludge are discussed by Wilson (223) in a comprehensive review. Organisms which may be found in sewage and sludge are those causing cholera, typhoid, Bilharzia, intestinal parasitic flat worms, hookworms, amoebic dysentery and poliomyelitis. The author draws the following conclusions: (1) Pathogenic micro-organisms and eggs and larvae of parasites survive in sewage and sludge but do not multiply because of the unfavorable conditions, (2) A progressive diminution of all forms of bacteria takes place in sewage with increasing degree of treatment, (3) There is a concentration of all types of bacteria, eggs and ova of parasites in the sludge. (4) The danger of pathogenic bacteria and animal parasites is in proportion to the numbers present in the original sewage. The author considers irrigation with raw or settled sewage objectionable and not permissible on crops used for human and animal consumption.

Stokes, Jones and Miles (193) undertook experimental work to determine the viability of certain pathogenic bacteria during drying and digestion of sludge. *Bact. paratyphosum B* and *Bact. typhi murium* were artifically added to sludges in great numbers. When added to sludge and applied to experimental sand drying beds the latter organisms could be recovered after 180 days. During the digestion of fresh solids with ripe sludge the same organism could be recovered up to 45 days.

Biology of Trickling Filters

Tomlinson and Stride (204) enumerate the different species of fly population trapped from the filters at several plants in England. *Psychoda* was the most prevalent followed by *Spaniotoma*. The seasonal succession of the various flies is given. The numbers of *Psychoda* as well as the quantity of film increased with filter loading. More *Psychoda* emerged from the coarser sized filter media than from the finer media. Fewer *Psychoda* emerged from alternating double filters than from a single filter.

Lloyd (138) gave a comprehensive and critical review of the information available on the role, incidence, ecology and types of animal life in sewage purification processes, with particular emphasis on trickling filters and the activated sludge process. The same author (139) states that trickling filters are a very favorable environment for insects due to the abundant air and food supply. The insect fauna is characterized by a great number of a relatively few species which colonize the bed successfully. Out of one hundred different species encountered 99.7 per cent belong to six species.

Role of Micro-organisms in Floc Formation and Sewage Purification

Hardin (85) states that certain flagellates have the ability to flocculate various bacteria when grown in culture media. Watson (221) suggested a possible mechanism for such flocculation as brought about by protozoa. He stated that in the case of a certain ciliate, mucus is produced to which bacteria adhere before being digested. The mucus, not being diffusible, remains in the neighborhood of the ciliate and the increase in the viscosity of the medium causes the entanglement and flocculation of bacteria.

Pillai and Subrahmanyan (166) isolated the protozoan *Epistylis* from aeration tanks and purified it free of bacteria. When introduced into sterile medium and aerated, it was at least as active in purifying sewage as normal activated sludge. They concluded that aerobic purification of sewage is essentially due to the protozoan activity and that bacteria play only a secondary part.

Viehl (213) conducted laboratory experiments on the purification of sewage under aerobic and anaerobic conditions. His findings are in line with similar studies reported earlier; namely, that when the surface is exposed the B.O.D. reduction is faster and hydrogen sulfide production is less than in closed bottles. Septic sewage should, therefore, not be placed on biological filters.

Sewer Corrosion

Hammerton (84) emphasized the role played by the chemical characteristics of water in relation to sewer corrosion. He classified water with less than 300 p.p.m. sulfate as one of low risk of sulfate attack and water containing 1,000 p.p.m. or more of high risk. He further reviews and discusses the remedial and preventive measures such as control of hydrogen sulfide production, surface coatings and ventilation.

Pomeroy (168) discusses corrosion problems of iron when exposed to sewage and other liquids containing dissolved sulfides. He gives analyses of the corrosion products which show a high percentage of iron and sulfur, the former being in excess, indicating that not all the iron is present as sulfide but that some of it is present as oxide. The corrosion products are bulky and hard. Iron structures in sedimentation and sludge digestion tanks are subject to corrosion by sulfides, as are sewer outfall pipes of iron carrying septic sewage.

Several reasons are advanced for sewer ventilation by Pomeroy (167), which might be summarized: (1) to eliminate lethal or explosive gases from the atmosphere, (2) to reduce corrosion, (3) to prevent escape of odors. The author states that while ventilation is not a cure-all, it has a broader field of usefulness than is generally realized.

Parker (163) isolated a bacterium, which he named *Thiobacillus concretivorus,* from the corrosion products of concrete exposed to atmospheres containing hydrogen sulfide. This organism is similar to *Thiobacillus thiooxidans.* It is an autotrophic organism, capable of deriving its energy from the oxidation of sulfur and utilizing carbon dioxide as a source of structural carbon. It produces sulfuric acid in culture medium in high concentration (10 per cent). It does not, however, utilize hydrogen sulfide. The activity of this organism would explain the production of sulfuric acid in the corrosion process provided free sulfur is first formed from hydrogen sulfide. In a second paper (164) the author undertook painstaking laboratory proof of the part played by *Thiobacillus concretivorus* in pure culture in the corrosion of concrete. An atmosphere of water vapor, H_2S and ammonia was aspirated over an inoculated cement block. After six weeks' exposure to this atmosphere the inoculated block began to show signs of corrosion and about 75 per cent of the hydrogen sulfide supplied was removed and sulfates were formed. The initial conversion of hydrogen sulfide to sulfur may be non-biological.

Analytical Procedures

The Ninth Edition of "Standard Methods for the Examination of Water and Sewage" is nearing the publication stage. A summary of recommended changes by the committees, which was edited by Norton and Symons, appears in a current issue of the *American Public Health Association Journal* (145). The changes consist of simplification in the arrangement and presentation of subject matter as well as the deletion of old and the adoption of new methods.

In the field of disinfection, Hallinan's (82) ortho-tolidine-arsenite test for differentiating among a free chlorine, chloramine and false residual was confirmed and modified. Gilcreas and Hallinan (76) and Gilcreas (75) present supplementary data on the ortho-tolidine-arsenite (O.T.A.) test in conjunction with the regular ortho-tolidine (O.T.) test. A weak solution of sodium arsenite is added fifteen seconds after the addition of ortho-tolidine, to destroy chloramine compounds. The ortho-tolidine color is therefore caused by the free or active chlorine and the interference due to manganese or nitrite. A second sample is first treated with sodium arsenite to destroy all free or combined chlorine before ortho-tolidine is added. Any ortho-tolidine color in the second test is a blank or a measure of the amount of interference. The first, or flash test, minus the blank, is the true or active residual chlorine. If a third ortho-tolidine test is made without sodium arsenite, the subtraction of the active chlorine residual and interferences will yield the "chloramine" residual. Hirsch (104) simplifies the procedure by determining a flash (15-sec.) reading and a 5-min. ortho-tolidine reading of the interference plus active chlorine, and the interference plus active chlorine plus combined chlorine, respectively. The amount of interference is determined separately, using double strength sodium arsenite prior to ortho-tolidine. The magnitude of the interference was suggested as being of value in judging the quality of sewage plant effluents.

In studying the application of oxidation potential measurements in determining the concentration of germicidally active chlorine in water, Chang (47) concluded that although consistent and characteristic potentials were frequently observed at the cysticidal point for gaseous chlorine and chloramines in tap water, irregular potentials were usually obtained in raw water. Evaluation of the significance of the oxidation potential of a chlorinated raw water was not attempted in view of the complicated oxidation-reduction systems that exist, the uncertainty of the reversibility of these systems, and the presence of dissolved oxygen.

In a Standard Methods Committee report, Mallmann (141) reviewed the developments in bacteriological methods and techniques. *Streptococcus fecalis* was detected on a new medium found to be specific for these organisms. A further evaluation of E. C. medium for coliform organisms was also reported.

Nielson (160) reviewed the development and predicted greater use of electronic instrumentation for measurement and control in water supply and sewage treatment. The Symposium on Analytical Colorimetry and Photometry, presented at the 47th Annual Meeting of the American Society of Testing Materials, has been published in booklet form (75 pages), and is available at $1.00 per copy (4). A Klett-Summerson photometer was used by Noll (161) for the determination of nitrate in boiler water by Brucine reagent. A calibration chart was prepared from brucine-treated solutions containing 0 to 10 p.p.m. nitrate nitrogen. The light source passed through a 470 millimicron color filter, then through a 13-mm. diameter test tube containing the brucine-nitrate blue color, onto the photocell. The Brucine reagent appeared stable for months. The brucine-nitrate color developed rapidly and remained stable for over an hour, and the presence of high concentrations of soluble boiler water ions did not interfere. The method was accurate to approximately 0.1 p.p.m. nitrate nitrogen. A photo-electric photometer was also used by Adams and St. John (2) for the colorimetric determination of potassium as chloroplatinate. The method was reliable and convenient. A precision of 2 per cent was obtained with samples containing 0.2 mg. of potassium or more.

By increasing the quantity of iodide in the Winkler method for determining dissolved oxygen, Pomeroy and Kirschman (169) claimed diminished interference due to organic matter, reduced loss of iodine vapor, and a sharper starch-iodide end-point. They recommend that the hydroxide-iodide solution, which is usually 12.5 N in alkali and 0.9 N in iodide, be replaced by one which is 10 N in sodium hydroxide and 6 N in sodium iodide. Additional data is desirable to (a) justify the increased cost of reagents for the increased accuracy achieved and (b) clarify the extent of iodide decomposition when concentrated sulfuric acid is added to the iodide enriched sample prior to titration.

In the benzidine method of sulfate analysis, the factors governing occlusion and incomplete precipitation have been investigated by McKittrick and Schmidt (148). A procedure has been developed that gives results correct to within 0.5 per cent when 2.5 to 10 p.p.m. sulfate ions are precipitated.

A referee committee on Standard Methods of Sewage Analysis for the determination of grease reported (89) on a comparative study of three current procedures. Each procedure had certain advantages and disadvantages over the others. The referee committee defined grease as, "that material which is extracted from an acidified sample of sewage by petroleum ether (b.p. 40° C. to 60° C.) when using the standard procedure as outlined by the committee." The standard procedure as agreed on by the committee is given in detail and consists of the refrigeration method combined with a wet extraction of the filtrate, if necessary.

Hirsch (103) modified the aluminum dish method for determining the suspended solids in aeration tank liquor by omitting the dish. The tared weight of a previously dried paper filter is recorded on the bottom of the paper. A sample of aeration liquor is filtered, the paper peeled off, dried, and weighed. The weight and the subtraction of the tare weight are recorded on the underside of the filter paper while only the result in p.p.m. need be recorded on a data sheet.

An empirical index for determining the efficiency of primary sedimentation consisting of the sum of the p.p.m. of suspended solids in the primary tank effluent and the percentage of suspended solids remaining in the effluent, was reported as being of value by Doman (55). An index below 110 was considered satisfactory in most cases.

Dawson and Jenkins (53) developed micro-analytical methods for the examination of sewage. Techniques are described for ammonia, nitrite, and nitrate nitrogen, phosphorous, dissolved oxygen and B.O.D. Glass stoppered bottles, having a capacity of 3 to 4 ml., were used for D.O. and B.O.D. determinations. This interesting application was discussed by Hatfield (53) who indicated the difficulty of obtaining micro-representative samples on such a heterogeneous material as sewage.

The water flea, *Daphnia magna,* was proposed by Anderson (5) as a convenient and reliable test organism for determining toxicity thresholds of various substances found in industrial wastes. The cultivation of the animals and the test procedures are described in detail.

ZoBell and Brown (230) have found that toluene, cresols, thymol, carbon bisulfide and ethyl ether are not dependable for the chemical preservation of water samples. One-half per cent of either chloroform or phenol, or 0.25 per cent of formic acid were satisfactory, although a mixture of 0.5 per cent each of chloroform and phenol was preferred. Acidifying the water to pH

1.5 prevented the activity of most organisms.

McBride and Preston (146) used a device for vacuum sampling liquids and suspensions. A bottle or flask stopper was fitted with a T-tube. A pinch clamp was placed on the side tube used for evacuating the bottle while a greased ground glass stopper closed the delivery tube. A number of bottles were tied to a pole and lowered to the proper depth. The glass stoppers on the delivery tubes were removed by pulling short lengths of string attached to a common string.

Sedimentation

Of the comparatively large number of papers presented on sedimentation during the past year, a considerable number were reviews and summaries of previous work. Among the best of these were those of Tark (196) and Merz (149) on design and operation, respectively.

On new developments in the field, the papers of Camp (44) (45), Anderson (7), and Howland (109) were among the best. Camp (45) presented a summary of the known principles of sedimentation essential to the development of design theory. His paper is divided into ten parts, as follows: (1) settling velocities of individual particles; (2) nature of settling processes in water and sewage treatment; (3) settling analyses of suspensions; (4) clarification theory for an ideal basin—*a.* "For any given discharge, the removal is a function of the surface area and is independent of the depth of the basin." *b.* "The concentration of suspended matter at any cross-section in the settling zone increases with the depth below the surface, and decreases with the proximity of the cross-section to the outlet end of the basin"; (5) tractive force and bedload movement; (6) effects of turbulence on sedimentation; (7) flocculent suspensions—in which the author concludes that the additional flocculation caused by turbulence in the tanks may speed up the settling to a greater extent than turbulent mixing retards it and that increased removal should be expected from tanks with higher velocities than are commonly used; (8) overflow rate, detention period, velocity, and tank dimensions; (9) short circuiting and stability.

The author presents a tentative design for a settling tank based upon the principles developed in his paper. It is of the multiple tray type. For final settling tanks in the activated sludge process he recommends the elimination of the dividing wall between aeration tank and settling basin.

Anderson (7) describes certain "density currents" found in the final settling tanks of activated sludge plants where the mixed liquid from the aeration tanks, when introduced in the settling tank, drops to the bottom because of its greater density, flows along the bottom just above the sludge blanket and is deflected upward by the opposite end wall, thereby inducing a counter current in the upper levels back towards the influent end. All attempts to prevent this current by the use of baffles were fruitless. It was, therefore, decided that the customary method of placing the effluent weirs at the far end of the tanks is unwise, as in this position they are directly in the path of this density current. It is suggested that they be placed further forward towards the influent end. It is the author's opinion that the overflow rate for such weirs should not exceed 20,000 g.p.d. per ft. of weir. In reference to depth he suggests that, in general, (a) for circular tanks with central inlet, the radius should not exceed about five times the side water depth; (b) for rectangular tanks the flow length should not exceed about seven times the depth; and (c) the depth below the effluent weirs should be not less than ten feet or twelve feet, depending on whether the weirs are located forward or at the upturn of the density current, respectively.

In reference to inlet design, the mixed liquor should be introduced as gently or at as low a velocity as possible to minimize density currents, and in reference to sludge outlets, they should be so located at the inlet end to avoid moving sludge any greater distance than necessary along the bottom. Gould (78) in discussing Anderson's article claims that sludge outlets should be at the outlet end of the tank since there is a prevailing current in the sludge blanket along the bottom towards the outlet end. Townsend (206) in a later discussion, recommends multiple inlets and outlets for both liquid and sludge to reduce density currents.

Howland (109) gives formulas and charts for simplifying the procedure of designing a venturi flume for controlling velocities in grit chambers, as proposed by Bushee (42).

Vokes and Jenkins (214) modified one of the upward flow sedimentation tanks for settling activated sludge with central inlet and peripheral discharge to allow the flow to enter horizontally at an angle to cause rotation. The effluent from the modified tank contained more suspended solids than from the upward flow tank.

Pöpel (170) states that in continuous flow settling tanks surface loadings should not exceed 2.2 to 2.5 meters per hr. Convection currents do not materially affect clarification and kinetic energy should be destroyed as much as possible.

Chemical and Mechanical Treatment

Studies on the use of chemicals in treating sewage continue. Gehm (68) reports that the coagulation of sewage with ferric chloride is not materially affected by the addition of digester supernatant liquor of good quality. Liquors from partly digested sludge and fresh solids increase the coagulant demand considerably when added to the sewage. Effluent from sewage treated by ferric chloride coagulation contains the smallest amount of iron when the optimum clarification is obtained. The treatment of various types of sewage to complete clarification with ferric chloride or ferric chloride and lime reduces the chlorine demand to about one-third that of the raw sewage. A ferric chloride-acid treatment results in a reduction of the chlorine demand of about one-fourth.

Keys and Travaini (124), confronted with an overloaded activated sludge plant at Phoenix, Ariz., made 258 tests over a 7-month period to determine the effect of chemicals in reducing the concentration of the raw sewage. They estimated that if the laboratory results could be duplicated in the plant that 16 m.g.d. of sewage could be treated in the plant formerly treating 12 m.g.d. These investigators further report on methods of producing coagulating chemicals in the sewage treatment plant.

Gehm's (69) work on the chemical treatment of soapy waste waters may be helpful to sewage treatment plant operators who are troubled with excessive amounts of soapy wastes. The experiments show that treatment with sea water, spent zeolite softener reagent and mixtures of calcium and magnesium salts resulted in a high degree of clarification and in the formation of a curdled sludge.

Kozma (128) reports on the use of ferric sulfates at the Joint Meeting sewage treatment plant, Rutherford, N. J. It was found that the ferric sulfates used are more economical than liquid ferric chloride or alum, which were previously used at this plant.

Friel (65) reports that he believes that the development of a sewage treatment plant providing a maximum flexibility of operational control and usage in a combination of chemical and biological processes offers many possibilities in the solution of sewage treatment problems which have requirements based on highly variable composition of sewage to be treated.

Biological Filters

Heukelekian (98) (99) (100) (101) has reported on studies comparing the biochemical and biological characteristics of a biofilter and a standard filter. Both filters harbored much smaller quantities of biological film during the summer and vertical distribution was fairly uniform. In the winter, maximum accumulation of film in the standard filter was in the top layer while in the biofilter it was at the 2-ft. level, with a minimum in the top layer. Seasonal range of biological film in the standard filter was from 8 to 12 lb. (dry basis) per cu. yd. of stone and in the biofilter it was from 5.5 to 11 lb. Film accumulation on the biofilter was stated to be related to the B.O.D. and suspended solids loading, but in one experimental period, application of the entire flow to one filter did not materially increase the accumulation. Insect larvae were present in almost equal numbers in the biofilter regardless of season. A marked seasonal difference occurred in the standard filter. Analyses for ash, B.O.D., grease and nitrogen indicate the biofilter film to have a greater stability with depth. The nitrogen content of the biofilter film was highest, corresponding to a protein content of from 45 to 50 per cent. Temperature and loading were found to be predominant factors in determining the biochemical character of films. Sludge collected from the secondary clarifier of the biofilter was less stable than films from the lower levels, indicating that a part of the sludge came from sloughings from the higher levels. The numbers of ciliates, flagellates and rhizopods were practically the same for both filters. The biofilter acts as an oxidation device as well as a "colloider." The biofilter gave a variable output of nitrites and nitrates, with greatest production in summer. Nitrifying organisms were found to be present in the biofilter film at all times, regardless of oxidized nitrogen concentration in the final effluent. Film from the top two feet of both filters had the highest nitrifying capacity as determined by aeration tests with sewage for 24 hours. These findings support the view that nitrifying organisms are not adversely affected by carbonaceous oxidation and can exist where the B.O.D. of the film is high, provided that aerobic conditions prevail. The biofilter produces a higher ratio of nitrites to nitrates than does the standard filter, which indicates that the nitrate formers are less firmly established in the former. The difference between the standard and biofilter is quantitative rather than qualitative. Primary tanks were found to act as oxidative devices, in accordance with previous reports, when the filter effluent was being recirculated through them and when the temperatures were favorable. Bacterial removals in the biofilter system were quite variable. Good removals of coliform organisms were common, but total counts in the final effluent often exceeded total counts in the primary tank effluent, particularly in the winter. The biofilter showed much greater seasonal variation in percentage of B.O.D. and suspended solids removals.

Additional reports on the use of alternating double filters come from England. Mills and Calvert (152) report on the conversion of standard filters to an alternating double filtration system to handle an increased loading of camp sewage and laundry waste at a considerable savings in capital investment. Results of operation were entirely satisfactory; B.O.D. was reduced from 325 to 4.5 p.p.m. and oxygen consumed from 57 to 9 p.p.m.

Hunter (111) presents information on the operation of enclosed aerated filters during acceptance tests. The filters were 18 ft. deep, provided with forced downward ventilation, equipped with rotary distributors and designed for application of 388 gal. per cu. yd. per day, approximately 3 times the rate of application on standard filters at the same location. Considerable ponding of the aerated filters resulted. Coarser rock was substituted in the filters but ponding still persisted. During 1942, seven tons of fungus growths were manually removed from the surface, and 4.5 tons in 1943. During the latter year, 2.23 times as much sewage was treated per unit volume of rock on the aerated filters as on the standard open filters; B.O.D. removals were 82.2 and 73.9 per cent, respectively, of the applied loading. The filter was accepted despite the ponding difficulties.

Mills (150) reports results of studies of the operation of the alternating double filtration system and of the single stage filter, as conducted at Birmingham, England, during the past four years. The single stage filter was operated at rates varying from 58 to 80 gal. per cu. yd. per day, which represented the maximum it was capable of handling. The rates of application on the alternating double filtration units increased from 160 gal. per cu. yd. per day during the first year to 240 to 250 gal. The filters were alternated once a week during the first two years and once a day during the last two years. The quality of the effluent from the alternating double filters at four times the rate was equal to that from single filtration.

The case for continuous filtration with recirculation of part of the effluent receives little support from the report of Mills (151). His results are partially negated by a number of factors: (1) A filter considered unfit for single and alternating double filtration studies was used; (2) The top 2.5 ft. of bed consisted of ¾-in. round gravel; (3) The bed was 6.25 ft. deep and (4) A recirculation ratio of 1: 1 was used. Some ponding occurred during the winter. Despite these handicaps, when loadings as great as 250 gal. per cu. yd. per day were applied, an effluent was obtained which was superior to that given by the primary filter of the double filter system but poorer than that given by the double and single filters. Loadings on the double and single filters were 210 and 60 to 80 gal. per cu. yd. per day respectively.

Taylor (197) reported on experiences in winter operation of covered and uncovered sewage filters at Air Force training schools in Saskatchewan and Manitoba. Open filters were found to slough during sub-zero weather and lose all effectiveness until spring weather when higher temperatures allowed restoration of the biological film on the rocks. In covered filters the rock temperature was sufficiently high to insure maintenance of reasonable purification at all times. Covered beds with continuous flow were found to maintain a rock temperature about 8 deg. F. higher than corresponding beds with intermittent flow.

Edmondson and Goodrich (58) reported on the use of a "cyclo-nitrifying" filter to provide tertiary treatment for part of the effluent of a bio-aeration plant. The filter effluent normally contained in excess of 20 p.p.m. of oxidized nitrogen and when mixed with the primary tank effluent in equal volumes to form the bio-aeration tank influent, resulted in overcoming bulking and in general improvement of effluent quality, as measured by O.A., B.O.D. and stability tests. Their data indicate that from 0.15 to 0.21 lb. of oxidized nitrogen can be produced per cu. yd. of filter media per day and that the production is influenced little by rate of application over the range of 800 to 1,400 gal. per cu. yd. per day. Oxidized nitrogen was produced at approximately 10 per cent of its cost in the form of sodium nitrate.

Hurley (114) discusses the application of the various types of filters and filter systems. Veatch (211) reviews the experience the Army has had with various installations of filters.

Halvorson and Smith (83) presented a scheme of sewage treatment in which preliminary sedimentation ahead of biological filtration is eliminated.

Patents

Process patents have been issued to Levine (137) for a two-stage filter system with settling tanks following both stages and recirculation from both tanks to the primary settling tank, and to Montgomery and Livingston (156) for a method of purifying sewage by downward percolation through a submerged aerated filter bed.

Activated Sludge

Theory

In order to obtain a more accurate count of the bacterial population of activated sludge floc, Allen (3) broke up the floc by passing it through an homgenizer. From 11 to 100 times as many bacteria were found in the homogenized sludge as in the raw sewage. A maximum of 2,200 million bacteria per ml. was obtained on nutrient agar from homogenized sludge. The study indicated that the total number of bacteria increased during the aeration of sewage and even after floc was formed, a large number of bacteria remained in the supernatant liquor. When more sewage was added to this floc and the mixture aerated, the bacterial count again increased, but in this case the bacteria were rapidly associated with the floc leaving fewer in the supernatant liquor. All species of bacteria isolated were rod forms. Most of them were gram negative, non spore forming and had no action on sugars. According to Keefer (122), laboratory experiments indicate that sewage containing large quantities of grease can be oxidized by batch operated activated sludge.

Operation

Edwards (59) has reviewed activated sludge operating practice and Greeley (80) has discussed the development of the process. Greeley suggests as conventional loadings with domestic sewage:

(1) 25 to 30 lb. B.O.D. applied per 1,000 cu. ft. of aeration tank capacity per day.
(2) 1 to 2 lb. B.O.D. added per 1,000 cu. ft. air supplied.

Imhoff (115) in 1943 estimated a suitable loading for German plants to be 31 lb. of B.O.D. per day per 1,000 cu. ft. of aeration tank capacity.

Dreier (57) has given an excellent summary of operating experience from 29 mechanical activated sludge plants.

The use of porous diffuser tubes has been discussed by Roe (177). He stated that the advantages of tube diffusers are: greater contact volume, longer detention period of air because of the lower air velocities, better tank circulation and elimination of the center core. The decreased head required, which amounts to about 2 ft., may save 7 to 10 per cent on blower power.

An excellent report has been presented by Townend (205) on the operation of the Mogden activated sludge plant, England's largest, for the 10-year period 1936–45. With an average flow of 72 m.g.d. the aeration period including reaeration was 7.5 hours and the air consumption 0.97 cu. ft. per gal. or 717 cu. ft. per lb. of B.O.D. removed. The aeration tank solids averaged 2,400 p.p.m. Even during the war years, the plant effluent was excellent and averaged 8.3 p.p.m. B.O.D. and 7.0 p.p.m. suspended solids for the 10-year period. The diffuser plates, which have a permeability of 45 to 50, are fastened into cast iron boxes and air applied through a galvanized iron pipe. After three years, a sudden increase in the air pressure of 1–2 p.s.i. occurred. An investigation showed that the plate clogging was caused by an accumulation of rust from the boxes and the pipe and from some soot. The boxes were sand blasted and sprayed with zinc. The plates were burned at

800 to 900° C. and the permeability was brought back to the original value.

Setter and Edwards (189), in laboratory experiments, found that moderately clogged diffuser plates may be cleaned in place by treatment with chromic-sulfuric acid or caustic soda followed by air blowing of the dry plates. When plates were badly clogged at top and bottom, vacuum applied with a water wash to the top of caustic treated plates followed by blowing the dried plates at a pressure of 2 p.s.i. for 5 to 18 hr. was successful in restoring the permeability. The vacuum water wash removed the sandy material from the top of the plate and the air blew out or redistributed the clogging material at the bottom.

Mann (142) reported that at the Ley Creek, Syracuse plant, a larger flow was treated and less air was required when the aeration tank solids were reduced from 3,000 to 4,000 p.p.m. to 1,500 to 1,800 p.p.m. and the average aeration period was decreased from 6.6 to 4.4 hours. The effluent was as good or better than before and the activated sludge process appeared to stand industrial waste shocks better and to recover sooner.

The principles of modified sewage aeration or high-rate activated sludge have been applied on full plant scale at the New York Jamaica sewage treatment plant since October, 1943. According to Setter, Carpenter and Winslow (192) raw sewage without presettling was aerated for either 2.0 to 2.5 or 4 to 5 hours, and settled for three hours. The aeration solids averaged 375 p.p.m. and the air consumption for aeration 0.34 cu. ft. per gal. of sewage. Irrespective of the concentration of aeration tank solids, 70 per cent of the B.O.D. and 83 per cent of the suspended solids were removed with 2.0 to 2.5 hours aeration and more than 75 per cent of the B.O.D. and 85 per cent of the suspended solids were removed with 4 to 5 hours aeration. The excess sludge averaged 5.85 per cent solids.

Shapiro and Hogan (191) found at the New York Bowery Bay plant that with modified sewage aeration, the air ratios were reduced to 0.39 cu. ft. per gal. sewage or to about 2/3 of the previous air requirements needed with conventional activated sludge. With an average aerator suspended solids of 500 p.p.m. and a 2.5-hour aeration period, more than 85 per cent of the B.O.D. and suspended solids were removed.

Sludge Bulking

The control of sludge bulking continues to hold the interest of operators. At San Antonio, Berg (32) avoids bulking by returning activated sludge solids to the aeration tanks in the ratio of 10 parts by weight of returned sludge solids to 1 part of incoming sewage solids and by applying air at a rate of 900 cu. ft. per lb. of B.O.D. of primary effluent. Careful control of the volume of digester supernatant returned to the clarifiers is also important. Kraus (129) found that a well oxidized digested sludge added to the return sludge would control bulking at Peoria. To oxidize the digested sludge it was mixed with activated sludge and aerated until all the sludge was converted to activated sludge and much of the nitrogen was changed to nitrates. This method of treatment made the disposal of digester supernatant very simple, and permitted greater loadings to the aeration and final settling tanks.

Experience at some army camps has added more information on the control of bulking with chlorine. After other methods failed, Kin (125) found that the application of 10 to 16 p.p.m. of chlorine based on the return sludge flow eliminated bulking at a plant in one of the southern camps in ten days. At the time of the chlorine treatment, the concentration of solids in the return sludge flow was only 700 p.p.m. Tapleshay (195), from data obtained from a number of plants, found that continuous chlorination of either return sludge or aeration tank effluent improved the sludge index but that less chlorine was required when it was applied to the return sludge. He observed that the dosage of chlorine is a function of the sludge index and the dry weight of solids in the return sludge. The concentration of grease in the return sludge, which varied from 4.8 to 29.9 per cent, did not seem to have any effect on the sludge index.

In a mechanical aeration plant at Greece, N. Y., Denise (54) eliminated bulking by aerating the settled sewage before addition of the return sludge. Other changes in operation made at the same time may have assisted in eliminating bulking.

Rising Sludge

It seems to be well established that the rising of sludge in final settling tanks is caused by the buoyancy of gaseous nitrogen formed by the reduction of nitrites or nitrates. Brandon and Grindley (39) reported that a concentration of 50 to 60 p.p.m. of ammonium nitrate caused rising of sludge in laboratory experiments, and smaller concentrations produced rising sludge on plant scale tests. They suggest that the liberation of gases could be prevented by the addition of substances which inhibit bacterial action. Sawyer and Bradney (186) found that substances inhibiting nitrifying and denitrifying organisms also caused poor B.O.D. and organic nitrogen removals and therefore produced unsatisfactory effluents. According to Lockett (140) rising sludge can be prevented by eliminating short circuiting in aeration tanks and by promptly withdrawing sludge from the final tanks. It is also necessary to apply air at rates high enough to insure constant and thorough mixing (7 to 12 cu. ft. per hr. per sq. ft. of tank surface) and to provide an aeration period long enough to produce an average of 8 to 12 p.p.m. of nitrate nitrogen in the effluent.

Design

As a result of his work in "density currents," which are the gravity flows produced in one fluid by another fluid of slightly greater density seeking a lower level, Anderson (7) has set up certain design values for secondary settling tanks. He believes that the loading should average about 900 to 1,000 gal. of aeration tank effluent per sq. ft. per day with a maximum of 1,600 to 1,800 gal. per sq. ft. per day. The detention period should be 1.7 to 2.6 hr. depending on the depth. For circular tanks with center inlet, the radius should not exceed 5 times the sidewall depth. For rectangular tanks where the inlet velocity is more easily reduced, the flow length should not exceed 7 times the depth. In general, the depth below the effluent weirs should not be less than 10 ft. and the inlet velocity as low as possible without dependence on baffles. The weir loading rate should not exceed 20,000 g.p.d. per ft. of weir even when the weirs are placed away from the upturn of density currents. At customary surface ratings, the size of circular tanks with center feed and peripheral effluent weirs is limited to a maximum diameter of 80 ft. but larger tank sizes are possible by providing effluent troughs carried on brackets away from the wall. Anderson prefers the sludge withdrawal sump at the inlet end, based on experiments in which the sump was so placed. Gould (78), from comparative studies of sludge withdrawal point locations, prefers to have the sludge withdrawal sump at the effluent end of the tank.

Chlorination

The advantages of chlorinating sewage for disinfection, for the control of odors and septicity, and for reduction of B.O.D., have received general recognition. The specialized applications of chlorine have developed slowly because only limited research has been performed to determine the basic reactions involved. It is encouraging to note that more investigations of research nature have been made in this field during the past year.

Chlorination Applications

Single unit tank cars are used to supply chlorine at the Detroit sewage treatment plant, and an automatic device has been developed to indicate when a car is empty. Liquid chlorine discharges from the tank car through a 150-lb. chlorine cylinder which is mounted on a scale. When no more chlorine remains in the car, the chlorine is next removed from the cylinder and the resulting loss in weight on the scale sounds an alarm. Many other safety precautions have been taken at this plant (27).

Careful control of chlorine dosage at the Buffalo sewage treatment plant has resulted in improved disinfection despite both an increase in sewage flow and a reduction in total chlorine applied. The average chlorine application at this plant is 2.45 tons per day (19).

In the works proposed for the Boston sewage treatment plant at Nut Island, where preaeration, chlorination, and sedimentation are to be provided, Kennison (123) mentions that an existing building will be converted to use for chlorine storage rooms and chlorinating equipment.

Chlorination for Disinfection

The Interstate Sanitation Commission has conducted studies (22) to determine the chlorine contact period in those sewage works which discharge effluents requiring disinfection. By applying fluorescent dye at the point of chlorine application, the actual time of contact before sewage reaches the receiving water was determined, indicating the proper holding time of chlorinated samples.

Study of an epidemic of infective hepatitis, which occurred in a large summer camp and affected 350 of 572 persons, indicated the causative virus of this disease to be waterborne. The source of contamination appears to have been infective sewage from a cesspool near the camp well. A study by Neefe, Stokes, Baty, and Reinhold (159) employed human volunteers and proved that ordinary chlorination did not inactivate the virus but that superchlorination beyond the break-point to provide a chlorine residual of 15 p.p.m. after 30 min. contact would do so.

The cercariae of *Schistosoma* can be rendered non-motile by chlorine doses of 0.5 to 1.25 p.p.m., and can be rendered non-infective by a chlorine dose of 1.25 p.p.m. acting for 4 min. or by a dose of 0.44 p.p.m. acting for 18 min., according to a study by Gonzalez, Biaggi, and Leon (77).

While chlorine dioxide may be of no present interest in the treatment of sewage, its growing application in the water works field should be recorded. Studies by McCarthy (147) show this material to be more affected by organic matter than is chlorine and, consequently, a given concentration is less effective for disinfection.

Chlorination for Control of Odors

Chlorine continues to play an important role in odor control (26). The trickling filter influent at Flint, Mich., is treated with a chlorine dose equal to one-half of the chlorine demand. A dose of 2.0 p.p.m. is applied in upsewer chlorination at Atchison, Kan., to overcome the effects of industrial waste. At Rutherford, N. J., both raw sewage and filter influent are chlorinated.

At Rockville Centre, N. Y., the use of prechlorination at pumping stations controls odors and prevents septicity in sewage delivered to the modified activated sludge plant, as described by Andersen (6). The clarified effluent is chlorinated to maintain a residual of 2.0 p.p.m., residual chlorine tests being made every hour. Princeton, N. J., obtains not only odor control but improved coagulation and digestion as well through the application of iron chloride produced from chlorine and scrap iron (25).

Chase (48) includes prechlorination as a remedy for offensive odors produced by trickling filters receiving septic sewage. Doman (56) notes that at the Old Greenwich, Conn., plant supernatant liquor is settled in separate units and then is returned to the primary settling tanks without deleterious effect, but such return does increase the chlorine demand.

Chlorination in Activated Sludge Treatment

Dreier (57) describes the use of chlorine for control of bulking in mechanical activated sludge sewage treatment plants at Batavia, Ill., Bucyrus, Ohio, Great Lakes, Ill., and Radnor-Haverford, Pa. At Great Lakes, chlorination of return sludge is started at the first evidence of impending bulking, using a dose of 4 p.p.m. based on the flow of raw sewage. Bulking is reported to occur frequently at Radnor-Haverford but excellent control is accomplished by chlorination of the return sludge using a dosage of 10 p.p.m. based on the return sludge flow.

Prechlorination and preaeration are employed at Greenville, S. C., to improve scum collection (24). In discussing the findings of Eliassen and Schulhoff (6D) that at Army sewage treatment plants the inclusion of chlorine in preaeration accomplished no increased removal of grease by subsequent processes, Mahlie points out that grease received at municipal sewage treatment plants differs in composition from that at Army plants.

In reporting on the operation of the Jackson, Mich., activated sludge sewage treatment plant, Cameron (43) states that during the last year little if any trouble has been encountered in keeping diffuser plates free and open. An occasional application of chlorine into the main air line, or the blowing out of the system by using additional blower capacity for 24 hr., has solved this problem.

Chlorination in Industrial Waste Treatment

Friel and Wiest (66) report on eighteen months of operation of an industrial waste treatment plant utilizing chlorination to destroy cyanides. Chlorine apparently reacts to form cyanogen chloride which quickly hydrolyzes to non-toxic ammonia and carbon dioxide. This process was developed by laboratory study and the results of plant scale operation are highly satisfactory.

In Connecticut, as described by Wise (225), wastes from a textile plant discharging dyeing and finishing wastes through an equalization and controlled flow system are satisfactorily handled at a municipal sewage treatment plant. Chlorine demand of the various wastes at the mill ranged from 8 p.p.m. to 3,200 p.p.m. Domestic sewage flow averaged 16 m.g.d. and textile wastes 0.9 m.g.d. The chlorine demand of textile wastes as discharged averaged 2,060 lb., but the chlorine demand of mixed textile wastes and domestic sewage averaged only 1,300 lb.

Superchlorination continues in use as a method for the pretreatment of packinghouse wastes at Austin, Minn. Hill (102) reports that the process includes plain sedimentation, the application of chlorine (3,500 to 4,500 lb. of chlorine per day to a flow of about 1.8 m.g.d.) and sedimentation. This treatment precipitates a large percentage of the protein material and subsequent chemical flocculation at the municipal sewage treatment plant accomplishes only a small additional improvement. Combined packinghouse and domestic wastes are treated on trickling filters.

Gehm (70) reports the chlorine demand of paper pulp wastes to be in the range of strong domestic sewage (10 to 20 p.p.m.) and that chlorination to provide a residual of 0.2 p.p.m. reduces the *B. coli* count to less than 1 per ml. Lagooning was resorted to (133) for disposal of industrial wastes containing considerable oil at a Lockport, N. Y., industrial plant and odor was controlled effectively with sodium hypochlorite. According to Friel (65), prechlorination of sewage usually accomplishes a considerable reduction in the dose of coagulant required for chemical treatment plants.

Chlorination Research

Griffin and Chamberlin (81) investigated the effect of heavy doses of chlorine on sewage, using samples from one plant where raw, settled, aerated, and activated sludge effluents were available. Laboratory tests were made using chlorine doses up to 400 p.p.m. in order to determine the changes resulting from break-point chlorination and the existence of free available chlorine residuals. The ratio of chlorine to ammonia at the break-point in sewage is of the same order as that found in water chlorination, *i.e.* 10: 1. Ammonia is destroyed progressively from the first appearance of a chlorine residual until the break-point is reached, and thereafter it completely disappears. Albuminoid nitrogen is not appreciably affected by the amounts of chlorine used in this study. All appreciable reductions in B.O.D. take place ahead of the break-point and the greatest reductions per pound of chlorine applied occurs at the first appearance of a chlorine residual.

The control of sludge index by chlorination of return sludge was accomplished by Tapleshay (195) at three Army sewage treatment plants. For these plants he has devised a mathematical relationship as a basis to determine the dosage of chlorine to apply to a bulked sludge. He reports that this principle (the proper chlorine dose is a function of the sludge index and the dry solids in the return sludge) has been employed at several activated sludge plants treating municipal sewage and that the results have, in almost all cases, corroborated the original findings.

Kin (125) has found chlorination of return sludge at the Camp Butner, N. C., activated sludge plant to constitute a successful corrective for bulking. A dose of 10 p.p.m., based on return sludge flow, for ten days and at a reduced rate for another ten days was employed. Threatened bulking is now checked by repeating the treatment.

After determining that the rising of activated sludge can be correlated with the presence of nitrites and/or nitrates, Sawyer and Bradney (186) studied the effect of chlorination to control nitrification. In laboratory studies, three feeding experiments were run in which return sludge was chlorinated before each feeding, using doses of 4, 7, and 10 p.p.m. The results show that both nitrite and nitrate formation were inhibited by this treatment and some denitrification resulted. High organic nitrogen and B.O.D. values of the treated sludge, however, led the authors to the conclusion that the purifying ability of the activated sludge had been seriously impaired. The results cited do show marked increases in effluent B.O.D., but they also show that a considerably longer period of time elapsed before rising of the sludge occurred.

Gehm (68) has investigated certain factors affecting chemical treatment of sewage and reports laboratory studies showing that coagulation with ferric chloride reduces chlorine demand an average of 67 per cent; with ferric chloride and lime (pH 9.0) the average reduction was 61 per cent; with ferric chloride and sulfuric acid (pH 4.0) the average reduction was 25 per cent; settling without added chemicals reduced chlorine demand 36 per cent. He also studied the reductions in B.O.D.

accomplished by chlorinating sewage effluents after chemical coagulation: the B.O.D. of sewage coagulated with ferric chloride was further reduced 7.6 per cent; that of sewage coagulated with ferric chloride and lime was reduced 13.2 per cent; ferric chloride and acid effected a reduction of 14.6 per cent.

Chang (47) reports great difficulty in applying the oxidation potential method of determining germicidally active chlorine in water, and the evaluation of potential measurements on sewage would appear almost impossible.

Sludge Digestion

Research

In their investigations of the benefits and disadvantages of rapid digestion of sewage sludge in the thermophilic temperature range, Fischer and Greene (64) report on plant scale investigations at Jackson, Mich., the tests conducted at Aurora in 1931 are first summarized. These tests made it evident that sludge heating methods other than by conventional hot water coils would be necessary in order to maintain thermophilic temperatures.

In the Jackson, Mich., tests stage digestion of raw primary and waste activated sludges was involved. Stage digestion evidently helped to classify the higher volatile matter in the primary tank. At approximately the same density of the mesophilic and thermophilic digested sludges about 1.6 times the maximum mesophilic loading was obtained in the thermophilic system. The most satisfactory range for primary thermophilic tank operation appears to be 125° to 130° F. This makes the heat requirements for thermophilic digestion about double those for mesophilic operation. The experiences encountered in heating the digester by means of contact type heaters and live steam are described.

Ridenour, Backus and Sherron (175) report on laboratory investigations of the effects of polysulfide treated case hardening, copper and zinc plating solutions on sludge digestion. The rate and quantity of gas produced by digestion were used as indexes of industrial waste toxicity. The data submitted indicate that a material concentration of each waste could be tolerated by the sludge digestion process before impairing digestion. A definite tolerance for sodium cyanide has to be built up in digestion. Because the basic constituent of each waste was calcium polysulfide, all wastes increased the H_2S content of the digestion gas.

In South Africa the demand for formalin increased as the importation decreased during the war. A serious shortage of this important chemical resulted. Following the original suggestion of Wilson (17) to use the methane in digestion gas as a raw material for the production of formaldehyde, the city of Johannesburg and the Department of Commerce and Industries of South Africa set about conducting plant scale experiments with such an end in view. The production of formaldehyde (HCHO) from methane (CH_4) by direct oxidation produces inconsequential quantities of the former. Consequently the methane was first converted to methyl alcohol which was dehydrated to produce formaldehyde.

Tank Design

Velzy (212) ably sketches the problems involved in handling sludge from the time it leaves the settling tanks until it enters and leaves digestion. He lays needed emphasis on designing digestion tanks to keep the accumulating top scum moist.

Sludge Pumping

Yeomans (228) describes a better method of pumping sludges in a digestion system by means of a sludge ejector (old fashioned air displacement pump or *monte jus*) operated by digestion gas under the constant pressure provided by any standard pressure storage gas holder.

Imhoff Tanks

According to Daniels (52) "The Imhoff tank had the misfortune to be born long before the principles of sludge digestion were known and, as a result, probably the majority of them was underdesigned as to sludge capacity." The author of this didactic treatise deals with the various factors influencing capacities and relationships which should prevail in the design of such tanks.

Operation

Samson (183) reports on the use of four fixed cover type digesters devoted to single stage operation at moderate temperature ranges. The author considers the most valuable feature of the 4-year old installation to be the provision of sampling cocks at 1-ft. intervals throughout the entire depth of each tank. Another valuable feature of the installation is the provision of power driven scum breakers and sludge stirring mechanisms. In order to thicken the raw sludge before pumping to digestion tanks it is held in the primary tanks for two days. The thickened raw sludge entering digestion has a relatively low volatile content, which probably accounts for the expressed preference for single stage digestion at this plant at Tonawanda, N. Y.

Barton (29) describes an interesting list of experiences and observations in operating the 75,000 cu. ft. digestion tank and auxiliary equipment at Findlay, Ohio. Ground garbage is treated with the sewage flow at this plant.

Townend (205) contributes an informative account of ten year's practice in sludge digestion and gas utilization at the Mogden Works of the West Middlesex Main Drainage project which is the largest complete treatment plant outside the United States and which serves over a million of the Greater London suburban population.

The entire output of mixed primary sludge waste activated sludge, and sludge from storm water tanks (480,000 U. S. gal. daily) passes through digestion, with the first and second stages seven miles apart. The supply of digestion gas for power purposes made a most valuable contribution to the conservation of national resources, saving over 1,500,000 U. S. gal. yearly in fuel oil which, if imported, would have cost about $300,000. In a decade of operation, the digestion and power plant have shown no failure of any kind. In regard to power requirements the power plant is entirely self supporting, with no outside power reserve. It has been more completely trustworthy than the public power supply.

Of the ten engines installed (550 b.p.h. each on gas) 8 run on the digestion gas and 2 are reserved for fuel oil. Six drive turbo-compressors and 4 are coupled to D.C. generators. Some gas is used for motor vehicle fuel.

Theory and Operation

Langford (135) presents a brief treatise on general theory and practical operation of digestion tanks. The round table discussion on operating temperatures in digestion tanks is concluded in *Sewage Works Engineering* (20).

Supernatant

Realizing the prime importance of producing rapid and effective separation of supernatant liquor from digested solids in the operation of digestion tanks, Rudolfs and Fontenelli (181) report on results obtained in laboratory experiments and in the operation of digestion tanks in three sewage treatment plants.

The volumes of supernatant which could be obtained from stored fresh solids, ripe sludge and digestion mixtures were determined from laboratory experiments. The quantities of supernatant liquor produced from raw sludge, single- and two-stage digestion were determined from plant operation. The percentage of separation of liquor was higher in actual plant operation than in laboratory equipment. In the plants investigated the digestion temperatures were maintained at 82° to 84° F. The various factors influencing the production of supernatant and its separation from suspended solids are systematically listed.

The various factors and problems involved in the production, treatment and disposal of digester supernatant are also presented by Erickson (62). Some factors affecting the volume of supernatant are outlined and, in order to use the term "supernatant liquor" significantly, an attempt is made to give it existing sense in some definition by a process of elimination.

It is logically claimed that the supernatant liquor problem is comparatively recent and has apparently developed with the advent of separate sludge digestion. It was not so much of a problem with Imhoff tanks. The author argues that a continuous removal of liquor at a low rate of flow from modern separate sludge digestion tanks will simulate conditions under which a good quality of liquor is slowly displaced from Imhoff tanks. The equipment suggested for this purpose was previously described by Schlenz (187) and reviewed in This Journal.

Various methods of treating digester supernatant are described, and the experimental results obtained at Cleveland, Ohio, Camp Shelby, Miss., and Geneva, Ill., by the use of atomized aeration and settling are graphically shown.

Chamberlain (46) discusses the foregoing paper, the three characteristics of strong digester supernatant inimical to its easy disposal (B.O.D., suspended solids, and septifying ability), and lays emphasis on the immediate oxygen demand (5-min. B.O.D.) of this liquor and its satisfaction. The types of treatment used to satisfy this demand and to remove suspended solids at Bucyrus, Ohio, and Geneva, Ill., are described.

The serious supernatant problem at Scott Field, Ill., was solved in an unusual manner according to Tharp (199), *i.e.*, by eliminating the supernatant. The digestion temperature was raised from 90° to 102° F. to accelerate digestion and the schedule of pumping to digestion and withdrawals of sludge from same were changed to eliminate supernatant and any necessity for finding a definition for it.

Notwithstanding the foregoing, the most novel method of dealing with the problematic liability of poor supernatant has been disclosed in Peoria, Ill. Reference to this interesting subject has been taken elsewhere in this review under the heading of *Activated Sludge*. However, it deserves cross reference here in reviewing literature on the subject of supernatant liquor.

Kraus (129) has evidently converted the inimical liability of supernatant into a remarkably effective asset in activated sludge treatment. If his disclosures are confirmed elsewhere, he will have demonstrated the spirit of real invention by converting treatment enemies into allies of value in solving two problems simultaneously, *i.e.*, that of controlling the bulking of activated sludge and that of supernatant treatment. At Peoria he has developed a method of controlling the sludge index in sludge activation by the application of digested sludge or digester supernatant that has been properly seeded with activated sludge.

Digester Gas Hazards

Langford (134) presents a constructive discussion of the important subject of "Safety Considerations in the Design of Gas Utilization Facilities." As the subject title indicates the author considers the hazards resulting from the production, use and wasting of digester gas and the reduction of these hazards to men and plant structures by the proper design and installation of all equipment having anything to do with the production, storage, distribution and utilization of this gas.

For the safe distribution and utilization of digester gas the constant insurance of keeping the gas under positive pressure is of fundamental importance. The importance of proper ventilation of plant structures and the control of the various methods of ventilation are stressed. Finally, from the standpoint of safe practice in design, installation, and utilization of the gas, general specifications are discussed relative to practically all structures, equipment and piping from the digestion tanks to boilers and chimneys.

In spite of safety considerations, occasional explosions of digestion gas take place. The conditions which led to such an explosion at the treatment plant of Monroe, Michigan, are described in *Sewage Works Engineering* (18). Building walls were displaced and some equipment was damaged. The plant operator suffered from shock but was not seriously injured.

Gas Utilization

Boehm (34) describes the novel Worthington gas engine equipped to be readily shifted from the use of digester gas to the use of fuel oil or to any combination of the two without interrupting the load. The first installation of this engine was made at the New York Tallman's Island plant.

Gas Holders

Seven years after putting a 50-ft. diameter spherical gas holder into service at Green Bay, Wis., it was cut out of service and thoroughly inspected. Martin (144) states that due to the protective coating of paint and oil it had thoroughly resisted rust and corrosion.

Digestion Tank Repair

Urban (209) tells of solving a problem involving the replacement, in a 6-in. drain line from a floating cover digester, of a flanged valve when there was no other valve on the line. It was done without either admitting air into the digester or the loss of sludge from the same.

Patents

The following U. S. patents relating to digestion were issued in 1944 and 1945 to: (1) Schlenz and Cox (188) on a method of treating supernatant liquor from a digestion tank by means of aeration, sedimentation and returning the settled solids to digestion and the clarified liquid to sewage treatment; (2) Branzell (40) *et al* on a continuous two-stage digestion tank for fibrous material; (3) Piatt (165) for arrangements for removing digestion gases from a two compartment digestion system, without disturbing the tank content; (4) Evans and Gutman (63) covering a plurality of rectangularly formed digestion chambers and (5) Burgett (41) for a septic tank constructed of molded cementitious materials.

Sludge Disposal

Army and Navy Plants

Greeley (79) calls attention to the hundreds of sewage treatment plants built by the Army and Navy during the past three years and urges that their operating experience be summarized for application to municipal projects. There appears to be a trend, he says, toward simplifying sludge disposal. Dumping wet sludge in the ocean and lagooning are examples of this. The author also notes a desire by some municipal authorities to dispose of garbage and sludge together. The location of high temperature refuse incinerators at sewage treatment plants is one satisfactory method of accomplishing this.

Elutriated Sludge Plant Design

Trends in elutriation plant design are outlined by Genter (74). In sewage treatment vacuum filters are now being used to serve about 14,000,000 persons. The plants involving short circuiting all fresh solids to the filters and heat driers or incinerators without the benefits of digestion serve somewhat over 6,000,000 population. About 22 per cent of this population is served by the world's largest existing filter installation at the Southwest plant in Chicago. The advocates of sludge digestion, with and without elutriation, have installed filters to serve almost 8,000,000 population. This service is about evenly divided between elutriation and non-elutriation. The latter is best represented by Cleveland, Ohio, and Buffalo, N. Y. The dozen or so illustrations involving elutriation serve slightly over 4,000,000. The largest of these installations are at Baltimore, Md., and the District of Columbia, each serving about a million population.

Chemistry, says Genter, has come to play an important role in the economics of mechanical dewatering and the processing of sludge prior to filtration. The most efficient chemical is ferric chloride. The dose requirements vary greatly. Measured in terms of domestic sewage sludge dosed and filtered per 1,000 persons daily, the most expensive are both the fresh waste activated sludges of high volatile content and the thin digested sludges derived therefrom; namely, from 11 to 12 lb. of ferric chloride. The least expensive are the heavy, highly mineralized, well elutriated digested sludges requiring about 1 lb. ferric chloride per 1,000 persons daily. Between these dosing extremes lie the other variations. Installations using sludge digestion and elutriation have demonstrated that it improves filter yields while materially reducing the chemical requirements.

Genter (73) has developed an equation for computing the coagulant demand of sludges for filtration as follows: $X = 1.08Y_1 + 1.6Y_2$ where X is total chemical dose, Y_1 is the percentage of alkalinity in the sludge solids and Y_2 is the ratio of volatile matter to ash in the sludge.

Hubbel (110) and Garrity (67) state that elutriation has not proven successful in Detroit. It is to be hoped that details of the methods of operation and of the actual results obtained will be forthcoming to reveal why the experience at Detroit is at variance with other reported results. One digestion tank is used for partial digestion and gas production. The partially digested sludge mixed with raw sludge, grit and scum is filtered on vacuum filters to 70 per cent moisture and fed to the incinerators. The ash is sluiced to lagoons. The ash yield is 2,000 tons a month and methods other than lagooning, such as barging or cement production, are being considered. About 0.19 gal. of fuel oil per unit ton burned is used mostly in warming up periods.

Vacuum Filter Areas Required

Zack (229) gives in Table 1 the vacuum filter areas required for the sludges listed.

TABLE 1.—Vacuum Filter Areas Required for Various Sludges

Type of Sludge	Conditioning Chemicals	Sq. Ft. per 1,000 Persons
Undigested activated sludge	Aluminum sulfate	40.0
Undigested activated sludge	Ferric chloride	3.5
Raw plain-settled sludge	Lime and ferric chloride	1.0
Chemically-precipitated raw sludge	Lime and ferric chloride	2.0 to 3.0
Digested elutriated primary sludge	Ferric chloride	0.6
Digested elutriated sludge from complete treatment	Ferric chloride	1.1

Use of Ferric Chloride as Conditioner for Sludge Beds

Halvorson and Smith (83) describe seven existing small sewage treatment plants which can be housed in a single building where screenings from a 14-

mesh self-cleaning fine screen and raw humus sludge from a tile media Aerofilter are treated with ferric chloride and dewatered on enclosed sludge beds of sand in 4 to 6 hr. Less than 2 lb. of chemical is used per 100 gal. of sludge and only 20 sec. of flash mixing is required. The purpose of the process is to reduce the discharge of B.O.D. and nitrogen in the plant effluent by eliminating digestion and, therefore, the need of supernatant liquor return to the raw sewage. Other advantages of doubtful value are mentioned.

Use of Alum to Hasten Sludge Drying

Thompson (201) at Stratford, Conn., following the example of Sperry at Aurora, used alum at a cost of about $8 per 70,000 gal. of sludge to hasten dewatering on open sludge beds. The reduction in water content of the sludge in 24 hr. has been nearly twice as great for treated sludge as for untreated sludge. The treated sludge dries in less than one-half the time required for untreated sludge, and the dried residue is thinner, lighter in weight and, therefore, more easily removed. Odors have been reduced and a greatly overloaded Imhoff tank plant has been kept in fairly good operating condition pending contemplated alterations and additions in the postwar era.

Use of Refuse Incinerator Heat for Sludge Drying

Van Kleeck (210) gives favorable comment to the use of waste refuse incinerator heat at Stamford, Conn., for drying an elutriated digested primary sludge. In an article written for operators describing and discussing the common drying processes, the important role of sludge conditioning processes prior to dewatering is emphasized.

Fertilizer

Investigations in England during the war for production and estimation of value of manure from sewage sludges with and without composting with refuse have been pursued. Bould (37) describes a method of composting town refuse with fresh sewage sludge in cells furnished with drain pipes or filter bed tiles, the purpose of which is to furnish ventilation and aeration to the pile during fermentation, which raises the temperature to 65° C. within a week. Within 3 weeks the compost was free of obnoxious odors. The depth of the pile was 4.5 ft. In order to minimize the losses of organic matter and nitrogen during the fermentation, it is recommended that the aerobic stage should be limited to 2 weeks followed by 1 to 2 months of the partially anaerobic stage. Best results were obtained with refuse-sludge ratios of 1 : 1 on a wet basis or 20 : 1 on a dry basis. In spite of the increase of ammonia nitrogen during the fermentation, nitrogen immobilization takes place when the mature compost is added to the soil.

Crowther (51) reported the results obtained from the application of sewage sludge on potatoes, barley and mangolds. Comparisons were made of sludges and farmyard manure supplemented with commercial fertilizers. The sludges used were: (a) primary digested sludge dried on sand beds and (b) digested primary and excess activated sludge dried on sand beds. The primary digested sludge failed to increase the yield with any combination of fertilizers while the digested primary and excess activated sludge increased the yield under all conditions but not to the same extent as farmyard manure with similar combination of fertilizers.

Müller (157) conducted experiments with raw and digested sludge treated in various ways.

To control fly breeding in raw sludge during drying in open beds at Cairo, Egypt, (220) the sludge is dried in thin layers. Before the hatched larvae pupate and after the first layer is dried, another layer of liquid sludge is spread over it. When a bed is nearly full by repeated "flooding" action, a layer of sand is spread over the top and flooded with settled sewage.

Mechanical Equipment

Many manufacturers of sewage works equipment (21) stress a report of a survey by the Water and the Sewage Works Manufacturers Association which led to the conclusion that "no radically new equipment or processes (are) being planned for immediate postwar marketing." Nevertheless, there is repeated reference in the literature to mechanical equipment in descriptive articles of sewage treatment plant design. For example, attention is directed to an article by Riddick (174) describing the design of a plant for the treatment of wartime industrial waste, in which the importance of mechanical equipment is emphasized. That mechanical equipment is not confined to large plants is emphasized by Bell (30) in an article on the design of small plants. Marston (143) points out that "certain operations about sewage treatment plants can be handled with better results and at the same time avoid unpleasant manual labor." He emphasizes his remarks by calling attention to mechanical equipment used in cleaning grit chambers, removing sludge from sedimentation tanks and in in the handling of sludge, in the aeration of sewage, and in settling tank design.

In a staff article in *Sewage Works Engineering* (21) much space is given to manufacturers of sewage works equipment for the description of their products and to predict things to come. A result is a comprehensive review of up-to-date products. Among the products and equipment described are: "package" sewage treatment plants for small installations; electrical controls and equipment providing greater safety in gas-filled chambers and to protect other electrical equipment from overload; a new "adjustable-multiple-venturi-flume-distributing baffle" to distribute the flow of water or sewage into rectangular settling basins; a flocculator which has no underwater bearings, chains, or moving drives, with favorable power consumption, called a Walking Beam Flocculator; Duracite, a resin-cement "resistant to most inorganic acids, organic acids, alkalies of any degree of concentration, oils and solvents, with high compressive and tensile strength, and temperature range between 350° and 375° F.; improvements in Infilco grit removal mechanisms, the development of an improved hydraulic skimmer, and the advantage if direct recirculation in high-capacity biological treatment; a synthetic-resin paint known as Resoweld Paint, for protection against corrosion; prefabricated concrete pipe in longer lengths with rubber gaskets to furnish a high degree of water-tightness in joints. Increased use of aluminum in sewage works is predicted.

In discussing trends, Camp (44) states: "It is possible to note present trends and to prophesy by projecting these trends into the future. Unfortunately the trends in some quarters are contradictory to those in others. There is lack of agreement as to what constitutes the best basis for the design of settling tanks. . . . Too much emphasis must not be placed upon mechanical equipment to the neglect of the sedimentation process itself. . . . There is a trend towards the use of longer and narrower tanks for final settling in the activated sludge process. . . . Progress will continue to be made by the manufacturers of sludge removal and skimming equipment in the direction of reducing the weight of the equipment and prolonging its useful life. As a result of the advances in metallurgy brought about by the war, there will doubtless be many new steel alloys available to provide durable wearing surfaces and minimize corrosion. It is also probable that there will be wider use of non-ferrous metals. More effective protective coatings, particularly some resulting from the use of plastics are also likely to be available for mechanical equipment. Better electrical equipment and a wider variety of speed reducers will also be available.''

Pöpel (171) reports experiments on mechanical flocculation which lead to the conclusion that mechanical equipment is efficient in every respect in sedimentation and coagulation, except possibly that the flocs are fragile and disintegrate when the velocity exceeds 13 f.p.s. Anderson (21), through his revelation of the existence of ''density currents'' in settling tanks has contributed much to the design of inlet and outlet equipment therefore. For example, he states: ''that for effluent weirs located away from the upturn of the density currents, the overflow rate should not exceed 20,000 g.p.d. per ft. of weir; and for weirs located within the upturn zone the rate should not exceed 15,000 g.p.d. per ft.''

Greeley (79) points out that the past three years have given opportunity for experience in high-rate trickling filters, sewage ponds, unheated sludge digestion tanks, sludge lagoons, and sanitary fills. In sludge disposal the trend is towards digestion and the production of gas for power and heating. The combined disposal of garbage with sewage is focusing attention on grinders for central station installation and on home waste-food grinders.

Langford (134) describes equipment connected with the safe collection, storage, and distribution of gas. This equipment includes boilers, gas piping, meters, traps, pressure regulators, waste gas reliefs, flame traps, flame cells, pressure gages, waste gas burners, explosion reliefs, gas holders, pressure-vacuum reliefs, lightning arresters, digestion tanks, and explosion-proof electrical equipment.

Richardson (173) has described a new development in sludge metering characterized by the continuous injection of water into a venturi tube and its connections.

Zack (229) predicts that the trend during the past 20 years toward mechanization of sludge disposal processes will become more pronounced in the postwar period. Genter (74) describes equipment used in sludge elutriation and describes experience in the conditioning of sludge which has made possible smaller conditioning tanks and piping in vacuum filters.

Outside of the field of sewage treatment, Bogert (35) reports a prediction that solid volute propellors will be preferred to open impellers; flexible shafting will be used in vertical pumps, and flexible couplings on horizontal pumps; variable speed drive will be attained by either variable speed motors or variable reduction gears. There will be more extensive use of close-coupled, vertical type pumps in well ventilated dry wells. Recent developments in sewage pumps include the close-coupled type of horizontal installation, where pump and motor are built into the same frame, resulting in considerable saving of space requirements and simple shaft alignment.

In the field of construction, Bennett (31) describes various types of sewer trenching machines. Cohn (50) concludes his series of articles on the maintenance of sewage works equipment. Among the Buyers Guides in the field of sewage equipment may be included those published by *Water Works and Sewerage* in the June issue and by *Water and Sewage* in the July issue.

Industrial Wastes

Disposal of industrial wastes as a national problem has been of interest in 1945 both in the U. S. and Great Britain, with rather divergent policies resulting. In the U. S. there has been emphasis on the function of the trade organization as a research agency, with co-operative support by governmental bodies, whereas in England the Ministry of Health supervises the research and may now try to apply the 1937 Act (Drainage of Trade Premises), temporarily shelved during the war. Nothing similar to this Act has been under consideration in Congress, although both the Mundt and Spence Bills provide loans for construction of new treatment plants for industrial wastes, but do not set up any method for levying operating charges on industry.

A very surprising innovation in England has been proposed by Hurley (113) who is dissatisfied with the 1937 Act and suggests that all industries contribute to a national fund in proportion to the cost of disposing of their wastes in local sewage treatment works by primary, intermediate or complete treatment and that the Government then reimburse the local sewage authority, with rebate to the industry if the wastes are pretreated at the factory. Thus there would be no shopping around for the best deal in the case of new industries and there would be no discrimination in dealings with all industries tributary to certain sewage treatment works. The scheme would require a committee of experts, who would fix the rates, but local authorities would administer the Act and make necessary tests. So far, this is only a suggestion, but it is evident that the 1937 Act needs revision and this scheme may offer an improvement.

In Los Angeles, Knowlton (127) suggested a schedule of excess charges for treatment by activated sludge of various types of wastes, based on volume, B.O.D. and suspended solids. This is similar to the scheme proposed by various other cities, including Chicago and Buffalo. Mohlman (153) called attention to the wide variation in rate of losses from various plants inside the same industry and deprecated the tendency to form trade research groups rather than to install waste treatment plants. On the other hand Hoak (107) reaffirmed the efficiency of modern industry and stated that trade associations and research fellowships represent, in part, the discharge of the obligation that industry owes to play an equitable part in the reduction of pollution. Gehm (71) also stresses the advantages of the integrated national program of the pulp and paper industry and states that research is to be "implemented by the solution of immediate pollution problems." There is renewed activity in waste disposal reported by Trebler (208) in the dairy industry, a new committee has been organized by the chemical manufacturers, and the tanners, textile industry, petroleum industry and iron and steel manufacturers are more active recently in the field of waste disposal.

Packinghouse Wastes

Hill (102) reported the problems in handling packinghouse wastes at Sioux Falls, S. D., and Austin, Minn., where the pollution loads from industry are from two to five times as great as the human sewage load. The use of washable primary and high-capacity intermediate trickling filters has helped greatly in reducing excessive strength of clarified wastes. Final treatment by activated sludge has encountered difficulty because of rising sludge induced by the high nitrogen content of the waste. This is a common problem where packinghouse wastes are treated in an activated sludge plant. Bragstad (38) reviewed the legal and financial affairs between the packer and city at Sioux Falls. The State Supreme Court held that a long-term contract between the two was void but did not order the wastes removed from the treatment plant.

Food Wastes

Canning of peas, corn and tomatoes produces the largest tonnage of wastes in the canned vegetable industry. Sanborn (184) reviewed the present status of salvage or disposal of wastes from these crops. Dry solids such as vines, husks and skins are used for feed;

tomato pomace was dried and sold for $35 per ton in 1944 compared with $21 in 1941. Greater recovery may be stimulated when drying units are available.

Citrus canning wastes are a problem in Florida, as reported by Ingols (116). Feed is made from grapefruit rinds but the press liquor contains as much as 10 per cent solids and its disposal is difficult and is being studied in a pilot plant. Disposal of more dilute canning wastes is usually accomplished by dilution in lakes, lagooning or sand filtration.

Lagoons have been used for many years for disposal of cannery wastes but they are usually odorous. Use of sodium nitrate to satisfy part of the B.O.D. will prevent or minimize odors. A study of lagoons and the use of sodium nitrate was made under the auspices of the National Canners Association, as reported by Warrick, *et al* (218). The wastes should be screened through a 40-mesh screen, and treated with sufficient sodium nitrate to satisfy 20 per cent of the 5-day B.O.D. The depth should not be greater than 5 ft. and the volume should allow for 125 per cent of the seasonal volume of waste produced. Ryan (182) states that Sanborn conducted tests in 1940 near Rochester, N. Y., and the results led to the use of 10 tons of sodium nitrate in a pea-waste lagoon in 1944, added in July. The B.O.D. rose from 750 p.p.m. on July 31 to 1,440 p.p.m. on August 10, later declining to 210 p.p.m. on September 2 and 57 p.p.m. at the end of October. The freezing of corn cannery wastes held in shallow lagoons through the winter has been reported (176) to result in considerable stabilization of the separated solids before the next warm season.

In England (118) disposal of waste waters from dehydration of potatoes, carrots and cabbages has not been much of a problem. The wastes from 40 tons of potatoes per day have a population equivalent of 12,000. Wastes are screened or settled and discharged to sewers. The sludge is bulky, gelatinous and putrefactive.

A foreign problem, the disposal of wastes from processing the coffee bean in El Salvador, was discussed by Ward (216). The green bean is partially fermented in order to remove the pulp and skin that enclose the coffee bean. The pulp and wash waters from the fermentation basins have a high B.O.D., equivalent to a population of 4,000 for a plant of moderate size processing 100,000 lb. of coffee ''cherries'' per day. At present the pulp is buried and liquid wastes lagooned, which is satisfactory in isolated areas. Chemical treatment results in only about 25 per cent reduction of B.O.D., consequently pilot plant studies of biological filtration are being made in co-operation with the Office of the Co-ordinator of Inter-American Affairs.

Fermentation Wastes

Rudolfs (180) discussed the treatment of wastes from fermentation processes, pointing out that they are usually fairly free from suspended solids but of high soluble strength, thus requiring dilution by recirculation or pretreatment before aerobic biological treatment. Anaerobic treatment, with collection and use of gas, appears promising as installed at the yeast plant in Pekin, Ill., of the Standard Brands Corporation. Sometimes nitrogen or phosphorus must be added to these highly carbonaceous wastes, to obtain good biological oxidation.

Mohlman (154) reported the B.O.D. (5-day) to nitrogen ratios of various types of wastes surveyed in Chicago. The ratio varied from 6 to 1 for sewage to 8 to 1 for packinghouse wastes, 18 to 1 for fermentation, 35 to 1 for milk products, and 70 to 1 for laundries and vegetable oil-processing industries. Principles of recovery of wastes inside the plant were discussed, with several specific examples.

Boruff and Weiner (36) traced the progress in recovery of distillery solids from the old days when still residues were only screened before discharge, to the modern plant developed at Hiram Walker, Inc., Peoria, where 800,000 g.p.d. of "stillage" with a B.O.D. of 15,000 to 18,000 p.p.m. is screened, centrifuged and dried to produce about 150 tons per day of "distillers' dried grains with solubles" worth around $20 to $30 per ton.

Pulp and Paper

Lagooning kraft mill wastes for 15 or 20 days results in a large reduction in the B.O.D. of the discharged effluent (72). A Texas mill settles the liquors in a small basin, followed by a 20-day storage lagoon.

Fiber losses have been minimized at a Pennsylvania paper mill by alum treatment, with vacuum filtration of the sludge, which is used in a board mill.

A small plant for production of alcohol from sulfite liquor has been in operation at Bellingham, Wash. Otherwise, the sulfite waste problem shows little alleviation.

Petroleum Wastes

The waste problems of the petroleum industry were outlined by Hart (86), including oil-field brines and refinery losses. In the latter, emulsions prevent efficient separation of oil by flotation but these emulsions can nearly always be broken by liming and heating to 160° F. (if the volume is low) or by use of chemicals tested in the laboratory.

Weston (222) presented a more detailed picture of petroleum wastes, including 137 references and estimates of cost of producing certain results. He claims that large complete refineries may be expected to have 0.5 to 3.0 per cent of their crude oil escape to the sewer, but that with the API separators it is possible to recover well over 95 per cent of the oil. Where the effluent must contain only 5 to 10 p.p.m. or less, chemicals will have to be used for breaking emulsions, leading to excessive costs. Waste caustic solutions are highly obnoxious but of low volume. They can be treated on biological filters if not too odorous because of mercaptans. Phenols must be extracted. Acid sludge is usually treated to recover H_2SO_4.

Chemicals and Non-Ferrous Metal Wastes

The Dow plant (172) for biological oxidation of phenolic wastes has been expanded by construction of 40 acres of holding ponds and a small activated sludge plant. Strong phenolic wastes average 1.25 m.g.d. and contain 600 p.p.m. phenol. They are discharged to ponds having a capacity of 42 m.g., thence diluted with weak wastes and fed to the trickling filters at 30 to 50 p.p.m. phenol. The four filters are 142 ft. in diameter each and 9.75 ft. deep. The activated sludge plant includes three mechanical aerators each 24 ft. square and 15 ft. deep, followed by a final settling tank, from which sludge is returned. The overall removal of phenol averages 98 per cent.

In Connecticut Wise (225) reports brass and copper wastes of most importance. Most of the losses are in the wash waters, containing about 105 p.p.m. sulfuric acid, 24 p.p.m. copper, 20 p.p.m. zinc and 20 p.p.m. chromium. Recovery processes are expensive because of the dilute character of the waste. Textile, oil and plating wastes are also important. A later paper (224) gives details on methods and costs of recovering metals by lime precipitation, estimated to cost 4.2 cents per lb. of metal recovered; second, use of electrolytic methods; and third, use of synthetic resins. These studies are to be continued. Studies are also being made of pickling liquor recovery and removal of cyanides from plating room wastes. The latter has been accomplished by the use of chlorine at an aircraft factory, in a plant designed by Friel and Wiest (66). The cyanide forms cyanogen chloride, CNCl, which quickly decomposes to harmless ammonium carbonate in the presence of hydroxide alkalinity. Batch treatment was considered most practical, in wooden tanks with 20 to 30 min. retention.

Oeming (162) has reviewed the status of waste disposal in Michigan, covering magnesium chloride brines, phenols, cyanides, oil wastes, paper, beet sugar and other wastes.

Wastes from TNT shell-loading plants were studied by Ruchhoft (179). Soil absorption and activated carbon treatment were the most promising procedures. Large doses of carbon are needed, from 17 to 50 grains per gal.

Pickling Liquors

Iron or steel pickling liquors are most generally treated with lime for neutralization of the free acid and precipitation of the ferrous sulfate. Hoak and Hodge (108) showed that it is cheaper to use limestone to neutralize the acid, and lime to a pH of 9.0 to precipitate the iron. Dolomitic limestones are unsatisfactory.

A further review of the pickle liquor problem has been prepared by Hoak (105). The low value of and limited market for recovered ferrous or ferric sulfates do not offer much hope for salvage, in spite of the many processes proposed.

Stream Pollution

Abatement and Control

There was an increase in the number of papers discussing stream pollution during 1945, all of which served toward the education of the public to a greater recognition of the problem. The increase in tastes and odors from industrial wastes due to war industries in the public water supplies along the Ohio River has created tremendous interest in the problem. According to Todd (202) the present pollution of the Ohio River at Wheeling, W. Va., is such that the water is unfit for a public supply. The fact that one paper entitled "Our Dead and Dying Rivers" (88) from *American City* was reprinted in *Readers Digest* is perhaps indicative of renewed interest. This was the first non-technical discussion of the problem to reach the public in a popular national magazine.

LeBosquet (136) on the basis of the Ohio River Pollution Study discussed the work of the states and interstate commissions on pollution abatement along with the problems of education and financing of abatement programs. Hoak (106) (179) maintained that the national economy is based upon the effective use of streams and that the stream should be considered a chemical and biological treatment plant that works satisfactorily as long as it is not overloaded. Murdock (158), reviewing Purdy's early work, discussed the operation of the Huntington Flat in the Potomac River as an efficient waste disposal plant. Adams (1) pointed out that half of the population of the state of Michigan is dependent upon surface waters as a source of public water supply, and also that these waters serve the major industrial plants, provide sport and commercial fishing and support game and wildlife. Consequently, although the stream can supply the oxygen required by the pollution if the load is not too great, pollution control is necessary to prevent impairment of the usefulness of surface waters.

Although the Tennessee valley contains relatively clean streams compared to other regions, Jones and Wolman (119) discuss the stream pollution and public health problems in relation to the changes caused by the construction of nine dams on the Tennessee and point out that in general the sanitary quality of the lake waters has been improved by impoundage. Chase (49) discussed the types of wastes and their effect on rivers and on water treatment plants, and cited the Androscoggin as a specific example of a grossly polluted stream. Kittrell (126) presented a lucid discussion of pollution studies and pointed out that objections to pollution abatement can be eliminated if a well-planned educational program follows a thorough investigation of pollution in the area.

The co-operation between Wisconsin industries and the state agencies in abating stream pollution was reported by Warrick (217). No fixed standards are used but each stream is considered as a special problem depending upon its uses.

The history of stream pollution control in Pennsylvania was reviewed by Stewart (192), who pointed out that the Act of 1937, upon which the Board bases its activities, goes far beyond the original Act of 1905. The 1937 Act provides for equal control over the discharge of trade wastes and includes additional features on stream life. The Board proposes that all sewage shall receive a minimum of primary treatment and that industrial wastes are to be treated to an equivalent degree. Stewart concluded by saying that the people have the right to clean streams and quoted a Pennsylvania court decision upholding the right of the people to have the streams, from which they draw their water supply, free from pollution. In carrying out the abatement program the Pennsylvania State Sanitary Water Board has ordered nearly 300 communities and 102 industrial companies to make plans immediately for sewage treatment works (9) (28). This includes 60 communities on the Schuylkill River (8). Incidentally, the State of Pennsylvania has signed three compact agreements for pollution abatement with other state groups during the year.

According to *Pipe Progress* (14) the stream pollution due to salt water from oil fields has been reduced by injection wells to the Woodbine sands in the East Texas field.

Symons (194) briefly discussed the development of pollution abatement programs and reviewed cost estimates of such programs from three sources. He stated that the striking of an economic balance between the extent of abatement and the capacity of a receiving watercourse and the development of the program on a regional or drainage basin basis are important considerations. Berry (33) also briefly reviewed pollution abatement programs, including Pennsylvania's and the Interstate Sanitation District plan involving the expenditure of $120,000,000.

Wisely (226) editorially reviewed the important service that state agencies are giving to insure the proper consideration of stream pollution abatement in postwar planning. He mentioned outstanding work in this field with limited staffs in a number of states and the valuable research studies being made on various localized problems toward the abatement of pollution by industrial wastes.

The progress that has been made by the Interstate Sanitation Commission in the past seven years in reducing the pollution of the waters of Long Island Sound and New York Harbor was reviewed in *Public Works* (16). In 1937 practically all of the 1,000 m.g.d. of the wastes discharged failed to meet the requirement while in 1944, 430 m.g.d. or 35 per cent met the requirement. The compact between the three states establishes standards based on the removal of solids and coliform organisms. Of the 70 plants in the district, 50 now comply with these standards.

The agreement on a plan to construct a $17,500,000 sewage collection and treatment system for Hamilton County (Cincinnati), Ohio, and the action of Louisville, Ky., in making application for federal aid in the design of a $7,000,000 treatment plant, as reported by *Engineering News-Record* (11), indicated that progress may be expected in pollution abatement on the Ohio River.

Abatement and Control Legislation

Walker (215) reviewed and summarized the many British laws relating to the pollution of rivers and streams from the Prescription Act of 1832 to the Public Health Act, 1936, and Defense Regulations, 1939.

The Minnesota legislature enacted a water pollution control act and established a Water Pollution Control Commission (12). The duties of the new commission include administration of pollution laws, investigation of pollution in waters of the state, establishment of pollution standards, establishment of orders requiring discontinuance of discharges, approval of plans for sewage works and issuance of permits for discharge of sewage and industrial wastes.

The Interstate Commission on the Potomac (10) went on record that a valley authority was unnecessary to end the Potomac River pollution, set up four classes of minimum water quality classifications (which must be adopted by each signatory state) and adopted two resolutions. One of these was to ask the federal government for aid in evaluating the extent of pollution and determining the best abatement procedure. The second resolution asked that the federal government assist the various interstate river basin commissions upon request by making studies and surveys, that the federal government finance construction projects that cannot reasonably be constructed by the states, and that a program for the solution of all river basin problems including pollution, flood control, soil conservation etc. be encouraged and initiated by the interstate compact method. In contrast to the above stand for federal financial aid Jordan (120) considered "the adoption of the grants in aid principle even for this worthy purpose, as a permanent part of national policy, not related to unemployment relief, is in the judgment of the author just as improper as the other intrusions of federal funds into local and regional problems." Jordan stated, however, that there are serious interstate stream pollution problems which, if not abated on the local or regional level, will inevitably, in the public interest, be handled at the national level. On the recommendation of Wolman, the Executive Committee of the American Water Works Association (23) endorsed the Spence and Barkley (HR592 and S1037) pollution control bills with the exception of sections 5, 6 and 7. These sections would establish grants in aid to political subdivisions and also to persons and industrial establishments. The AWWA especially endorsed those portions of these bills which call for USPHS investigations and studies of pollution abatement and waste treatment in co-operation with states making such requests, and also endorsed the publication of findings from technical studies and of reports and recommendations growing out of such investigations. Wisely (227) reviewed briefly the provisions of the three types of anti-pollution legislation now before Congress and concluded that the Spence and Barkley bills, with certain revisions, are best fitted to pollution control requirements.

Bacteriology and Biology

Sandholzer and Quimby (185) reported favorably on a new alkyl sulfate medium which inhibits gram positive bacteria and permits the gram negative forms to reduce nitrates. The detection of nitrites in the sample after 8 to 48 hr. incubation constitutes a presumptive test for the coliform group. As the comparative study by these authors included only 100 samples, a great deal more work must be done before this test is truly evaluated. Hunter, Patty and McKinley (112) also reported a simplified method for coliform bacteria which depends upon 24-hr. sample enrichment in tryptose medium followed by confirmation in the BGLB medium. Comparative results of this method and the standard procedure on 764 water samples appeared very promising.

The impounding of the TVA reservoirs has increased plankton productivity. Kruse (130) described the practical plankton counting procedures used on these reservoirs and 33 prevalent plankton species. Monie (155) described a practical determination of the correct dosage of copper sulfate to control various species of algae under different conditions which has had one year's trial. This test depends upon a color reaction with phenolphthalein after the water samples have been stirred for ½ hr. with varying trial doses of copper sulfate.

The methods used by the Wisconsin committee on the chemical treatment of lakes and streams to control micro-organisms and aquatic vegetation were described by Warrick, *et al* (219). The committee's fish studies indicated that the toxic doses of copper sulfate recorded in the literature for various species of fish hold only for very soft water. Hard waters removed copper by precipitation and under these conditions the toxic doses for large mouth bass increased to 80 to 160 p.p.m. The study indicated that arsenicals were preferred for the control of rotted weeds.

A 12-month survey of three Madison, Wis., lakes by Lackey and Sawyer (132) indicated that sewage effluents were the major contributors of inorganic nitrogen and phosphorus. One of these lakes (Waubesa) received 77 and 89 per cent, respectively, of these elements from the Madison sewage treatment plant effluent. The three lakes received from 73 to 422 lb. of inorganic nitrogen per acre per year and converted 46 to 51 per cent of this to organic forms. The concentration of the inorganic nitrogen in the surface waters was related to biological activity and algal blooming was shown to reduce inorganic nitrogen. Lakes in this region which do not receive sewage pollution to any extent do not produce troublesome blooms of blue-green algae. It was concluded that the Madison lakes would stop producing troublesome blooms in the absence of sewage pollution. In a second paper, these authors (131) reported that all of these lakes contained about the same species of plankton algae and protozoa, and that the number of organisms was a poor criterion of production because of discrepancy in organism size. The number of blooms or peaks of production for any and all species coincided with the quantities of plant nutrient material available.

Ellis (61) classified the components of trade wastes that are inimical to fish and related life into suspensoids, which smother bottom biota, organic matter contributing B.O.D. compounds affecting pH, salines and specific toxic materials. He reviewed the characteristic action of each group on fish and discussed means for correction.

Hart, Doudoroff and Greenbank (87) presented a manual designed to fill the need for clearly defined biological methods of evaluating toxicity of industrial wastes and chemicals to especially recommended fresh water fishes. The methods have been standardized and reduced to comparatively simple procedures that should be usable by independent investigators anywhere. The authors stated that the results of all standard evaluations may not be strictly comparable. Therefore, a more strictly standardized experimental test is proposed which provides for greater comparability and which is called a reference evaluation. A reference evaluation is one performed on any one of a limited variety of teleost fishes designated as *reference test animals,* at an experimental temperature which is within the limited *reference temperature* range, and with experimental water which conforms with certain requirements and is designated *reference water.* The toxicity evaluation is based upon the median tolerance limit, which is the concentration of the substance at which 50 per cent of the test animals survive for a given test period, usually 24 hr. This manual is a volume of over 300 pages and includes a comprehensive discussion of the problems and procedures for standard and reference toxicity tests in twenty sections and twelve appendices. The sources, kinds, identification, size, acclimatization and fitness of test animals are adequately discussed as well as stock ponds and tanks, water supply, dissolved oxygen and carbon dioxide tension, temperatures, properties and preliminary examination of substances to be tested, and the performance, evaluation, reporting and use of toxicity tests. This volume should be of immense value to all of those interested in studying the effects of pollution in streams on fish life.

Chemistry

Tödt (203) recommended determination of phosphate, nitrate and ammonia for estimating the degree of pollution of a stream by domestic sewage. The value of phosphate as a criterion of pollution in streams has not been extensively studied. Pomeroy and Kirschman (169) showed that the interference due to organic matter in the Winkler determination for dissolved oxygen can be reduced by increasing the iodide concentration in the alkaline iodide solution. They proposed that the iodide concentration in this solution be increased from 0.9 N to 6 N. This seems desirable for raw sewage examinations but does not seem necessary for stream studies. Kaye and Weiner (121) contributed a modified semi-micro Kjeldahl nitrogen procedure which it may be desirable to use in stream pollution studies. Thomas (200) studied the self-purification of sewage polluted water flowing through an 80-meter channel.

Ruchhoft and Meckler (178) contributed a spectrophotometric procedure for determining the concentrations of both unmodified alpha TNT and colored TNT in ditches and streams receiving wastes from TNT loading plants. Ruchhoft, LeBosquet and Meckler (179) reported that the conversion of alpha TNT to the colored form is the principal reaction which takes place when alpha TNT wastes are discharged into surface waters. During this conversion there is a slow reduction of the total TNT (25 to 35 per cent in 80 days). Neither alpha nor the colored derivative of TNT is attacked biochemically and concentrations above one p.p.m. have a retarding effect on biochemical oxidation in polluted waters. Consequently, no reduction of the alpha or colored TNT is obtained by natural purification in streams. The manual of Hart, Doudoroff and Greenbank (87) reviewed earlier also contains a section on the chemical conditioning and modification of water and a rather complete review on methods for the determination of dissolved oxygen.

Standards

The condition of the Mississippi River was determined by the examination of 905 river samples per year at the Minneapolis-St. Paul Sanitary District laboratory (15) and the detention period in the settling tanks was adjusted between 0.8 hours and 1.4 hours according to the requirements needed to maintain satisfactory sanitary conditions in the river. Murdock (158) reviewed the classification of streams on the basis of quality standards that are intended only as a means of describing streams during a survey.

Surveys

The Tennessee Stream Pollution Study Board published a report (198) designed to provide members of the Tennessee General Assembly with the information needed to enact legislation to control the pollution of Tennessee streams. Thirty-three per cent of a total population of 2,915,841 is connected to sewers and 100 m.g. of sewage is discharged to the streams each day. The industrial wastes discharged each day have a population equivalent of 1.35 times the pollution contributed by domestic sewage. Sewage treatment at present reduces the domestic sewage load about 7.4 per cent and the industrial waste load about 1.0 per cent. More than 11 per cent of the streams of the state are moderately to seriously polluted.

Heider reported on stream pollution surveys of a number of Indiana streams. His report on the lower Wabash (90) indicated that this stream ranks lowest in regard to the extent of sewage treatment in comparison with 13 other river basins in the state. Sewage and industrial waste treatment at Terre Haute is urgently needed because of the serious public health hazard imposed on the Vincennes water supply. On the upper Wabash, Heider (97) reported that 14 municipalities comprising 36 per cent of the population of towns and cities over 300 treat their sewage. In the lower Minor Ohio River Basin (91) only 5 per cent of the sewage received treatment. On the other hand 73 per cent of the population in cities is served with surface water supplies. The Indiana state pollution control agencies have urged that plans for treatment facilities on this basin be prepared. Heider also discussed the problem on the Maumee (92) the Whitewater (93), the Blue (94) the Muscatatuck (95) and the Patoka (96) where 73, 49, 36, 27 and 15 per cent respectively of the municipal populations are served with sewage treatment.

The general introductory report on the Potomac River Basin (117) reviewed the historical development and discussed the population distribution, the natural resources and the pollution problems of the basin. Sewage from a population of 1,520,000 is discharged into the system at a rate of 153 m.g.d. At present sewage treatment facilities reduce the sewage load to that of 1,000,000 people. Industrial wastes are contributed by 98 industries. Forty-eight of these treat 32 m.g.d. in some manner before discharge, while 50 plants contribute 20 m.g.d. untreated. The industrial wastes discharged have a population equivalent of 495,000. In addition the Potomac system receives 172,000 lbs. of sulfuric acid per day from mine drainage and 196,000 cu. yd. of silt annually. There are three problem areas namely, the Washington metropolitan area, an area partly covering the great valley and an area along the North branch of the Potomac.

REFERENCES

1. Adams, M. P., "Water in its Relation to Pollution." Report of Michigan Water Conservation Conference, January, 1944. Abstract in *This Journal*, **17**, 185 (1945).
2. Adams, M. F. and St. John, J. L., "Colormetric Determination of Potassium." *Ind. and Eng. Chem.*, Anal. Ed., **17**, 435 (1945).
3. Allen, L. A., "The Bacteriology of Activated Sludge." *Jour. of Hygiene* (London), **43**, 424 (1944).
4. American Society of Testing Materials, Analytical Colorimetry and Photometry." Amer. Soc. Test. Mat., 260 South Broad Street, Philadelphia, Pa. (1945).
5. Anderson, B. G., "The Toxicity Thresholds of Various Substances Found in Industrial Wastes as Determined by the Use of *Daphnia magna.*" *This Journal*, **16**, 1156 (1944).
6. Andersen, C. G., "Annual Report on Sewerage and Sewage Disposal for the Village of Rockville Centre, New York." Abstract in *This Journal*, **17**, 1018 (1945).
7. Anderson, N. E., "The Design of Final Settling Tanks for Activated Sludge." *This Journal*, **17**, 50 (1945).
8. Anon., "Pennsylvania Continues Fight on Pollution." *Eng. News-Rec.*, **135**, 17, 417 and 690 (1945).
9. Anon., "Schuylkill River Towns Get Pollution Notices." *Ibid.*, **134**, 2 (1945).
10. Anon., "Valley Authority Held Unnecessary to End Potomac River Pollution." *Ibid.*, **135**, 203 (1945).

11. Anon., "Ohio River Pollution Abatement Closer." *Ibid.*, **135**, 470 (1945).
12. Anon., "Minnesota Creates New Commission for Water Purification Control." *Ibid.*, **135**, 659 (1945).
13. Anon., "Inadequate Denver Sewage Treatment Charged by State-Action Threatened." *Ibid.*, **135**, 690 (1945).
14. Anon., "Stream Pollution in Oil Fields Lessened by Salt Water Disposal Systems." *Pipe Progress,* 9–11 (Dec., 1944).
15. Anon., "Adjusting Sewage Treatment to River Conditions." *Pub. Wks.*, **76**, 1, 25 (1945).
16. Anon., "The New York New Jersey-Connecticut Interstate Sanitation Commission." *Ibid.*, **76**, 10, 34 (1945). *This Journal*, **17**, 659 (1945).
17. Anon., "Producing Formalin From Sewage Digester Gas." *Pub Wks.*, **76**, 11, 42 (1945).
18. Anon., "Monroe Sewage Plant Blast Displaces Building Walls." *Sew. Wks. Eng.*, **16**, 19 (1945).
19. Anon., "Chlorine Studies at Buffalo Improve Disinfection Practice." *Ibid.*, **16**, 22 (1945).
20. Anon., "Heating Sludge Digesters." *Ibid.*, **16**, 27 (1945).
21. Anon., "Trends in Sewage Works Equipment." *Ibid.*, **16**, 75 (1945).
22. Anon., "The Value of Chlorine Contact Periods." *Ibid.*, **16**, 248 (1945).
23. Anon., "A.W.W.A. Actions." *Water Wks. and Sew.*, **92**, 217 (1945).
24. Anon., "Handling and Disposal of Tank Skimmings." *Sew. Wks. Eng.*, **16**, 400 (1945).
25. Anon., "Chemical Treatment of Sewage." *Ibid.*, **16**, 441 (1945).
26. Anon., "The Control of Sewage Plant Odors." *Ibid.*, **16**, 519 (1945).
27. Anon., "Sewage Treatment at Detroit." *Water and Sew.*, (Canadian), **83**, 10, 28 (1945).
28. Anon., "200 New Sewage Treatment Plants Ordered for Pennsylvania Municipalities." *Water Wks. and Sew.*, **92**, 50 (1945).
29. Barton, B. H., "Sludge Digestion Experiences at Findlay, Ohio." *Sew. Wks. Eng.*, **16**, 334 (1945).
30. Bell, G. S., "Miniature-Sized Plant Design." *Sew. Wks. Eng.*, **16**, 234 (1945).
31. Bennett, R., "Trenching Practice." *Water Wks. and Sew.*, **92**, 194 (1945).
32. Berg, E. J. M., "Bulking Cured by Control of Air and Return Sludge." *Sew. Wks. Eng.*, **16**, 286 (1945).
33. Berry, A. E., "Developments of the Year." *Water Wks. and Sew.*, **92**, 41 (1945).
34. Boehm, A. M., "The Worthington Dual Fuel Engine." *Water Wks. and Sew.*, **92**, 223 (1945).
35. Bogert, C. L., "Designing Better Sewage Pumping Stations." *Sew. Wks. Eng.*, **16**, 67 (1945).
36. Boruff, C. S. and Weiner, L. P., "Feed By-Product from Grain Alcohol and Whiskey Stillage." *Proceedings,* First Industrial Waste Utilization Conf., Purdue Univ. (1945).
37. Bould, C., "The Preparation and Nature of Town's Refuse—Sewage Sludge Composts." *The Surveyor,* **104**, 775 (1945).
38. Bragstad, R. E., "Industrial Wastes at Sioux Falls, South Dakota." *Proceedings,* First Industrial Waste Utilization Conf., Purdue Univ. (1945).
39. Brandon, T. W. and Grindley, V., "Effect of Nitrates on the Rising of Sludge in Sedimentation Basins." *The Surveyor,* **104**, 7 (1945).
40. Branzell, A. E.; Bloersen, L.; and Richter, J. C. F. C., U. S. Patent 2,359,543 (Oct. 3, 1944).
41. Burgett, N. J., U. S. Patent 2,378,616 (June 19, 1945).
42. Bushee, R. J., "An Improved Method of Velocity Control in Grit Chambers." *Water Wks. and Sew.*, **91**, 164 (1944).
43. Cameron, A. B., "Annual Report on the Jackson, Mich., Sewage Treatment Plant for the Year 1944." Abstract in *This Journal,* **17**, 837 (1945).
44. Camp, T. R., "Functional Design Trends in Sewage Settling." *Sew. Wks. Eng.*, **16**, 73 (1945).
45. Camp, T. R., "Sedimentation and the Design of Settling Tanks." *Proc., Amer. Soc. Civil Eng.*, **71**, 445 (1945).
46. Chamberlain, L. H., "Discussion." *This Journal,* **17**, 901 (1945).
47. Chang, S. L., "Applicability of Oxidation Potential Measurements in Determining the Concentration of Germicidally Active Chlorine in Water." *Jour. New England Water Wks. Assoc.*, **59**, 79 (1945).
48. Chase, E. S., "Trickling Filters—Past, Present, and Future." *This Journal,* **17**, 929 (1945).
49. Chase, E. S., "Stream Pollution." *Paper Trade Jour.*, **120**, 119 (1945); *Paper Mill News,* **68**, 116, 118 (1945).
50. Cohn, M. M., "Equipment Maintenance in Time of War." *Sew. Wks. Eng.*, **15**, 626 (1944); **16**, 145, 193, 238, 288, 344, and 395 (1945).
51. Crowther, E. M., "Manurial Value of Sewage Sludges." *The Surveyor,* **104**, 111 (1945).

52. Daniels, P. N., ''Care and Operation of Imhoff Tanks.'' *This Journal*, **17**, 995 (1945).
53. Dawson, P. S. S. and Jenkins, S. H., ''The Application of Micro-Analytical Methods to the Examination of Sewage.'' *This Journal*, **17**, 525 (1945).
54. Denise, W. D., ''Operation of a Mechanical Aeration Activated Sludge Plant.'' *This Journal*, **17**, 127 (1945).
55. Doman, J., ''A Modified Index for Sedimentation Efficiency.'' *This Journal*, **17**, 3 (1945).
56. Doman, J., ''Discussion of Treatment and Disposal of Digestion Tank Supernatant Liquor.'' *Ibid.*, **17**, 906 (1945).
57. Dreier, D. E., ''Summary of Experience in Mechanical Activated Sludge Plant Operation.'' *This Journal*, **17**, 101 (1945).
58. Edmondson, J. H. and Goodrich, S. R., ''The Cyclo-Nitrifying Filter.'' *Inst. Sew. Purif., Jour. and Proc.*, **57** (1943).
59. Edwards, G. P., ''Operation of Activated Sludge Plants.'' *This Journal*, **17**, 1255 (1945); *Water Wks. and Sew.*, **92**, 312 (1945).
60. Eliassen, R. and Schulhoff, H. B., ''Auxiliary Methods of Removing Grease from Army Sewage.'' Abstract in *This Journal*, **17**, 1291 (1945).
61. Ellis, M. M., ''Industrial Wastes and Fish Life.'' *The Surveyor*, **104**, 399 (July, 1945); *Water Wks. and Sew.*, **92**, 171 (1945).
62. Erickson, C. V., ''Treatment and Disposal of Digestion Tank Supernatant Liquor.'' *This Journal*, **17**, 889 (1945).
63. Evans, G. E. and Gutman, J., U. S. Patent 2,367,270 (Jan. 16, 1945).
64. Fischer, A. J. and Greene, R. A., ''Plant Scale Tests on Thermophilic Digestion.'' *This Journal*, **17**, 718 (1945).
65. Friel, F. S., ''Chemical Treatment.'' *Sew. Wks. Eng.*, **16**, 192 (1945).
66. Friel, F. S. and Wiest, G. J., ''Cyanide Removal from Metal Finishing Wastes.'' *Water Wks. and Sew.*, **92**, 97 (1945).
67. Garrity, L. V., ''Incineration of Sludge Meets Detroit Conditions.'' *Water and Sewage*, (Canadian), **83**, 11, 53 (1945).
68. Gehm, H. W., ''Research Covers Factors Affecting Chemical Treatment.'' *Sew. Wks. Eng.*, **16**, 12 (1945).
69. Gehm, H. W., ''Chemical Treatment of Soapy Waste Waters.'' *Water Wks. and Sew.*, **92**, 255 (1945).
70. Gehm, H. W., ''Effects of Paper Mill Wastes on Sewage Treatment Plant Operation.'' *This Journal*, **17**, 510 (1945).
71. Gehm, H. W., ''Coordinated Industrial Waste Research.'' *Ibid.*, **17**, 782 (1945).
72. Gehm, H. W., ''Trends in Handling Pulp and Paper Mill Waste.'' *Sew. Wks. Eng.*, **16**, 496 (1945).
73. Genter, A. L., ''Computing Coagulant Requirements on Sludge Conditioning.'' *Proc. Amer. Soc. Civil Eng.*, **71**, 307 (1945).
74. Genter, A. L., ''Sludge Elutriation Design.'' *Sew. Wks. Eng.*, **16**, 188 (1945).
75. Gilcreas, F. W., ''Improved Residual Chlorine Test.'' *Water Wks. and Sew.*, **92**, 131 (1945).
76. Gilcreas, F. W. and Hallinan, F. J., ''The Practical Use of the O-Tolidine-Arsenite Test for Residual Chlorine.'' *Jour. Amer. Water Wks. Assoc.*, **36**, 1343 (1944).
77. Gonzalez, J. O.; Biaggi, N.; and Leon, J. R., ''The Effect of Chlorine on the Motility and Infectivity of the Cercariae of Schistosoma Mansoni.'' Abstract in *Pub. Health Eng. Abs.*, 82, (Sept., 1945).
78. Gould, R. H., ''Discussion of The Design of Final Settling Tanks for Activated Sludge.'' *This Journal*, **17**, 63 (1945).
79. Greeley, S. A., ''Sludge and Waste Treatment.'' *Sew. Wks. Eng.*, **16**, 137 (1945).
80. Greeley, S. A., ''The Development of the Activated Sludge Method of Sewage Treatment.'' *This Journal*, **16**, 1135 (1945).
81. Griffin, A. E. and Chamberlin, N. S., ''Exploring the Effect of Heavy Doses of Chlorine in Sewage.'' *This Journal*, **17**, 730 (1945).
82. Hallinan, F. J., ''Tests for Active Residual Chlorine and Chloramine in Water.'' *Jour. Amer. Water Wks. Assoc.*, **36**, 296 (1944).
83. Halvorson, H. O. and Smith, R. L., ''Sewage Treatment Without Digestion.'' *Sew. Wks. Eng.*, **16**, 614 (1945).
84. Hammerton, C., ''The Corrosion of Cement and Concrete.'' *Inst. of Sew. Purif.* (Oct. 21, 1944). Abstract in *This Journal*, **17**, 403 (1945).
85. Hardin, G., ''Flocculation of Bacteria by Protozoa.'' *Nature*, **151**, 642 (1943).
86. Hart, W. B., ''Treatment of Oil Industry Wastes.'' *This Journal*, **17**, 307 (1945).

87. Hart, W. B.; Doudoroff, P.; and Greenbank, J., "The Evaluation of Industrial Wastes, Chemicals and Other Substances to Fresh Water Fishes." Waste Control Laboratory Atlantic Refining Co., Philadelphia, Pa. (1945).

88. Harvey, H., "Our Dead and Dying Rivers." *Amer. City*, **60**, 106 (Sept., 1945).

89. Hatfield, W. D. and Symons, G. E., "Determination of Grease in Sewage." *This Journal*, **17**, 16 (1945).

90. Heider, R. W., "Stream Pollution in the Lower Wabash River." *Monthly Bull., Ind. St. Bd. of Health*, **44**, 186 (Aug., 1944).

91. Heider, R. W., "Stream Pollution in the Lower Minor Ohio River Basin." *Ibid.*, **48**, 71 (Mar., 1945).

92. Heider, R. W., "Stream Pollution in the Maumee River Basin." *Ibid.*, **48**, 91 (April, 1945).

93. Heider, R. W. "Stream Pollution in the Whitewater River Basin." *Ibid*, **48**, 134 (June, 1945).

94. Heider, R. W., "Stream Pollution in the Blue River Basin." *Ibid.*, **48**, 169 (July, 1945).

95. Heider, R. W., "Stream Pollution in the Muscatatuck River Basin." *Ibid.*, **48**, 187 (Aug., 1945).

96. Heider, R. W., "Stream Pollution in the Patako River Basin." *Ibid*, **48**, 215 (Sept., 1945).

97. Heider, R. W., "Stream Pollution in the Upper Wabash River." *Ibid*, **48**, 285 (Dec., 1944).

98. Heukelekian, H., "The Relationship Between Accumulation, Biochemical and Biological Characteristics of Film, and Purification Capacity of a Biofilter and a Standard Filter. I. Film Accumulation." *This Journal*, **17**, 23 (1945).

99. Heukelekian, H., "The Relationship Between Accumulation, Biochemical and Biological Characteristics of Film, and Purification Capacity of a Biofilter and a Standard Filter. II. Biochemical Characteristics of the Film." *Ibid.*, **17**, 269 (1945).

100. Heukelekian, H., "The Relationship Between Accumulation, Biochemical and Biological Characteristics of Film, and Purification Capacity of a Biofilter and a Standard Filter. III. Nitrification and Nitrifying Capacity of the Film." *Ibid.*, **17**, 516 (1945).

101. Heukelekian, H., "The Relationship Between Accumulation, Biochemical and Biological Characteristics of Film, and Purification Capacity of a Biofilter and a Standard Filter. IV. Purification Capacity." *Ibid.*, **17**, 743 (1945).

102. Hill, K. V., "Treatment of Packinghouse Wastes." *This Journal*, **17**, 292 (1945).

103. Hirsch, A. A., "Determination of Suspended Solids in Aeration Tank Liquor." *Water Wks. and Sew.*, **92**, 28 (1945).

104. Hirsch, A. A., "Direct Reading Arsenite-O-Tolidine Test." *Ibid.*, **92**, 277 (1945).

105. Hoak, R. D., "Treatment and Disposal of Spent Pickling Liquors." *This Journal*, **17**, 940 (1945).

106. Hoak, R. D., "A Rational Examination of Stream Pollution Abatement." *Science*, **101**, 523 (1945).

107. Hoak, R. D., "Whither Industrial Waste Treatment?" *Sew. Wks. Eng.*, **16**, 494 (1945).

108. Hoak, R. D., "Treatment of Spent Pickling Liquors with Limestone and Lime." *Ind. Eng. Chem.*, **37**, 553 (1945).

109. Howland, W. E., "Design of Control Flume for Grit Chambers." *Water Wks. and Sew.*, **92**, 235 (July, 1945).

110. Hubbel, C. W., "Sludge Disposal at Detroit." *Water and Sewage* (Canadian), **83**, 11, 51 (1945). *This Journal*, **18** (March, 1946).

111. Hunter, A. and Cockburn, T., "Operation of an Enclosed Aerated Filter at Dalmarnock Sewage Works." *The Surveyor*, **104**, 51 (1945).

112. Hunter, C. A.; Patty, E., and McKinley, F., "A Simplified Bacteriological Procedure for the Examination of Water." *Water Wks. and Sew.*, **92**, 241 (1945).

113. Hurley, J., "A National Policy for Trade Effluents." *The Surveyor*, **104**, 731 (1945).

114. Hurley, J., "Some Notes on the Biological Filtration of Sewage." *Ibid.*, **104**, 209 (1945).

115. Imhoff, K., "Simple Calculations for Biological Treatment Works." *Gesundheits Ingenieur*, **66**, 164 (1943).

116. Ingols, R. S., "Citrus Canning Waste Disposal Problem In Florida." *This Journal*, **17**, 320 (1945).

117. Interstate Commission on the Potomac River Basin, "A Report on the Conditions Existing in the Potomac River Basin" 61 pp., Washington, D. C. (1945).

118. Jones, E. E., "Disposal of Waste Waters from the Preparation of Vegetables for Drying." *Soc. Chem. Ind.*, **64**, 80 (1945).

119. Jones, S. and Wolman, A., "Public Health Problems in Impounding Water in the Tennessee Valley." *Jour. Amer. Water Wks. Assoc.*, **37**, 327 (1945).
120. Jordan, H. E., "Policies in Postwar Planning of Water and Sewage Works." *Jour. Amer. Water Wks. Assoc.*, **37**, 470 (1945).
121. Kaye, I. A. and Weiner, N., "Semimicro-Kjeldahl Nitrogen Determination." *Ind. and Eng. Chem.*, Anal. Ed., **17**, 397 (1945).
122. Keefer, C. E., "Removal of Grease by the Activated Sludge Process." *Sew. Wks. Eng.*, **16**, 386 (1945).
123. Kennison, K. R., "Proposed Improvements in Sewage Disposal and Treatment in the Boston Metropolitan District." *This Journal*, **17**, 89 (1945).
124. Keyes, H. E. and Travaini, D., "The Autoxidation Process." *Water Wks. and Sew.*, **92**, 249 (1945).
125. Kin, S. R. "Sludge Bulking Controlled by Chlorination." *Water Wks. and Sew.*, **92**, 141 (1945).
126. Kittrell, F. W., "A Rational Approach to Stream Pollution Studies." *Civil Eng.*, **15**, 69 (1945).
127. Knowlton, W. T., "Industry Should Pay for Waste Treatment." *Sew. Wks. Eng.*, **16**, 505 (1945).
128. Kozma, A. B., "Three Months' Operation with Ferric Sulfates." *Sew. Wks. Eng.*, **16**, 134 (1945).
129. Kraus, L. S., "The Use of Digested Sludge and Digester Overflow to Control Bulking Activated Sludge." *This Journal*, **17**, 1177 (1945).
130. Kruse, C. W., "Practical Plankton Counting Procedures for Tennessee River Reservoir Water Supplies." *Taste and Odor Control Jour.*, **11**, 1 (April, 1945).
131. Lackey, J. B., "Plankton Productivity of Certain Southeastern Wisconsin Lakes as Related to Fertilization. II. Productivity." *This Journal*, **17**, 795 (1945).
132. Lackey, J. B. and Sawyer, C. N., "Plankton Productivity of Certain Southeastern Wisconsin Lakes as Related to Fertilization. I. Surveys." *Ibid.*, **17**, 573 (1945).
133. Lacy, I. O., "Solving an Oil Waste Problem Through Industrial Cooperation." *Water Wks. and Sew.*, **92**, 96 (1945).
134. Langford, L. L., "Safety Considerations in the Design of Gas Utilization Facilities." *This Journal*, **17**, 66 (1945).
135. Langford, L. L., "Theory and Operation of Separate Sludge Digestion Units." *Ibid.*, **17**, 1235 (1945).
136. LeBosquet, Jr., M., "Water Pollution and Correction." *Amer. City*, **60**, 100 (Oct., 1945).
137. Levine, M., U. S. Patent 2,366,917 (Jan., 1945).
138. Lloyd, L., "Animal Life in Sewage Purification Processes." Presented at meeting of Northeastern Branch of the Inst. of Sew. Purif. (April, 1945).
139. Lloyd, L., "Sewage Bacteria Bed Fauna in its Natural Setting." *Nature*, **154**, 397 (1944).
140. Lockett, W. T., "The Phenomena of Rising Sludge in Relation to the Activated Sludge Process." *The Surveyor*, **104**, 37 (1945).
141. Mallmann, W. F., "Report of the Standard Methods Committee on Examination of Water and Sewage." *Amer. Jour. Pub. Health*, **35**, 957 (1945).
142. Mann, U. T., "'Economized' Activated Sludge Tests are Promising." *Sew. Wks. Eng.*, **16**, 513 (1945).
143. Marston, F. Z., "Aeration and Activated Sludge." *Sew. Wks. Eng.*, **16**, 232 (1945).
144. Martin, G., "Spherical Digestor Gas Holder Unaffected by Corrosion." *Sew. Wks. Eng.*, **16**, 21 (1945).
145. Maxey, K. F. and Wolman, A., "Standard Methods for the Examination of Water and Sewage—Summary of Recommended Changes for the Ninth Edition." *Amer. Jour. Pub. Health*, **35**, 1335 (1945).
146. McBride, W. J. and Preston, L. N., "Device for Vacuum Sampling of Liquids and Suspensions." *Ind. Eng. Chem.*, **17**, 672 (1945).
147. McCarthy, J. A., "Chlorine Dioxide for the Treatment of Water Supplies." *Jour. New Eng. Water Wks. Assoc.*, **59**, 252 (1945).
148. McKittrick, D. S. and Schmidt, C., "Determination of Sulfate by the Benzidine Method." *Arch Biochem.*, **6**, 411, (1945).
149. Merz, R. C., "Operation of Screens, Grit Chambers and Sedimentation Tanks." *This Journal*, **17**, 810 (1945).
150. Mills, E. V., "Treatment of Settled Sewage in Percolating Filters in Series with Periodic Change in the Order of the Filters. Results of Operation of the Experimental Plant at Minworth Birmingham, 1940–1944." *The Surveyor*, **104**, 793 (1945).
151. Mills, E. V., "Treatment of Settled Sewage by Continuous Filtration with Recirculation of Part of the Effluent." *Ibid.*, **104**, 653 (1945).
152. Mills, E. V.; Calvert, J. T.; and Cooper G. H., "Treatment of Camp Sewage

and Laundry Waste Water by Alternating Double Filtration." *Ibid.*, **104**, 79 and 97 (1945).

153. Mohlman, F. W., "Plain Talk About Industrial Wastes." *Sew. Wks. Eng.*, **16**, 489 (1945).

154. Mohlman, F. W., "Utilization and Disposal of Industrial Wastes." *Proc.*, First Industrial Waste Utilization Conf., Purdue Univ. (1945).

155. Monie, W. D., "A Copper Sulfate Test for Algae Control." *Taste and Odor Control*, **10**, 1 (Aug., 1944).

156. Montgomery, J. A. and Livingston, L. E., U. S. Patent 2,388,795 (Nov., 1945).

157. Müller, E., "Sewage Sludge as Fertilizer." *Ges. Ing.*, **67**, 99 (1944).

158. Murdock, H. R., "Waste Utilization." *Ind. and Eng. Chem.*, **37**, 97 and 105 (1945).

159. Neefe, J. R.; Stokes, J.; Baty, J. B.; and Reinhold, J. G., "Disinfection of Water Containing Causative Agent of Infectious (Epidemic) Hepatitis." *Jour. Amer. Med. Assoc.*, **128**, 1076 (1945).

160. Nielson, D. M., "Electronics in Water Supply and Sewage Treatment." *Water Wks. and Sew.*, **92**, 271 (1945).

161. Noll, C. A., "Determination of Nitrate in Boiler Water by Brucine Reagent." *Ind. and Eng. Chem.*, Anal. Ed., 17, 426 (1945).

162. Oeming, L. F., "Industrial Waste Treatment and Control." *Amer. Jour. Pub. Health*, **35**, 722 (1945).

163. Parker, C. D., "The Corrosion of Concrete. I. The Isolation of a Species of Bacterium Associated with the Corrosion of Concrete Exposed to Atmospheres Containing Hydrogen Sulfide." *Australian Jour. of Exp. Biol. and Med. Science*, **23**, 81 (1945).

164. Parker, C. D., "The Corrosion of Concrete. II. The Function of Thiobacillus Concretivorous in the Corrosion of Concrete Exposed to Atmospheres Containing Hydrogen Sulfide." *Ibid.*, **23**, 91 (1945).

165. Piatt, W. M., U. S. Patent 2,364,472 (Dec., 1944).

166. Pillai, S. C. and Subrahmanyan, V., "The Role of Protozoa in Aerobic Purification of Sewage." *Nature*, **154**, 179 (1944).

167. Pomeroy, R., "The Pros and Cons of Sewer Ventilation." *This Journal*, **17**, 203 (1945).

168. Pomeroy, R., "Corrosion of Iron by Sulfides." *Water Wks. and Sew.*, **92**, 133 (1945).

169. Pomeroy, R. and Kirschman, H. D., "Determination of Dissolved Oxygen." *Ind. and Eng. Chem.*, Anal. Ed., **17**, 715 (1945).

170. Pöpel, F., "Separation of Suspended Solids of Municipal Sewage in Settling Tanks with Continuous Flow." *Ges. Ing.*, **65**, 413 (1942).

171. Pöpel, F., "Mechanical Flocculation of Suspended Solids in Municipal and Industrial Wastes." *Ibid.*, **66**, 213 (1943). Abstract in *This Journal*, **17**, 408 (1945).

172. Powers, T., "The Treatment of Some Chemical Industry Wastes." *This Journal*, **17**, 330 (1945).

173. Richardson, C. G., "A New Development in Sludge Metering." *Water Wks. and Sew.*, **92**, 198 (1945).

174. Riddick, T. M., "Sewage Treatment Plant Design." *Water Wks. and Sew.*, **92**, 99 (1945).

175. Ridenour, G. M.; Backus, R. D.; and Sherron, C., "Effect of Polysulfide Treated Cyanide Case Hardening, Copper and Zinc Plating Wastes on Sludge Digestion." *This Journal*, **17**, 967, (1945).

176. Riedesel, P. W. and Lawson, W. R., "Freezing as a Factor in the Stabilization of Corn Cannery Wastes." *This Journal*, **17**, 952 (1945).

177. Roe, F. C., "Porous Tube Air Diffusers." *This Journal*, **17**, 878 (1945).

178. Ruchhoft, C. C. and Meckler, W. G., "Colored TNT Derivative and Alpha TNT in Colored Aqueous Alpha TNT Solutions." *Ind. Eng. Chem.*, Anal. Ed., **17**, 430 (1945).

179. Ruchhoft, C. C.; LeBosquet, M.; and Meckler, W. G., "Wastes from TNT Shell-Loading Plants." *Ind. Eng. Chem.*, **37**, 937 (1945).

180. Rudolfs, W., "Biological Treatment of Soluble Organic Wastes." *Sew. Wks. Eng.*, **16**, 501 (1945).

181. Rudolfs, W. and Fontenelli, L. J., "Relation Between Loading and Supernatant Liquor in Digestion Tanks." *This Journal*, **17**, 539 (1945).

182. Ryan, W. A., "Experiences with Sodium Nitrate Treatment of Cannery Wastes." *This Journal*, **17**, 1227 (1945).

183. Samson, C., "Sewage Treatment Practices at Tonawanda, N. Y." *This Journal*, **17**, 367 (1945).

184. Sanborn, N. H., "Food Canning Waste Utilization." *Proc.*, First Industrial Waste Utilization Conf., Purdue Univ. (1945).

185. Sandholzer, L. A. and Quimby, F. H., ''More Rapid Presumptive Test for Coliform Bacteria in Water.'' *Jour. of Bact.*, **50**, 105 (1945).
186. Sawyer, C. N. and Bradney, L., ''Rising of Activated Sludge in Final Settling Tanks.'' *This Journal*, **17**, 1191 (1945).
187. Schlenz, H. E., ''Controlled Digestion.'' *This Journal*, **16**, 504 (1944).
188. Schlenz, H. E., and Cox, C. B., U. S. Patent 2,359,004 (Sept. 26, 1944).
189. Setter, L. R. and Edwards, G. P., ''Experimental Laundering of Air Diffuser Plates.'' *This Journal*, **17**, 867 (1945).
190. Setter, L. W., Carpenter, W. T. and Winslow, G. C., ''Practical Applications of Principles of Modified Sewage Aeration.'' *Ibid.*, **17**, 669 (1945).
191. Shapiro, R. and Hogan, J. W. T., ''Discussion of Practical Applications of Principles of Modified Sewage Aeration.'' *This Journal*, **17**, 689 (1945).
192. Stewart, A. H., ''Stream Pollution Control in Pennsylvania.'' *This Journal*, **17**, 586 (1945).
193. Stokes, E. J.; Jones, E. E.; and Miles, A. A., ''Effect of Drying and Digestion of Sewage Sludge on Certain Pathogenic Organisms.'' Presented at meeting of the Metropolitan and Southern Branch in London (1945). Abstracted in *This Journal*, **17**, 1302 (1945).
194. Symons, G. E., ''Industrial Waste Disposal.'' *This Journal*, **17**, 563 (1945).
195. Tapleshay, J. A., ''Control of Sludge Index by Chlorination of Return Sludge.'' *This Journal*, **17**, 1210 (1945).
196. Tark, M. B., ''Designing Sewage Settling Tanks.'' *Pub. Wks.*, **76**, 15, (1945).
197. Taylor, J. C. D., ''Experiences in Winter Operation of Sewage Filters.'' *Water and Sewage* (*Canadian*) **83**, 9, 26 (1945).
198. Tennessee Stream Pollution Study Board, ''Stream Pollution in Tennessee.'' Nashville, 48 pp. (1943–1944). *Jour. Amer. Water Wks. Assoc.*, **37**, 350 (1945).
199. Tharp, V. K., ''Licking a Supernatant Headache.'' *Water Wks. and Sew.*, **92**, 29 (1945).
200. Thomas, E. A., ''Studies on Self-Purification of Flowing Water.'' *Mitt. Lebenson Hyg.*, **35**, 199 (1944).
201. Thompson, W., ''Use of Alum to Hasten Sludge Drying at Stratford, Conn.'' *This Journal*, **17**, 376 (1945).
202. Todd, A. R., ''Ohio River Pollution Makes Water Unfit for Public Supply.'' *Water Wks. Eng.*, **98**, 1157 (1945).
203. Tödt, F., ''Chemical and Physical Methods in the Investigation of Water from the Spree.'' *Ges. Ing.*, **66**, 270 (1943).
204. Tomlinson, T. G. and Stride, G. O., ''Investigations into the Fly Populations of Percolating Filters.'' Presented to the Northeastern and Northwestern Branches of the Inst. of Sew. Purif. at Southport, Eng. (1945). Abstracted in *This Journal* **17**, 1301 (1945).
205. Townend, C. B., ''Ten Years Operation of the West Middlesex Works at Mogden, England.'' *This Journal*, **17**, 1146 (1945).
206. Townsend, D. W., ''Design of Settling Tanks for Activated Sludge by Anderson. A Discussion.'' *Ibid.*, **17**, 803 (1945).
207. Trask, J. D.; Melnick, J. L.; and Wenner, H. M., ''Chlorination of Human Monkey-Adapted and Mouse Strains of Poliomyelites Virus.'' *Amer. Jour. Hyg.*, **41**, 30 (1945).
208. Trebler, H. A., ''Waste Saving by Improvements in Milk Plant Equipment.'' *Proc.*, First Industrial Waste Utilization Conf., Purdue Univ. (1945).
209. Urban, R. C., ''Replacing a Digester Valve.'' *Water Wks. and Sew.*, **92**, 307 (1945).
210. Van Kleeck, L. W., ''Operation of Sludge Drying and Sludge Gas Utilization Units.'' *This Journal*, **17**, 1240 (1945).
211. Veatch, N. T., ''Filter Loadings.'' *Sew. Wks. Eng.*, **16**, 191 (1945).
212. Velzy, C. R., ''Problems in Handling Sewage Sludge.'' *Water Wks. and Sew.*, **92**, 31, (1945).
213. Viehl, K., ''Purification of Domestic Sewage by Digestion.'' *Ges. Ing.*, **65**, 394 (1942).
214. Vokes, F. C. and Jenkins, S. H., ''Experiments with a Circular Sedimentation Tank.'' *Inst. Sew. Purif., Jour. and Proc.*, 11 (1943).
215. Walker, G. E., ''The Law Relating to the Pollution of Rivers and Streams.'' *Jour. Inst. San. Eng.*, (England) **7**, 329 (1944).
216. Ward, P. C., ''Industrial Coffee Wastes in El Salvador.'' *This Journal*, **17**, 39 (1945).
217. Warrick, L. F., ''Wisconsin Industry Cooperates in Cleaning up State Streams.'' *Sew. Wks. Eng.*, **16**, 393 (1945).

218. Warrick, L. F.; Wisniewski, T. F.; and Sanborn, N. H., ''Cannery Waste Disposal Lagoons.'' *Nat. Canners Assn. Bull. 29-L* (1945).

219. Warrick, L. F.; Wirth, H. E.; and Van Horn, W., ''Control of Microorganisms and Aquatic Vegetation.'' *Water Wks. and Sew.*, **91**, 127 (1944).

220. Wasfi, M. and Raif, M., ''Fly Control at Cairo Sewage Farm at Gabal-Al-Asfar.'' *Jour. Royal Egptian Med. Assoc.*, **27**, 539 (1944).

221. Watson, J. W., ''Mechanism of Bacterial Flocculation Caused by Protozoa.'' *Nature*, **155**, 271 (1945).

222. Weston, R. F., ''The Waste Disposal and Utilization Problems of the Petroleum Industry.'' *Proc.*, First Industrial Waste Utilization Conf., Purdue Univ. (1945).

223. Wilson, H., ''Some Risks of Transmission of Disease During The Treatment, Disposal and Utilization of Sewage, Sewage Effluent and Sewage Sludge.'' Paper presented to the South African Branch of the Inst. of Sew. Purif., (1945). Abstracted in *This Journal*, **17**, 650 & 1297 (1945).

224. Wise, W. S., ''Treatment of Waste Produced in Metallurgical and Metal Working Industries.'' *Proc.*, First Industrial Waste Utilization Conf., Purdue Univ. (1945).

225. Wise, W. S., ''Industrial Waste in Connecticut and Their Treatment.'' *This Journal*, **17**, 338 (1945).

226. Wisely, W. H., ''State Pollution Control Agencies in Action.'' *This Journal*, **17**, 638 (1945).

227. Wisely, W. H., ''Congress Studies Federal Control of Stream Pollution.'' *Ibid.*, **17**, 847 (1945).

228. Yeomans, C., ''Sludge Pumping—A Better Way.'' *Water Wks. and Sew.*, **92**, 258 (1945).

229. Zack, S. I., ''Dewatering and Incineration of Sludge.'' *Sew Wks. Eng.*, **16**, 138 (1945).

230. ZoBell, C. E. and Brown, B. F., ''Studies on the Chemical Preservation of Water Samples.'' *Jour. Marine Research*, **5**, 179 (1944). *Chemical Abstr.*, **39**, 767 (1945).

Stream Pollution

STREAM SANITATION

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As man enters a virgin territory, he finds four basic resources available for his uses. Air and the sun's energy he can use without changing or depleting the supply. The other two—land and water—must be changed as his civilization develops because his progress is dependent upon the values drawn from these two resources. This discussion is concerned with the values of water to this development.

Mention of the word "water" engenders a wide variety of mental pictures. Just now, inspired by a discussion of stream pollution, the picture might be of a foul, grossly polluted stream, teeming with pathogenic organisms. Later in the year, during vacation time, the picture might be a glass of cool, sparkling water, a swimming pool, a place in which to fish, or to be used for other recreational purposes. At other times, depending upon one's current interest, it might represent power, transportation, or any one of the other uses to which water can be put. The writer hopes to present a somewhat different picture which, perhaps, might illustrate the over-all value of water.

Blood, carrying materials necessary for the growth and natural functions of living tissues, is forced by the heart through arteries and minute capillaries to all sections of the body. Here, the cells remove these materials and return to the blood the waste products of their metabolism. The blood then carries these wastes through the veins to the heart where it is again pumped, this time going to the lungs and other organs where the wastes are removed and the blood prepared for its next cycle through the system. It is easy to appreciate the delicate balance of conditions which must be maintained within this medium if life is to continue.

Comparable to this function of the blood is the role played by water in our civilization. For instance, water from a pure mountain stream is pumped through a city's arterial mains and eventually reaches each house and industry through small service connections. Here the water performs its necessary function and eventually leaves through the sewer system, to reach again the stream from which it originally came. But, as the water leaves the homes and industries, it carries with it the waste products of the metabolism or activity of the community. As these wastes enter the stream, natural forces are brought into play which, if given sufficient time, will remove or stabilize these pollutants. When this is accomplished, the water is again ready for use by a downstream community, and it may undergo numerous other such cycles before it finally reaches the ocean. If these pollutants are not removed, the communities downstream must search elsewhere for a suitable water supply. If they fail, they will be unable to realize their full potentialities in the developing economy, and it appears that failure on the part of a community to keep in step with progress results in retrogression. Water, therefore, is a necessity, and it must be considered a valuable resource or even a community's life blood. It should be protected and utilized wisely for the optimum development of our civilization.

In the early period of our history, when cities were small and sparsely located, the streams with their natural purification forces did a remarkably good job in serving us but, as the cities grew in size and industrial centers became more frequent, the load on the streams at times became too great for them to carry. A sufficient amount of time was not available for the purification of the waste materials and the streams lost their natural appearance and cleanliness. These conditions were reflected in the morbidity and mortality records of the downstream cities. Water-borne epidemics were experienced which retarded the growth of cities and sometimes threatened even to destroy them.

But civilization would not permit an interruption of its progress. By means of developing sciences and engineering skills, it was found that the water could be purified and rendered potable by slow sand filtration. Rapid sand filtration, a more efficient method of purification, was later perfected when the pollution became too great for slow sand filtration; and eventually disinfection and all the methods now in use in a modern purification plant for the production of a clear, tasteless and odorless, as well as a bacteria free water, were developed to meet the growing demands.

Such methods, however, are not preventive measures, in that they do not lighten the load carried by the stream, but are remedial measures designed to prepare the water for its next cycle. As such they constitute a vital, though in many cases a most expensive step in the utilization of this natural resource. In some instances even the modern filter plant is unable to process the water to the degree necessary for the safety of the community. As this fact was realized, science and engineering skills created our present methods of sewage treatment. Such plants remove a portion of the polluting material from the sewage leaving a community, thereby lightening the load on the natural forces of purification operating in the streams. This technique has now developed to the extent that domestic sewage can be discharged into the streams in a state of purity comparable to that of natural surface water. At the present time the over-all process of purification of our water supplies, or the preservation of this natural resource, consists of three complex steps—sewage treatment, natural purification, and finally the application of the methods used in modern water filtration plants. The first and third of these steps are man-made efforts to assist nature in maintaining the conditions necessary for his progress.

For continuing progress it is essential that these three steps be so designed as to permit the most economical and effective use of this valuable resource. While methods have been developed for the treatment of domestic sewage to the extent that in most cases the natural forces of the receiving streams are readily able to prepare the water for the third step, in many cases municipalities have failed to realize their responsibility in treating their sewage. Also, comparable progress has not been made in developing methods for the treatment of industrial wastes and, in most instances, industrial wastes are discharged without modification into the receiving stream. As a result, many of our streams have become open sewers, so grossly polluted that they are unsuitable for use as water supplies or recreational purposes, and will not support desirable aquatic life.

If the necessity for a balanced utilization of the three steps can be accepted, the question might be raised as to the extent of treatment required to maintain this balance. A general answer to such a question would be without meaning because each case offers a separate problem. Its solution will depend, among other things, upon the amount of water for dilution purposes and the uses to which the water is put by downstream users. Some of these uses are as follows: public and industrial water supplies; methods of disposal for sewage and industrial waste; recreation; fish life; navigation; power; irrigation; low flow regulation and general impoundage; and livestock watering.

The need for maintaining streams suitable for public water supplies has already been outlined. Closely allied to this use is the use of water for industrial processes. Modern methods of water purification are used to remove pollutional materials in order to meet the requirements for industrial uses. In many cases, these requirements are more rigid than those considered necessary for domestic purposes. These treatment processes cost money, and in many cases the characteristics of the water supplies have been important factors in the location of industrial plants.

It must be realized that waterways must be used for the disposal of sewage and industrial wastes, but it is essential that the total load of pollution should be kept low enough so that the stream can recover and be able to receive additional wastes without the creation of serious conditions. This should be done even though no water supplies are taken from the stream. Property rights, as well as the other uses of the stream, can be seriously affected by foul conditions.

We are becoming a fast living people, and complete relaxation at periodic intervals is essential for the preservation of our health. Recreational areas centered around streams and bodies of water are among places where such rest can be obtained. Streams improperly used for the disposal of sewage or industrial wastes are neither safe nor satisfactory for such uses. The Tennessee Valley is becoming conscious of its value as a recreational area; the State Department of Conservation estimates that in 1941 Tennessee received over $104,000,000 from recreational travelers.

The development of a balanced aquatic life requires fairly clean water. Fish must depend upon an aquatic environment for life and must adjust themselves to the varying conditions in the streams or perish. Some of the conditions resulting from pollution, to which they cannot adjust, are the presence of acids, alkalies, and toxic materials in lethal concentrations, the absence of oxygen and food, and the destruction of spawning grounds. It is impossible to measure the value of sport fishing in Tennessee in monetary terms. It is popular because in 1943, 116,900 resident hunting and fishing licenses were sold, and in 1941, before war restrictions, over 13,000 non-resident licenses were bought.

The next two uses—navigation and power—can be seriously affected by corrosion of submerged structures if the water contains significant amounts of acid. Irrigation, also, can be seriously affected by acid waters. Where irrigation is practiced, the use of polluted waters on certain crops is prohibited because of the hazard to public health.

Stream flow regulation can be affected by pollution. In some cases, the requirements of dilution for downstream pollution may be important factors in the operation of the system.

While the effect of pollution in surface waters on their use for watering livestock may not appear to be of much importance, it is actually a serious problem. In recent years, the courts have been full of lawsuits in which considerable amounts have been awarded for damages caused by polluting materials carried by streams used for such purposes.

The value of water and the need for its conservation have been appreciated in the Tennessee Valley for a considerable period of time, as is evidenced by the regulations that have been passed from time to time to control the amount of pollution reaching the streams. These regulations have never proved adequate and, in 1935, the health officers of the seven Valley states requested the Authority to collaborate in a study of the conditions of the streams and to determine the sources and characteristics of the pollutional material. This work began in the spring of 1936 and consisted of rather extensive studies of the Tennessee River and its main tributaries, along with a comprehensive survey of all of the industries which discharged liquid wastes. The work was carried out in co-operation with the states and with the U. S. Public Health Service.

The original investigations were fact finding in nature, and it was intended that the results were to be used in the preparation of regulations that would permit more effective control of pollution. By 1943, however, it was realized that legislation alone would not be sufficient. Regulations controlling pollution will be necessary, but administration is recognized as of much more importance than the regulations themselves. It was also realized that departments other than the health departments were very much concerned with the conservation of this resource and would be able to contribute valuable assistance to the program. The program should be a co-operative one in which the departments of conservation, planning, and agriculture could join with the health department in an effort to assist municipalities and industry in solving their individual problems.

With this in mind, an understanding was reached with the state of Tennessee in which the interested departments of the Authority would collaborate with the state departments in determining the exact needs in the Valley and in outlining fair policies under which the program could be carried out in order to meet these requirements. Later, a similar understanding was established with the state of North Carolina, and it is hoped that these principles can be made Valley wide in the near future.

Just recently the state has passed legislation for the control of pollution in Tennessee. The measure is patterned very closely after the legislation now in force in the State of Wisconsin, which has had remarkable success in cooperating with industry in the control of pollution in that state. It is believed that with wise administration of this legislation satisfactory reductions can be obtained in existing pollution, and adequate control can be maintained for future needs.

The following paragraph from the report *Stream Pollution in Tennessee*, prepared by the Stream Pollution Study Board and submitted to the legislature in support of the bill, illustrates the importance of surface waters in this state:

''Surface waters are used for many purposes and by most of the people in the State and, insofar as possible, the streams should be maintained in conditions suitable for these uses. In most cases, the value of these uses cannot be stated in exact terms but, without surface waters in a usable condition, it is known that progress in Tennessee would be retarded and eventually cease. The important uses of surface waters include their use for public and industrial water supplies, fish and other aquatic life, recreation, agriculture, power, esthetic values, navigation, and sewage and waste disposal. All of these uses are important, and there is no reason why the surface waters of Tennessee cannot be used for all of these purposes if a sound, reasonable approach to the problem of surface water pollution is taken.''

THE OPERATOR'S CORNER

CONSTRUCTIVE PUBLICITY IN PUBLIC RELATIONS

Publicity, the best medium by which the public may be informed of the existence and activities of the sewage works department, is an important tool in developing public relations. There is more than one kind of publicity, however, and it is just as necessary to avoid cause for newspaper stories concerning odor nuisances, fish destruction and damage suits resulting from negligent operation as it is to create a basis for favorable articles. The wrong kind of publicity represents public relations in reverse.

There is too often a false modesty about notifying the local newspaper of happenings that may reflect credit to operation and administrative personnel. To keep such information from the public is actually unfair, for the taxpayer is entitled to know what goes on in the governmental services he pays for.

The fundamental step in securing constructive publicity is to make contacts with local newspaper people, particularly the reporter who has municipal affairs as his "beat," and to make them acquainted with the facilities you have and what you do with them. Maintain these contacts and keep them on a friendly basis; a good story becomes better when written by a reporter who is a personal acquaintance. Do not hesitate to phone in an item that has news value; the newspaper people will prepare the article on the basis of their judgment as to the space it justifies.

These are a few of the things that may be developed into news items:

1. Plant or sewer system improvements that increase efficiency or reduce costs.

2. Financial developments, such as bond retirement payments.

3. Inspections by state engineers. If the first fundamental of public relations is fulfilled—a job well done—the inspection report, when received, should make a particularly good story.

4. Annual operation reports. A half-hour with the newsman will enable him to extract items of news value, such as operation costs, stream conditions, plant efficiencies, etc., and to restate them in non-technical language for public consumption.

5. Visitors who may be well known or from distant places. A reporter will frequently welcome the opportunity to interview such persons.

6. Pictures taken during a flood, after a heavy snow fall, of the flower garden or showing such an unusual scene as an ice covered, nozzle type trickling filter—all have news value. At Bloomington, Ill., an enterprising photographer considered the plant grounds so attractive that he reproduced color scenes in the form of post cards.

7. Personal items regarding department employees and officials. News of honors and awards, participation and attendance at technical meetings, etc., is particularly sought by reporters.

There will be other specialized source material for good publicity from time to time and such possibilities should always be utilized. Newsmen themselves may create opportunities, as in an instance in our own experience. A local reporter, while covering a story on a flood at the plant, became interested in the facilities by which sewage and outlet stream flows were measured. Thereafter, each time a rainfall of unusual intensity occurred, statistics on stream and sewage flows (credited to the sanitary district as source) became just as much a part of his article as the data from the weather bureau.

All this can be done without the department head being placed in the position of appearing to be seeking personal "glory." The publicity must be of the constructive type that emphasizes the service being rendered by the sewage works, it must have real news value and it should be well timed. One or two newspaper pieces a month will suffice to keep the public properly informed and reminded of department activities. The press agent's axiom that "It does not matter whether the news is good or bad—just so you get your name in the paper!" does not apply here.

Publicity is the lever by which public opinion is moved. Use it properly and it will elevate sanitation functions to their proper position in the public eye as an important community service.

W. H. W.

OPERATION OF MECHANICAL SCREENS, GRIT CHAMBERS AND CLARIFIERS *

By W. A. Darby

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"Good housekeeping" is important at any sewage treatment plant. Cleanliness is particularly important at the bar screens and grit chambers, which are generally the most offensive units of all. Liberal use of flushing hoses and routine cleaning schedules pay dividends. Even if the screens and grit chambers are kept in as clean a condition as possible, they are not too sightly; *extra* care and effort is required at these units.

Functions

Bar screens are installed for the removal of coarse bulky solids that may be organic or inorganic and grit chambers are provided for the removal of heavy silt and sand that is usually inorganic. These units should be considered more in the nature of protective devices for subsequent units than as treatment units in themselves. Their main functions are to remove materials which, if left in the sewage, would cause operating difficulties later in other parts of the plant. The actual amount of material removed from the sewage by these units will be small compared to the removal by the plant as a whole. The bar screens will remove about 2 to 3 cu. ft. of wet material per million gallons, and the grit chambers will average about 1.0 to 2.0 cu. ft. of wet sand per m.g. These removals may be expected when treating an average domestic sewage from a separate sewer system.

Bar Screens

The length of time and schedule of operation of mechanically cleaned bar screens is usually controlled by automatic devices. One type of device is a differential float control that is actuated by the loss of head through the bar rack. This differential is generally set for 2 to 3 in. When this loss is obtained, the screen is automatically started and continues to operate until the screen is clean. A limit switch is provided that will stop the cleaning device at any predetermined point. A switch for Hand-Off-Automatic control is provided.

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Another type of control used with bar screens is an automatic time clock. This clock normally has a day and night schedule and may be set for a desired number of minutes operation out of each hour. Either the length of time per operation or the number of operations per hour is greater for the daytime setting than the night setting. When time clocks are used, a maximum water level float switch is also used to protect the screen chamber in case the screen becomes blinded due to sudden surges and the time setting would not automatically start the screen cleaner. Limit switches are also provided with this type of control to stop the screen cleaning mechanism at any predetermined point. A Hand-Off-Automatic switch is also normally furnished with this type of control.

Grit Chambers

The grit chamber equipment is normally furnished with simple magnetic starters and possibly push button controls. Continuous operation is safest, but the size of the plant, rate of discharge of sand to the plant, etc., are factors governing continuous or intermittent operation.

The work of these units is not particularly spectacular, but is the most rugged part of the work done at a plant. Their work is similar to that of the guards on a football or basketball team; they are not usually in the limelight, but the team is not continually successful without good guards. The same is true of the part played by the bar screens and grit chambers in guarding the rest of the plant.

Primary Clarifiers

The clarifiers have for their main purpose the removal of settleable solids. The floating scum usually removed from the surface of these tanks is secondary in importance to the settled solids removed from the bottom.

The major work in a plant, in so far as the removal of solids is concerned, is done by the clarifiers. In a primary treatment plant, the amount of solids removed by the clarifiers, compared to the over all plant removal, will be 90 per cent or more of the total. Consequently, the operation of the clarifiers should be watched very closely to make sure that they are operating at maximum efficiency.

Sludge should be removed from the clarifiers in as fresh and thick a condition as possible. No hard and fast rule can be given for removal of the sludge, as the frequency of removal, method, etc., will be determined by the flow sheet of the plant, character of the raw sewage, including temperature, freshness, volatile content of the solids, etc. In some cases it may be satisfactory to pump sludge from the clarifiers once or twice a day, whereas in other cases more frequent pumping is necessary to prevent staleness or septic action in the clarifiers, and at the same time maintain a thick underflow from the units.

The following comparisons show, for a given weight of dry solids, the different volumes of sludges produced at different concentrations of solids in a primary and also a complete treatment plant:

Assumed: Flow of 1 m.g.d. raw sewage.

Sewage with 250 p.p.m. suspended solids, equivalent to 2,083 lbs. dry solids daily.

Wet sludge at 63 lbs. per cu. ft.

Primary treatment—60% removal of suspended solids = 1,249 lbs. solids per day.

Complete treatment—95% removal of suspended solids = 1,979 lbs. solids per day.

Example I—Primary Treatment

5% solids in sludge	= 24,980 lbs. wet sludge	= 395 cu. ft.
5% solids in sludge	= 15,612 lbs. wet sludge	= 248 cu. ft.
Excess water	= 9,368 lbs.	= 147 cu. ft.

Thus, there is 60 per cent more water pumped with sludge containing 5 per cent solids than with sludge at 8 per cent solids.

Example II—Complete Treatment

3% solids in mixed sludges	= 65,967 lbs. wet sludge	= 1,047 cu. ft.
5% solids in mixed sludges	= 39,580 lbs. wet sludge	= 628 cu. ft.
Excess water	= 26,387 lbs.	= 419 cu. ft.

Thus, there is 67 per cent more water pumped with sludge containing 3 per cent solids than with sludge at 5 per cent solids.

It is apparent from the above that it is necessary to watch closely the sludge pumping operation. A small difference in the percentage of solids in the sludge pumped to the digesters may have an appreciable effect on the efficiency of operation. Concentrated sludge will result in longer detention time for the solids in the digesters and, therefore, a better digested sludge, less digester supernatant returned for retreatment, better digester supernatant liquor, and less heat required for raising the temperature of a raw sludge to that of the digesters.

Removal of scum from the surface of the clarifiers, where it is not done mechanically, will be a matter of judgment. The scum should never be allowed to build up to such depth that it will be carried underneath the scum baffle and out into the effluent. After scum from the clarifiers has been pumped to the digesters, raw sludge should be pumped through the line to flush out the greasy material. Although it may not entirely prevent building up of grease in sludge lines, this sequence of scum and sludge pumping will assist in keeping the lines clear.

Special automatic controls are not normally furnished for clarifier units. A simple starter is usually furnished with a push button near each unit. For best operation the clarifier mechanisms should be run continuously. Continuous operation will provide for greater removal of suspended solids, thicker sludge, and less floating sludge. The last point is due to the fact that with the mechanism operating, the gas bubbles formed in the first stages of septic action will be broken and will not be allowed to build up to the extent that islands of sludge are floated to the surface.

Maintenance of equipment may be considered a part of operation. A series of articles published in several issues of *Sewage Works Engineering* in 1943 dealt with equipment maintenance in sewage treatment plants during war times. Detailed maintenance information submitted by several of the manufacturers of sewage treatment plant equipment was used as a basic for the data assembled and presented by Morris M. Cohn in this series. A review of these articles is recommended to those who seek specific maintenance information.

Conclusion

Bar screens, grit chamber mechanisms, and clarifiers are usually furnished by companies having experienced field service men. When the equipment is first put into operation, these men are generally present at the plant and it is then that the operator should receive thorough instructions in the operation and maintenance of the equipment. Operating and maintenance instructions, in printed form, are also furnished by the equipment manufacturers for future reference. These should always be kept at the plant in some place of easy access and not removed by the general contractor or filed in the city hall. By following these recommendations in detail, the best service and the longest life can be obtained from the equipment.

In these days of overload plants, understaffed personnel and, in many cases, old equipment, it is up to the operator to obtain the best operation possible from what he has, and to make it last.

SEWAGE CHLORINATION—REASONS AND RESULTS *

By Harry A. Faber

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An understanding of the principles involved in sewage chlorination will enable those using the process to apply it in particular treatment plants with maximum efficiency and economy. It is the purpose of this paper, first, to review some of the chemistry and bacteriology of the reactions which occur when sewage is chlorinated and, second, to illustrate how these fundamental principles may be used to improve plant operation.

Chlorine is applied to sewage in order to accomplish one or more of three well established purposes: disinfection, B.O.D. reduction, or the control of odors and septicity. Other specialized applications of chlorine in sewage treatment include control of activated sludge bulking, correction of trickling filter pooling, thickening of sludge, and removal of grease.

Chlorination for Disinfection

The first of these purposes, chlorination to kill bacteria present in sewage effluents, was the earliest and is still the most important reason for sewage chlorination. This is because treated sewage ultimately flows into running streams. When such streams are used for municipal water supplies, for public bathing places, or for the growing of shellfish, it is undesirable that they be polluted with bacteria which may produce disease.

The processes of screening, sedimentation, and biological treatment are extremely important in removing settleable and suspended solids from sewage, but they alone do not insure the elimination or destruction of pathogenic bacteria. The excrement of humans contains millions of bacteria. Many of these are dead cells, many of these are harmless types of bacteria, but many, too, may be bacteria capable of producing diseases such as typhoid fever. The living bacteria in raw sewage generally average from many thousand to several million per cubic centimeter of sewage.

In studying the use of chlorine for disinfection of sewage there are two points to consider: the action of chlorine in killing bacteria, and the action of chlorine on other substances in the sewage. The exact manner in which chlorine acts to destroy the normal life processes of bacteria has not, as yet, been explained. This is probably because several physical and chemical processes are involved in the death of bacteria. Like all animal and vegetable cells, bacteria are permeable to water. That is, water and materials in solution are able to penetrate the

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cell wall and be absorbed by the protoplasm. Since chlorine liberates nascent oxygen from water, it was early assumed that this nascent oxygen oxidized the bacterial cells and destroyed them. Nascent oxygen is formed thus:

$$Cl_2 + H_2O = HCl + HClO$$
$$HClO = HCl + O$$

Many years ago it was suggested this theory could account for only a part of the killing which takes place, and it was shown that chlorine compounds —not capable of liberating nascent oxygen—possessed an equally toxic effect. In recent years the destruction of bacteria by chlorine has been regarded as a process in which chlorine actually combines chemically with the protein constituents of the protoplasm, killing the organism either by the formation of poisonous compounds or by actual coagulation and precipitation of the proteins.

The presence of suspended organic matter and solids in sewage interferes with the killing action of chlorine. Actually, a very small fraction of the added chlorine is used directly in destroying bacteria, since the largest portion is taken up in reacting with other substances. The organic matter, by absorbing large amounts of chlorine, may leave too little available for disinfection. If the bacterial cells are imbedded in organic matter they will be protected from the chlorine because it will be difficult for chlorine to penetrate the organic matter. Another very important interference with disinfection efficiency is the presence of reducing substances in sewage. Materials such as hydrogen sulfide will actually neutralize the chlorine and thus decrease its killing power.

When chlorine reacts with organic matter, chlorine substitution products such as chloramines or chloro-proteins are formed. These compounds either possess delayed or slow-acting disinfectant properties or are at least made unfit for bacterial food. Some killing of bacteria may be due to these chloroproducts, but they alone cannot produce complete or dependable killing of bacteria. Only by providing excess chlorine over that required by the organic and reducing substances in sewage can the death of bacteria be insured.

When chlorine is added to sewage it reacts rapidly with the various organic materials, the reducing substances and bacteria. The amount of chlorine that will be required to satisfy the demand of these substances in sewage and leave a slight excess amount is called the *chlorine demand.* The chlorine demand of sewage will increase as the sewage changes from fresh to stale or septic, because sulfur compounds are decomposed by the action of bacteria with the liberation of hydrogen sulfide. The presence of hydrogen sulfide in sewage greatly increases the chlorine demand, since action between chlorine and hydrogen sulfide is a rapid one in which sulfur is precipitated.

Because of the numerous and rapid reactions which take place between chlorine and substances in sewage other than bacteria it is obvious that this chlorine demand must be satisfied and an excess amount of chlorine must be present in order to effect prompt killing of bacteria. This excess amount of chlorine is termed *residual chlorine.* When residual chlorine is present during the contact period provided, disinfection of most sewages may be expected to be complete.

From recent work it appears that the settleable parts of sewage require about 30 per cent of the chlorine demand, the non-settleable and finely suspended solids require about 40 per cent of the demand, and the soluble materials require about 30 per cent. Thorough and rapid mixing of chlorine and sewage is important to insure best utilization of the chlorine.

It has been found most desirable to specify chlorine dosage on the basis of the amount required to produce a definite excess or residual. The test for residual chlorine can be easily performed in a few minutes, and will show immediately whether the sewage, whatever its chlorine demand, is being adequately chlorinated.

The disinfection or *contact period* is the length of time between the instant at which chlorine is applied to the sewage and the time when the residual chlorine is measured. During this time chlorine combines with reducing substances, organic matter, and bacteria. If the contact period is at least 15 to 30 minutes, and residual chlorine is present at the end of this time, there is reasonable assurance that sufficient chlorine has been added to kill pathogenic bacteria.

Sewage does not have the same chlorine demand during all of the 24 hours of the day, during each day of the week, or during the various seasons of the year. The major cause of variation in demand is the change in concentration of organic matter in the sewage with the time of day or with the day of the week. Temperature is another factor, and its effect is noted by changes in chlorine demand at various times of the year. The demand of both raw and treated sewage shows variations from such causes and, of course, the application of chlorine must be varied in accordance with the changes in volume or flow of sewage.

In order to insure an ample excess or residual chlorine at all times to disinfect the sewage properly, the test for residual chlorine should always be made at the time when the sewage effluent is the strongest, or when it requires the largest dose for treatment. By making a series of residual chlorine tests to determine when the sewage has its greatest chlorine demand, the time of maximum dose requirement may be determined. Then, such a test should be made at the same time each day. At most plants the demand will be greatest during the forenoon. During the later part of the day the chlorine demand will probably decrease to a considerable extent. It will then be possible to decrease the chlorine application and still maintain the desired residual for the weaker sewage.

Chlorine application could be changed frequently by manual control each hour or regularly by an automatic chlorinator and, while this control would result in the greatest economy of chlorine, in a small plant this would be expensive and impractical. Determining the maximum chlorine demand and rate of flow during each period, setting the chlorine rate at 8 A.M., 4 P.M., and midnight will give about the maximum efficiency of plant operation. When the plant must be run by one operator, the chlorine dose may be set in the morning to insure an adequate residual at the time of greatest chlorine demand during the day and set again when he leaves in the afternoon for that dose which will be required to insure an ample residual at the time of greatest chlorine demand during the night.

Occasional bacteriological tests should be made to determine, both before and after chlorination, the number of bacteria in the sewage. This will indicate the number of per cent of the bacteria which are killed by chlorination. Furthermore, the types of bacteria may be determined. But such a study requires time, special experience and equipment, and is unnecessary for routine plant operation. The residual chlorine determination shows within a few minutes whether or not the dose of chlorine is adequate to maintain the required residual. In general, the residual specified is based on the particular treatment plant conditions, and various state health departments require that residuals ranging from 0.2 p.p.m. to 1.0 p.p.m. chlorine be maintained after contact periods of from 15 to 30 minutes.

Reduction of Biochemical Oxygen Demand

When the recommended procedure for sewage chlorination is followed, not only will the desired bacterial reductions be obtained, but a marked reduction in oxygen demand of the effluent will be accomplished. After sewage effluent is discharged to a stream that has a dissolved oxygen content higher than that of the sewage effluent, further purification of the sewage by aerobic bacteria takes place. But this depletes the dissolved oxygen content of the stream because aerobic bacteria are those types requiring oxygen for their life process. So much oxygen may be required that the amount in the stream may be seriously depleted. If the oxygen supply of a stream is low, objectionable fungus growths may occur and fish may be killed.

If the B.O.D. of a sewage is reduced by chlorination, less load or pollution is contributed to the receiving stream. It appears that the organic materials in the sewage that serve as food for bacteria and would be acted upon with the removel of oxygen from the stream become unsuitable for food after chlorination. In fact, these organic chloro-compounds are toxic to bacteria and are not reduced with the utilization of oxygen, or are very slowly made available for food.

Chlorination to the recommended point produces a reduction in oxygen demand of the effluent of from 15 to 35 per cent. The reduction is roughly proportional to the quantity of chlorine absorbed by the sewage. For 42 samples of different sewages studied, the 5-day B.O.D. reduction was 2.4 p.p.m. for each 1 p.p.m. chlorine added. When sewage was very stale the average reduction of B.O.D. was 2.6 p.p.m. for each 1 p.p.m. chlorine added. The application of chlorine for reduction of B.O.D. is of particular advantage to primary treatment plants, since the usual 30 per cent B.O.D. reduction may be increased to as much as 50 per cent when the effluent is chlorinated.

If the oxygen supply of a stream receiving sewage is greatly depleted, anaerobic growths will occur. That is, bacteria which grow in the absence of air will break down food materials in the sewage with the production of septic conditions or foul decomposition odors. When the oxygen demand of the sewage effluent is reduced by chlorination these anaerobic conditions may be prevented. Normal reaeration of the stream may then occur and the added sewage will not impose too great a load and consequent pollution. Even when a plant is well operated, the receiving stream may be of inadequate capacity during hot summer months and periods of low rainfall to produce a satisfactory effluent. Riparian owners have been successful in a number of stream pollution suits and chlorination may be an economical emergency measure for maintaining proper stream conditions.

Odor Control by Chlorination

Domestic sewage which is fresh and contains some dissolved oxygen does not have an offensive odor, but when it becomes old or stale through the accumulation of sewage solids or because of long flows, decomposition sets in. Hydrogen sulfide (H_2S) is the most important odor produced as a result of such decomposition. At low temperatures, or when the sewage is diluted by rainfall, there may be a little or no production of hydrogen sulfide.

The conditions that favor hydrogen sulfide production are: high temperature of the sewage, long flows and solids deposition in sewers, the presence of sulfates and of certain industrial wastes in the sewage. Under favorable conditions, sulfur-splitting bacteria decompose sulfates and other sulfur compounds and release hydrogen sulfide gas. The addition of chlorine to produce the residual desired for disinfection will suppress or prevent the action of the sulfur-splitting bacteria and will react with hydrogen sulfide already produced to precipitate the sulfur. The precipitated sulfur is no longer volatile or odorous but may be present in such an amount as to add to the turbidity of the sewage, thus:

$$H_2S + Cl_2 = 2HCl + S$$

If chlorine is to be added merely for the purpose of preventing hydrogen sulfide odors, it is usually unnecessary to add sufficient chlorine to satisfy completely the chlorine demand and produce a residual. The odor reduction is approximately in proportion to the chlorine added. In case sufficient chlorine to secure a residual is not carried through the plant, however, it will be necessary to add a second dose of chlorine to the plant effluent to insure disinfection. Theoretically, 2 p.p.m. of chlorine are required to combine with 1 p.p.m. of hydrogen sulfide, but in actual plant experience considerably more than this quantity will be required. From two to five times the theoretical amount is generally necessary. This is because chlorine is rapidly reacting with the organic matter and bacteria present at the same time it is being reduced by the hydrogen sulfide. Therefore, since the additional chlorine is used for disinfection and B.O.D. reduction it is not wasted.

When chlorine is applied for odor control, it is generally applied as the raw sewage enters the treatment plant. By this procedure the settling tanks are maintained in a fresher condition, odors are reduced or eliminated, effective chlorine contact time is obtained, and final disinfection is simplified. In most plants less chlorine is required by this procedure than by chlorination for disinfection alone. The chlorination of sewage as it enters the plant may not be enough treatment to control odors, and it may be more desirable to chlorinate the sewage in the sewers some distance ahead of the plant. Even less chlorine might be required by this method because less is required to prevent the action of sulfur-splitting bacteria than to precipitate the sulfur after hydrogen sulfide has been produced.

Other Uses for Chlorine

In the operation of trickling filter plants, it sometimes becomes necessary to remove growths which may clog the surface of the filters and result in pooling. The application of chlorine or hypochlorites to pooled filters has been proven a successful control measure in a number of plants. Loosening and removal of surface growths has generally been accomplished by the application of a heavy dose of chlorine in the effluent discharged to the filters for a period of several days. At the same time this may loosen and remove the growths in the distributing system.

If the interstices between the filter stones are clogged by an accumulation of solids or grease the passage of air is reduced and the filter will not function properly. Adequate preliminary treatment will prevent such an accumulation, but chlorine may be necessary to loosen accumulated deposits and maintain the filter in a clean condition. The weight of opinion indicates that with reasonable dosing the effect of chlorine on nitrification produced in sprinkling filters is not harmful. In certain cases it is held to be beneficial but it is possible that the improvements noted may be due to the removal of scum or clogging material to permit better aeration. The chlorination of sewage applied to sprinkling filters has apparently some value as a means of controlling filter flies. The effect is greatest on the larvae, and the increase of adult flies is thereby prevented. Some observers have noted the reduction of odors prevalent at trickling filters when chlorine is applied.

In the operation of activated sludge treatment plants, the bulking of sludge in final settling tanks frequently results in the discharge of a turbid effluent. The application of chlorine, generally to the return sludge, has been proven a successful control measure in a number of plants. Improvement in the settling characteristics of the return sludge and of the mixed liquor may result within a few days after starting chlorine treatment and chlorination may be required only intermittently for this purpose.

Sufficient experience has been obtained with this application to show that the continuous treatment of return sludge, with a relatively small dose of chlorine, should be started as soon as the first stages of bulking appear. Not all types of bulking activated sludge can be corrected by chlorination, but that caused by the excessive growth of fungus types of organisms in sludge—which is a prevalent type—has frequently been corrected by this method of treatment. It appears that the chlorine dose must be adequate to restrict the development of fungus organisms, but not so heavy as to destroy other biological growths. Some activated sludge treatment plants now employ return sludge chlorination successfully as a routine part of treatment.

In the operation of sludge thickening units, for concentrating waste activated sludge prior to digestion, the sludge often proves difficult to settle. Chlorination of the supernatant liquor, or carefully controlled chlorination of the sludge itself, has been adopted in several installations as an important aid to settling. Poor settling is generally due to biological action which produces gas bubbles in sufficient quantity to keep sludge particles dispersed. When biological action is reduced by chlorination, the sludge is permitted to settle in a quiescent state and more concentrated solids can be withdrawn to digesters.

In the operation of activated sludge treatment plants, poor aeration may be caused by the presence of abnormally large concentrations of grease in the raw sewage. While a large proportion of grease is always removed with settleable solids in the primary settling units, it has been found in some treatment plants that prechlorination in conjunction with preaeration results in a considerably improved removal of grease in primary settling. When the amount of grease carried into aeration units is decreased, a return sludge lower in grease content and having a greater oxidizing ability is produced.

These additional uses of chlorine in sewage treatment are thus seen to be especially applicable to improving the operation of overloaded plants. Chlorination may be employed as an integral part of plant operation for disinfection, for B.O.D. reduction, or for controlling odors and septicity; it may be employed for specialized purposes in conjunction with biological treatment processes. Among all other methods of sewage treatment, chlorine is peculiarly suited to oxidizing, sterilizing, controlling odors, retarding decomposition, and coagulating protein matter. These characteristics should be utilized in plant operation.

OPERATION AND MAINTENANCE OF MECHANICAL EQUIPMENT *

By Stanley E. Kappe

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The municipal sewage works of today is highly mechanized in comparison with those in the not too distant past. This mechanization has brought new and greater responsibilities to operating staffs and crews. The writer does not agree, however, with the view in some quarters that the average sewage

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treatment plant is becoming too highly mechanized and too complicated for the type of operators available.

There is a heavy investment of public funds in sewage treatment plants and sewerage systems. The operator has a great financial responsibility—the protection of this original investment while holding maintenance and repair costs to a minimum. What can the operator do to prevent failures and keep maintenance and repair costs at a minimum? The first answer is for him to become intimately familiar with all the equipment in his plant and with the conditions under which it must function.

The operator should study thoroughly the instruction books furnished with the equipment. If any of these manuals are not at hand, copies will be gladly furnished upon request of the manufacturers. The instruction books will provide basic maintenance information, both in regard to construction features of the equipment and in the theory of operation. The operator should become familiar enough with the equipment so that he can tell at a glance whether or not it is functioning properly.

Unfortunately, most of us do not take time to familiarize ourselves with equipment. We wait until an emergency arises and learn the hard way.

Reputable and reliable manufacturers through field investigations, research laboratory studies and improvements in technique of manufacture, try to furnish equipment that is dependable, accurate, long-lived and trouble-free. The consulting engineer and contractor should see that the equipment is properly installed. Thorough inspection during construction and installation is very important and eliminates faulty operation when the equipment is placed in service. Many trouble jobs and costly repairs can be traced to poor installation. The operator should co-operate by seeing that the equipment is given proper care. If something goes wrong, give the designing engineer and manufacture an opportunity to offer suggestions and help correct the troublesome condition. Most consulting engineers and manufacturers are agreeable and will go out of their way to help correct trouble jobs.

Proper care and attention means good housekeeping. It is easier to keep equipment clean and in repair than it is to make emergency repairs where everything is covered with grease, dirt or sludge and where the various parts are rusted together.

Inspection

The operator's work begins and ends with thorough inspection, as frequently as the service requires. Although equipment is designed for automatic operation, its maintenance is not. A small amount of regular manual attention will help maintain operation at peak efficiency and keep maintenance costs down.

A complete record of inspection and servicing should be made on cards or forms suitable for the purposes required and kept on file. Each operator should report on equipment during each shift, thus enabling immediate maintenance if necessary. The frequency of inspection and degree of thoroughness will vary with the location of the equipment and the nature of the service. The schedule should be elastic and adapted to the needs of each plant. It cannot be over-emphasized that a complete understanding of the mechanism is essential for proper inspection, care and maintenance. If cuts, drawings and instruction bulletins showing and describing the working parts of each individual piece of equipment have not been furnished, the operator should write to the manufacturer for them. Keep up to date a regular inspection and maintenance schedule. At all times, know the condition of the equipment and correct immediately any weaknesses before further trouble develops.

In general, any item of sewage works equipment will comprise the following component parts: (1) the driver, usually an electric motor, (2) the electrical controls, (3) the bearings (ball, roller or sleeve type), (4) the power transmission device such as shaft, belt or gears, and (5) the driven unit, which may be a pump, sludge collector, blower, etc. Only the fundamentals of maintenance at these component parts will be discussed in this paper.

Electric Motors

Three-phase, squirrel cage motors are most often used in sewage plants. These motors require very little attention. Under average operating conditions, the grease with which the bearing housings of the motors are packed before leaving the factory is sufficient to last approximately one year. Too much grease causes bearing trouble due to excessive friction or damage to the motor windings because of excess grease deposits on the insulation.

Horizontal motor bearing housings are equipped with a fitting for adding grease and another for expelling grease through a relief plug when the bearing becomes full, thus preventing overloading. Grease should be added to motors while they are running. Allow the motor to run long enough after adding grease to permit the rotating parts to expel any excess grease before replacing the relief plug. This is important.

Vertical motors also have pressure relief plugs, but due to the design of vertical motors the location of the plug is not very effective. For this reason, the manufacturers recommend that grease be added sparingly when using a pressure gun and strongly urge that the motor be disassembled and the housing repacked with the proper amount of grease to assure effective lubrication.

Many motors have been damaged by overgreasing. In order to minimize this trouble, the motor manufacturers are now constructing motors with prelubricated sealed ball bearings and bearing housing without grease fittings. The prelubricated ball bearings in general purpose motors have proved, according to the manufacturers, that they can operate continuously for five years without greasing. Thus, one of the major items of induction motor maintenance, periodic lubrication, has been reduced to one grease packing job in five years and overgreasing and grease seepage into windings has been eliminated.

Motors located in damp locations such as underground pump stations have been damaged seriously by excessive condensation. So has the control equipment. In such locations the best cure seems to be the installation of a small blower that will have adequate capacity to change the air as often as is necessary to prevent condensation. Gravity ventilation by means of pipe openings is frequently inadequate.

It is good practice to blow out with dry compressed air, at pressures not exceeding 80 p.s.i., dust, dirt and other accumulations from motor windings. The frequency of such cleaning will depend on the location and type of motor.

Motors should not be started and stopped too frequently. The starting current of a motor is generally several times its full load current and these starting currents will store up heat in the windings. A similar condition is created in overloaded motors. The excess heating in the windings will bake out the insulation, causing it to become dry and brittle and eventually flake off and cause failure.

Where motors are installed in hot locations, some authorities feel that consideration should be given to the use of oversize motors. These motors would not use any more current, would work below maximum capacity and would be less likely to overheat.

If a motor is ever submerged in water, the bearings should be immediately removed and dried to prevent them from rusting and the motor should be sent to the repair shop for a thorough cleaning and to be baked out before it is returned to service.

Regardless of the type of motor used, perform the following each week:

1. See that the shaft is free of oil and grease from bearings.
2. If oil is used, check oil level in bearings.
3. Start motor and see that it is brought up to speed in normal time and rotates in correct direction.
4. Examine commutator and brushes.
5. Inspect for tightness all wiring connections.
6. Keep the interior and exterior of the motor free from moisture, oil and dirt.

Every six months:

1. Drain, wash out and renew oil in sleeve bearings.
2. Check grease in ball or roller bearings.

Once a year clean out and renew grease in ball or roller bearing housings and, if necessary, clean motors thoroughly.

Electrical Control Equipment

Practically every motor is protected by a fused main line switch and an across-the-line type starter. In addition, the service may require float switches and other automatic devices to start and stop the motors, and manual start and stop switches for operating convenience. The control fuses and thermal units used should comply with NEC or local code recommendations. The fuses and thermal units are generally rated at not more than 125 per cent of the name plate limit.

The fused mainline switch and starter protects the motor against "burn out" from short circuits, grounding, high inrush of starting current, overload, phase failure, low voltage and high voltage. When new motors are installed, the size of the heating element in the starter should be checked against current requirements of the motor. A starter with an oversize heating element or with a "jumper" around the element gives no protection.

If a starter cuts out frequently for no apparent reason, check its location. Perhaps it is located too close to a radiator or some other outside source of heat that is causing the trouble. In such cases the manufacturers recommend the use of the next size unit.

About every six months trip the starters manually with a piece of dry wood to make sure that the tripping element is not corroded and that the motor has protection. See that all clearances are normal and that the parts work freely. If the contact points are pitted, worn or are arcing, the tips should be renewed or filed smooth and treated with vasoline and then adjusted and lined up properly. Contacts that arc will become seriously pitted and the high starting current may burn out the motor if the faulty points cause the motor to start and stop too frequently.

If the starter trips out, find the cause and correct it before the starter is reset. Suggested procedure for locating the trouble:

1. Check the driven unit to make sure that it is operating freely and that there is no binding or obstruction.
2. Check wiring and control for loose connections.
3. See whether contact points are pitted, worn or are arcing.
4. If motor is of brush type, check brushes for sticking or for sparking while motor is running or starting.
5. Check rating of fuses and thermal unit.

6. Check whether the fuse and thermal unit location is affected by exposure to an outside heat condition such as the gas burner, rays of the sun and other sources.

The switchboard should be inspected frequently and kept clean. Vibration may cause loose terminal connections when they are least suspected. The insulators should be wiped clean to prevent flashover to the ground.

Dirty contacts are costly power consumers. An operator of a 0.5-m.g.d. plant, after cleaning thoroughly all contacts, fuses and fuse holders, was surprised to find a reduction in the power bill of $25 per month thereafter.

Motors and controls will give the best service if they are maintained in a dry environment, free from corrosive gases such as hydrogen sulphide, the common enemy in sewage works.

Float Switches

Float switches deserve more attention than they are generally given. Floats that hang unprotected by a guide pipe or other means are apt to be moved sideways by the motion of the incoming sewage, causing the chain or rod to bind or to bend and become inoperative.

If the float operates inside of a pipe, grease will in time coat the inside of the pipe and the float, and stick the float in a position that will either keep the pump running continuously or in an off position until the trouble is discovered. The damage that may be caused by floats sticking is obvious. Such a condition can be minimized by:

1. Installing a pressure flushing connection in the top of the float pipe so that the pipe can be thoroughly flushed as frequently as may be necessary, preferably by a circular motion imparted to the sewage in the guide pipe. In some installations a permanent connection has been made between the float guide pipe and the vent on discharge side of the pump. The connection to the float pipe is made on a tangent to induce a strong circular motion to the water in the float guide pipe. The connection should be made above or at the maximum level in the wet well.

2. By scraping the grease off the float and guide pipe at least once a week and removing the scrapings entirely from the float guide pipe enclosure.

3. By dripping fresh water continuously into the float guide pipe enclosure. This should be done without creating a cross connection.

4. By replacing the float guide pipe with an open enclosure or cage made of three or four 1-in. pipes.

5. If the automatic switch is of the electrode type, by keeping the electrode free of grease and by seeing that the leads are well insulated against grounding. If the float switch is of the mercury type, the mercury tubes should be held tightly in place. If an inspection reveals that the tubes are turning black, it may be an indication of air leakage and the tubes should be renewed.

Bearings

Bearing troubles may be caused by abrasive material coming in contact with the bearing surfaces, by water or moisture causing the bearings to rust, and by misalignment.

Misalignment is one of the main causes and may result from poor installation, settling of the foundation, or damage caused during shipment of the equipment. It is therefore important to check the alignment frequently.

During construction, equipment is often stored without any protection from grit or water. At this time grit or water often gets into the bearing housing and later the bearings fail. Contractors are cautioned continuously but a visit to a job will often reveal equipment of ball bearing construction not properly protected or under water. The contractor, however, is not the only offender. Too many pump stations have been inspected where the ball bearings on vertical sewage pumps were submerged because the operator failed to remove water accumulating in the dry basin housing the pumps. For this reason, automatic sump pumps are preferred for drainage instead of connections to sewage pump suctions that require manual attention.

To determine the quietness of bearing operation, place the ear against a screw driver or a length of metal rod, one end of which is firmly pressed against the bearing housing. If a rumbling or unevenness is noticed it may be due to dirt; a whistling sound, to improper lubrication. A noisy bearing is a warning that should be heeded without delay. Replacement should be effected before other components become seriously damaged.

Bearing Lubrication

The principles involved in the lubrication of ball bearings differ radically from the fundamentals governing in the case of plain or sleeve bearings.

In a sleeve bearing the load is supported by an oil film and the maintenance of this film under varying speeds, loads and temperatures is the deciding factor in the selection of the type of lubricant used, as well as the method by which it is to be applied.

In the case of a ball bearing, the high unit pressures existing between the balls and races when under load definitely prevent the formation of an unbroken oil film and the load is, therefore, directly supported by the balls and races, which are in metal-to-metal rolling contact. Since the contact between the balls and their separators cause a sliding rather than rolling friction, lubrication is required at these points. The chief duties of a ball bearing lubricant are, therefore:

1. To provide a tenuous lubricating film between balls and separator pockets.
2. To dissipate heat caused by deformation of load-carrying members, and separator.
3. To prevent rust or corrosion of the bearing parts.
4. To aid in protecting the bearing against dirt, water, acid fumes or foreign matter of any kind.

Oil is the most efficient bearing lubricant. Oil lubrication is, however, desirable only with high operating speeds, subnormal or abnormal temperatures, and installations involving a single lubricant for the bearings as well as other mechanical parts of the equipment.

Grease is most generally used for ball bearings operating at normal temperatures and where splashing and leakage of the lubricant must be prevented. It has the advantage of offering maximum protection against the entrance of foreign materials into the bearings.

Failure of grease lubrication can only occur from:

1. Rapid evaporation or oxidation of the lubricant due to high operating temperatures and inadequate quantity present.
2. Too large a space around the bearing, allowing grease to be thrown far away from the rotating parts.
3. Loss of grease, due to closure not retaining it.

As experience has shown that many greases increase considerably in volume under the churning action of the bearing parts, it is very important that the housing and bearing be packed not more than one-half to two-thirds full. This will allow the grease, under operating conditions, to expand without building up pressure enough to force it out of the bearing housing.

If oil lubrication is used and the oil becomes dirty, it should be drained and the bearing flushed with mineral seal oil and again drained before new oil is applied.

Greases satisfactory for anti-friction bearings are broadly divided into two classes: those having a soda soap base and those with a lime soap base.

At temperatures between 32° and 115° F., a properly made lime soap base grease is usually satisfactory. Above a temperature of 115° F. the lime soap grease when operated for any length of time is unsuitable as the oil will separate from the base and the residue is detrimental to the bearings.

For higher temperatures, a soda base grease should be used.

If grease is used and it cakes or becomes dirty, flushing with mineral seal oil may not be sufficient to remove the old deposit. In such cases, if a soda soap base grease is used, flush with a hot oil-water emulsion. During this cleaning, rotate the bearing. In case a lime soap base grease is used, a more drastic cleaning is necessary. Some types of liquid cleaners (containing petroleum solvents), which will not attack steel and which when mixed with water will readily emulsify, should be used for such conditions. For flushing, the manufacturers of bearings recommend a hot oil-water emulsion followed by an oil flushing. The housing should then be filled with the proper amount of new grease.

No set rule on bearing lubrication fits all installations. If in doubt, play safe. Change the lubricant before it is too dirty.

Too much oil will not hurt sleeve bearings, but too much grease will cause friction and heat in ball bearings. The main function of grease is to protect the steel elements against corrosion and not friction. Check the bearing temperatures with a thermometer at least once a month.

The wear at sleeve bearings should be checked every three months. Generally allow 0.002 in. clearance plus 0.001 in. for each inch of shaft diameter. This is important on motors of all types to prevent occurrence of an unbalanced air gap between rotor and stator in order to maintain efficiency and to prevent damage should both these parts come in contact.

When cleaning around equipment, the hose should not be directed against the bearing housing. Floor sweepings and water may be forced into the bearing housing.

Power Transmission Equipment

Shear Pins

These pins are installed to protect such equipment as plunger pumps, sludge collectors, etc., from serious mechanical damage, just as fuses protect motors.

Make sure that the shear pin is not too big. Every few months remove the shear pin and rotate the driver shaft a few minutes without rotating the driven unit shaft, to make sure that the couplings are free on the shaft, and then replace the pin. There are many cases on record where the operator failed to follow such advice until the flights were ripped apart by stones thrown into the settling tanks by children or when a squeegee was left between the flights. Check all shear pins and make sure that the couplings are not frozen.

Misalignment

The alignment between the driver and driven elements of any piece of equipment should be checked at frequent intervals. Misalignment has caused many burned out bearings and motors, sprung or broken shafts, damaged gears, and more rapid wear and tear of equipment than is normal. The original installation might have been satisfactory, but foundations will settle, bases will warp and bearings will wear. Misalignment might also be caused by the shifting of a slightly unbalanced motor or because the motor or driven unit was not fastened properly to the base plate.

In guarding against misalignment see that the flexible couplings are perfectly aligned and that they are kept that way. Keep in mind that although flexible couplings between a driver and driven unit are designed to permit and to withstand misalignment, the bearings of the equipment are not designed to carry misalignment. Flexible couplings are used to allow easy assembly of equipment but they must be lined just as truly as rigid couplings.

If couplings are furnished on equipment where leather is likely to be attacked by mildew and other fungus growths, flexible couplings designed so that the leather is in compression and not tension, should be used. Otherwise, all metal flexible couplings or other similar couplings should be used.

In past years, vertical pump installations were equipped almost entirely with solid shafting between motor and pump. This type of shafting requires proper alignment at all times. In recent years, the solid shafting has been replaced with flexible tubular shafting, similar to the tubular drive shaft and universal joint used in automobiles. This shafting is designed to permit angular misalignment and is far superior to solid shafting. Many troublesome existing solid shafting jobs are today being replaced with flexible type shafting.

If the H-beams carrying the intermediate bearing are not heavy enough, rigidity can be improved by filling the upper portion with concrete.

Grit Chamber Mechanisms

Grit chambers are designed to settle and remove the most troublesome form of sewage solids. Do not allow the grit to accumulate to the point that the collectors become seriously overloaded. This condition is allowed to occur too often.

The grit chamber should be given very close attention because on its effectiveness depends the protection of pumps, sludge collectors, digester mechanisms, etc. from costly wear and tear. If it is not given proper attention, there will be clogged sludge lines, particularly at the foot of vertical sections of sludge piping and at check valve bodies, and a digester full of a gritty mixture that will not flow to the sludge beds but must be removed manually.

Where there are mechanical grit collectors, examine all wearing parts at frequent intervals. If excessive wear is taking place, find and correct the cause. If such wear is not due to misalignment or other abnormal condition, consideration should be given to welding stellite or some other similar hard material to the vulnerable parts.

Comminutors

Next in importance to the grit chamber is the bar screen or the comminutor. The grit chamber protects the plant equipment from gritty material whereas the screen or comminutor gives protection from clogging material and rags that so often cause sludge collector chains to jump sprocket wheels. This discussion will refer only to comminutors.

The comminutor is a cutting and screening machine. The equipment is ruggedly built to withstand the heavy duty imposed but its cutting edges will, however, wear and become dull. For this reason, the cutting parts (combs, cutters, and shear bars) are all replaceable. Dull cutting parts should be replaced as soon as possible or sharpened in the case of the cutters. Do not allow a few worn cutters or a worn comb or shear bar to shorten the useful life of the other parts.

The coarse material is quickly and economically disposed of when the cutters, combs and shear bars are sharp. When these replaceable parts are allowed to become dull, however, the coarse material is not quickly cut, but is slowly shredded and torn apart.

The life of the replaceable cutting parts depends on the amount of abrasive matter in the sewage and upon the operator. To increase that life, where possible, the comminutor should be installed on the downstream side of grit chambers. If a grit chamber is not provided ahead of the comminutor, the operator should dewater the comminutor basin and remove any stones, tramp material and grit that may accumulate. The frequency of cleaning depends on the characteristics of the sewer system and can be best determined by experience.

When the comminutor basin is dewatered, clean the comb, inspect the cutting edges and replace any section that may be badly chipped or damaged. Examine each cutting tooth and replace those that are dull. Inspect the shear bars. Replace any shear bar that may have a groove deeper than 0.02 in. worn across its face. Inspect the basin seal. Replace it if it becomes worn or damaged enough to allow rags to pass or wedge between the basin and the drum. The basin seal will wear rapidly if the comminutor is operated dry. When operating the comminutor without sewage, run a stream of water from a hose on the basin seal.

To obtain the most satisfactory cutting, the comminutor should be operated continuously. Continuous operation also requires the least power.

Pumping Equipment

Centrifugal pumps of the horizontal dry pit type, vertical dry pit type or vertical submerged type, equipped with the so-called non-clog type impeller, are generally used for pumping raw sewage, primary and final effluents, secondary tank sludges, and for recirculation. Pumps having a propellor type impeller are also used for recirculation on some high capacity filter plants.

Centrifugal pumps have also been used to pump primary sludge, digested sludge and chemical sludge, but they are generally not recommended for these services. Plunger pumps and specially designed centrifugal pumps are best suited for pumping these sludges. The scru-peller pump, a specially designed centrifugal pump, has been used for pumping raw sewage. A number of such installations were made since 1934 in outlying pumping stations where a non-clogging installation was required.

A centrifugal pump consists essentially of only one moving part, an impeller rotating in a casing. The impeller is supported on a shaft that is in turn supported by a thrust bearing and one guide bearing in vertical dry pit and horizontal type pumps and two or more guide bearings in submerged type pumps, depending on the depth of the wet well.

Vertical dry pit type pumps are constructed almost exactly the same as horizontal pumps. The bearings are generally of the ball type. Scru-peller pumps are fundamentally the same as horizontal centrifugal pumps, except that a stellited screw, stellited cutting bars, and a stellited cutting ring are mounted on the suction side of the impeller for cutting up the solids before they reach the impeller.

Submerged type pumps are constructed differently from dry pit pumps in that the thrust bearing, of ball bearing construction, is generally located above the motor floor level where it will be free from floor drainage and sweepings and in that the pump casing, guide bearings and shafting are extended into the wet well. Ball bearings cannot be used for guide or intermediate bearings because the sewage would soon cause them to rust. For this reason, submerged type pumps are built with sleeve type guide bearings of bronze or stainless steel.

Lubrication

Lubricate the ball bearings on vertical pumps equipped with grease fittings about once a month, using a high quality lime-base grease with a consistency comparable to grade No. 0. On such pumps the grease line generally enters the housing just above the bearing so that the excess grease will lay on top of the bearing and gradually work down into it. The bearings, like those on motors, should be taken out, cleaned and repacked with grease about once a year.

Steady or intermediate guide bearings can be greased with the same grease as used for the pump bearings. These bearings ordinarily need greasing only once in three to four months.

Horizontal pumps are generally constructed with an oil reservoir in the bearing housing. Keep the oil level just below the overflow point of the filling cup when the pump is idle. If the oil reservoir is kept full, the oil will splash out. A good medium grade neutral, mineral engine oil of SAE 20 or 30 viscosity is generally used.

On some pumps the oil passes through a wick filter before it reaches the reservoir. This filter should be renewed at least once a year. Likewise, the bearing housing should be drained, flushed and refilled with new oil at least once a year.

If the thrust bearing on submerged type pumps is grease fitted, lubricate with the same grease used for vertical pumps. If it is equipped with an oil cup, refill the cup about once or twice a week with a good medium grade of neutral, mineral engine oil, SAE viscosity No. 30 or 40. The guide bearings are generally lubricated with a light lime-base grease with a consistency comparable to No. 00. It is advisable to grease the lower sleeve bearing daily to protect it and the shaft from grit; it should be greased at least once a week and the other guide bearings about once a month.

Stuffing Box Maintenance

The dry pit type horizontal and vertical pumps are constructed with stuffing boxes to prevent sewage from leaking out around the shaft or air leaking into the pump. The submerged type pump depends on the snug fitting of the lower sleeve bearing and a felt washer or seal of some kind to prevent leakage around the shaft.

Depending on the type and condition of the impeller, a wide range in pressure there may be developed on the back side of the impeller. Most nonclog impellers produce a pressure at the stuffing box from 70 to 90 per cent of the pumping head. For this reason, the stuffing box on dry pit type pumps and the lower sleeve bearing on submerged type pumps are subject at all times to damage from grit. The stuffing box or packing gland of a dry basin pump and the lower sleeve bearing on the wet well type pump require more maintenance than any other part of the pump and may cause the most trouble if these points are not given proper attention.

The pressure on the stuffing box or packing gland can be reduced by connecting the pump air vent to a pipe line which will continuously discharge into the wet well or some other suitable place while the pump is in service. This connection will also remove and reduce the amount of grit that otherwise might be forced into the packing. This idea is being adopted by at least one manufacturer for application to submerged type pumps to protect and reduce grit damage at sleeve bearings.

Since the packing in the stuffing box rubs against the shaft, it is just as important that it be lubricated as the bearings. In pumps handling clear water, the packing is lubricated internally with the water pumped, but sewage contains grit and therefore cannot be used for lubrication.

Grease is used but seldom with complete success because some grit invariably works back into the grease, imbeds into the packing and forms a fine abrasive cloth which soon wears out the packing and shaft sleeve. An external supply of water for the seal is the most satisfactory lubricant.

If a grease seal is used, and the head

does not exceed about 20 ft., the seal should be fitted with a spring loaded pressure type grease cup. Grease should be forced through the packing daily at a rate of one oz. per day. If the head is greater than 20 ft., spring loaded pressure grease cups are not too effective. In such cases a hand type grease gun should be used and the grease should be applied daily.

If a water seal is used the pressure should be greater than the shutoff head of the pump. This pressure may be secured by a float controlled tank located at the highest point of the building or with the aid of a small pump. This water pressure should never be obtained by a direct connection with the drinking supply because a cross connection would be created. The life of the packing and shaft sleeve depend almost entirely upon the effectiveness of the grease or water seal. There should be a slight leakage of water from the packing box when the pump is running to keep the packing cool.

Never tighten a gland more than necessary. Finger tight should be ample, otherwise excessive pressure will cause the shaft sleeve to wear rapidly and the tight packing will act as a brake band and increase the load on the motor.

If the stuffing box leaks excessively, remove the packing and examine the shaft sleeve. If the shaft sleeve is badly grooved or scored, it should be replaced or repaired immediately. Otherwise, the stuffing box will continue to leak excessively and, regardless of the frequency of repacking, the packing life will be too short.

If the packing becomes worn, remove it entirely and clean out the stuffing box thoroughly. It is bad practice to use part new and part old packing. When repacking, it is important to see that the first two layers are properly in place before more is added. Otherwise, the bottom layer may be forced in unevenly and may leave a pocket for grit to collect. The packing should be installed with butt joints, staggered around the shaft.

Packing of Pumps

No single packing can be flatly recommended. The type of packing that should be used depends on: (1) variations in operating methods, (2) operating conditions, (3) operating requirements, and (4) the operator. There are many different kinds of packing. Those commonly used for sewage are: (1) metallic, (2) semi-metallic, (3) soft asbestos impregnated with graphite, and (4) leather.

Bearing to bearing surfaces require some cooling agent as oil, grease or water. Packing containing rubber is not recommended because it will expand when in contact with sewage.

Soft asbestos, impregnated with graphite, is the most generally used packing, particularly in centrifugal and plunger type pumps. It is particularly recommended where grease or water seals are not provided. Metallic or semi-metallic packing should be used only where water or grease seals are used.

Lubrication of the packing does three things: (1) increases efficiency and reduces friction to a minimum (2) prolongs the packing life, and (3) controls leakage without undue gland pressure.

A generous supply of lubricant should be applied to the packing when it is being installed. Thereafter, the lubricant can be applied by a hand pressure grease gun if grease is the lubricant. The ideal way is to use a forced feed lubricator applying a small but continuous amount of grease at a constant pressure.

Wearing Rings

Some sewage pumps are provided with wearing rings on the impeller only and some have a second ring on the pump suction plate. Grit will often get between the wearing rings and the impeller proper or suction plate and soon causes wear to the extent that the wearing ring tears loose with a terrific impact.

On sewage pumps the trend is to eliminate wearing rings, which are generally of a soft material such as bronze, and to rebuild periodically the worn parts by spray welding with a hard material which has longer life and gives less trouble than the wearing ring.

If pumps are equipped with wearing rings, never allow them to run dry. Water is a lubricant and cooling agent between rings and casing. Examine wearing rings at regular intervals. The clearance between the bottom of the wearing ring on the impeller and suction plate on sewage pumps is about 0.015 to 0.020 in. The diametrical clearance is 0.005 to 0.008 in. on each side on cold liquid service and about 0.010 to 0.012 in. on hot liquid service. If the clearance becomes as much as 0.010 in. on cold service and 0.015 in. on hot service, it is cheaper to replace or rebuild the clearances than pay for power lost in leakage or recirculation within the pump.

Check the piping on the suction and discharge sides of the pumps. Make sure that the weight of this piping is not placing an excessive strain on the pump and distorting the casing. If it is, misalignment troubles, can be expected, with rapid wear of the wearing rings due to metal to metal rubbing and binding.

Wearing rings will wear more rapidly if the impeller is not properly balanced before shipment or if the rag, solid load, or operation is such as to unbalance the impeller while the pump is in service. Operating conditions that cause undue vibration should be avoided.

Plunger Pumps

The modern plunger pump is generally used for pumping raw and digested sludges. Because of its positive displacement characteristics, it will pump mixtures of sludge sewage gas and air equally as well as liquids.

Like all reciprocating pumps, these units must be packed to prevent leakage between the piston and cylinder. This packing is one of the most frequent causes of trouble. If the packing is too soft, too loose, or improperly placed, sludge will leak out and dirty the pump room. If the pump has a suction lift, and the packing is in a poor condition, enough air may be sucked through the packing to prevent the pump from priming. If the packing is too tight, scored pistons and broken shear pins may result.

Opinions differ as to the most satisfactory type of packing. Generally a square, twisted, graphite impregnated asbestos packing is the best, particularly if the piston is ground smooth. In operation, a liberal use of a fairly heavy cylinder oil around the packing will prolong the life of the pump and the packing and make it possible to keep the packing tight enough to reduce leakage to a minimum. It is considered good practice to add some oil to the packing each pumping day.

Before a plunger pump is operated after new packing has been installed or after it has been idle for a length of time, all nuts on the packing gland should be loosened and the pump should be run with the gate valves closed and with the check valve covers open to "break in" the packing. The nuts on the packing gland should then be carefully tightened so that the packing is uniformly compressed around the piston. New packing should never be added to the top of old packing for the same reasons mentioned in the discussion on centrifugal pumps.

The ball valves should be examined occasionally and if they are worn one-half inch from the original diameter, they should be renewed because otherwise they are likely to jam in the valve chamber or valve seat. If the valve seats show extensive wear they should be renewed. Under normal conditions the pillow block needs to be greased only at 6-month intervals. The oil cup on top of the connecting rod should always contain some oil.

The pounding noise made by plunger pumps is sometimes objectionable. This pounding is due to the reversal stresses caused by stopping and starting the flow of sludge in the pipe line at each stroke of the pump. The noise can often be minimized by reducing the pump stroke or by installing air chambers on the discharge and suction sides of the pump. To be of any value, the air chambers should be large and should be located as close to the pump valves as possible. A periodic check should be made to see that there is an air cushion in the air chambers and that they are not filled with the liquid being pumped.

In some cases pounding has been eliminated by placing an air snifter valve on the suction side of the pump. This does a good job but it is not recommended. Such a valve will admit at each stroke a small amount of air with the sludge and where the discharge is to a digester it is possible to pump in enough air to create an explosive mixture.

Pump Operation Hints

1. Never throttle the pump by closing a suction line gate valve. The turbulence created may cause serious vibration and cavitation and thus damage the pump.
2. Never run a pump longer than necessary with the discharge valve closed, especially if wearing rings are used in the pump. The recirculation taking place within the pump may loosen the wearing ring and cause it to jam the impeller. Also, power is converted into friction—overheating the water to an extent that expansion of the metals may cause metal to metal rubbing and binding.

   Furthermore, the grit in the sewage may increase the clearances between the impeller and casing and thus seriously reduce pumping capacity and non-clogging ability.
3. If the pump is in operation and the discharge gate valve is closed, open it slowly.
4. Closing the discharge gate valve before stopping the pump is occasionally advisable to prevent pipe strains or water hammer effects. This, of course, applies to hand operated units only.
5. When shutting the pump down for a protracted period, the motor disconnect switch should be opened, all valves on suction, discharge and water seal lines shut tight and the pump completely drained of water by removal of vent and drain until all the water has been removed. This will protect the pump against sedimentation and freezing. It is also a good policy at this time to inspect the pump and bearings thoroughly so that all necessary servicing may be done during the inactive period.

Pump Troubles

If the pump is not delivering enough water, the causes may be: (1) air leakage in suction piping, (2) suction piping air-bound, (3) air leakage in stuffing box, (4) impeller partially or completely clogged, (5) wrong direction of rotation, (6) suction inlet not insufficiently immersed, or (7) solids content in excess of pump design characteristics.

If the pump works for a while and the capacity decreases, check the following:

1. Incomplete priming because of a poor piping arrangement on the suction side of the pump, containing high points at which air or gases may accumulate. Incomplete priming may also occur on pumps which have a turned down

suction elbow and a discharge nozzle on the bottom of the pump casing in a horizontal position. If such a pump is operated under suction lift conditions, it may be impossible to eliminate all of the air from the upper half of the pump casing.

2. Air leaks in suction piping or stuffing boxes if pump has a suction lift and not a positive suction head.
3. Air or gases in the liquid being pumped in an amount greater than the pump can force out of the discharge.

If there are clogging difficulties, be sure that oversize material is not reaching the pump or the piping leading to the pump. Besides the other factors mentioned previously, keep the following conditions conducive to clogging in mind:

1. The rolling action of sewage solids and other foreign material in sewers causes balls or wads of material to form, which may clog the pump if not removed or cut up by such protective devices as screens and comminutors.
2. Under certain conditions, the centrifugal force of pumps will cause spiral rotation in suction lines. This spiral flow has been known to cause stringy material and other solids to enmesh and form a rope of solids, which upon reaching the pump, clogged the impeller.
3. Circular wet wells designed to cause circular flow to keep the solids in suspension have been known to develop grease balls which clogged pump suction lines. Where such clogging occurred, the circular flow condition was eliminated by installing baffles.
4. Deposition may occur in dead spots formed in wet wells due to the location of the inlet sewer. At times this deposition will break loose and cause clogging difficulties. This condition can be corrected by placing baffles to eliminate the dead spots.
5. Sludge collectors repeatedly turning over and pushing sludge to the sludge hopper have been known to gather wads of coarse material of sufficient size to clog suction lines. Where this condition occurs, it may be found necessary either to run the collectors more frequently or to increase the slope toward the sludge hopper so that the sludge will be moved and not merely turned over and over.
6. If a bar screen is not cleaned as often as necessary, the velocity through the reduced screening area will soon reach 3 f.p.s., which will unwind rags and pull them through the screen.
7. The screen chamber may be located too close to a sewer that is discharging with a free fall so as to force all but the largest material through the screen.
8. Cleaning the bar screen with a hose stream forces all the material through the screen chamber. This is not good practice.
9. Perhaps the clogging is in the check valve. Check valves installed in vertical positions on pump discharge lines have been jammed by grit and solids packed tightly against the check valve by surges when the pump stops. This clogging is not caused by the pump. If the check valve were in a horizontal position, it would not be possible for the grit to jam it because the grit and solids would be flushed out when the pump starts.

Some operators faced with vertical check valves have made provisions to blow off the discharge lines into the wet well, thus to remove the grit periodically before it can form an obstruction at the valve. Other operators have provided flushing connections.

Conditions causing clogging, if located, should be corrected as soon as possible because clogging is expensive in labor, time and in the damage that may be caused by flooding.

Sludge Collection Equipment

Sludge collector mechanisms include motors, gears, bearings, flights, chains and other items. This equipment, like any other and perhaps more so than some, requires especially careful supervision of installation. If the equipment has been poorly installed, and not aligned properly, costly wear and tear may be expected. Misalignment will cause excessive wear of sprockets, chains, wearing shoes and will engender motor troubles.

Chains should be kept tight at all times to prevent flights from chattering and causing excessive, uneven wear of wearing shoes and supporting rails. All bolts on attachment links and wearing shoes should be kept tight. Wearing shoes should be replaced when necessary to prevent flights from dragging on the bottom of the tank. If the shoes wear too rapidly, consideration should be given to the use of stellite or some other similar hard alloy.

Excessive slack should be removed from the chain either by means of the take-up screws, where they are provided, or by removing links from the chain. Care should be taken to see that the same adjustment is made to both chains. Both take-up screws in the same tank should be given the same number of turns and the shaft should be kept square with the center line of the collector. Where links are removed from the chain, they should be taken from points in the chain exactly opposite each other, and the same number of links removed from each strand.

If the equipment is going to be out of service for any length of time and the tank dewatered, the manufacturer's recommendation regarding removal and storage of flights and chains should be followed.

If the sludge collectors do not move forward but turn the sludge over and over before it reaches the sludge hoppers, thus causing balls or wads of coarse material to form, try to effect correction by changing the frequency and duration of operation. If this does not correct the trouble, it may be corrected by increasing the slope of the tank bottom.

In time, the teeth on the drive sprocket will wear round. This wear will be more rapid if there is misalignment. Most operators merely put the chains back on the sprocket each time the chain jumps off and hesitate to replace the worn sprocket until they are compelled to because the replacement of this part is no easy task. The equipment must be completely dismantled and realigned to do so. At New Haven, Conn., Supt. Chas. Copley has solved this problem by replacing the solid sprockets with split construction type sprocket drives.

Rotary Distributors

At a filter with stationary nozzles, one clogged nozzle means only a small area taken out of service. At a rotary distributor, the area taken out of service by a clogged nozzle is much greater. The nozzles should be kept clean.

Foreign clogging materials should be removed as often as is necessary. If the nozzles are not kept clean, the load imposed on the reduced filter area will reduce the effectiveness of treatment. The distributor arms should be flushed out daily.

The arms of the distributor should be level and the center column kept plumb. Adjust the turnbuckles on the guys and stays to compensate for expansion and contraction due to temperature changes.

If ice tends to form on the outer edges of the filter during winter operation, every effort should be made to prevent interference with the movement of the rotary distributor, not only to secure distribution of the sewage over the entire filter, but also because it might unbalance the adjustment of the distributor arms and center column.

Air Diffusers

In plants using compressed air diffusers, proper and adequate air filters should be provided to clean the air and eliminate clogging on the inside of the tubes. The filters should be cleaned when the loss through the filter increases 0.5 in. of water or as often as is required. Otherwise the tubes or plates will clog and the increased blower pressure will materially increase power costs.

Where swing diffusers are used, swing the tubes above the sewage when the blowers are shut down. This procedure will reduce outside tube clogging. Picture a coarse diffuser tube as a medium full of small tube openings. When air is being discharged from the inside to the outside, the air prevents the liquid and solids from entering the diffuser pores. As soon as the air is shut off, the hydrostatic head forces the sewage and solids which it contains through the small openings into the diffuser media and into the submerged air lines. When the blower is again put in service, the compressed air will force the water and most of the solids back into the tank. A portion of the solids, however, will be retained somewhere in the diffuser pores and will restrict the air passages. It is evident that too frequent blower shut-downs will increase clogging of diffusers and make it necessary to clean them more often.

Periodically, lift the swing diffuser out of the tank with the air "on." The air will blow off any clogging material on the outside of the tubes. Further improvement can be secured by hosing the tubes with water under pressure; the hose should be directed at an angle to prevent solids from being forced into the tubes.

Spare Parts and Special Tools

Generally when a plant is turned over to an operator, he finds that he has been given a very great responsibility, but that no tools were provided to maintain the equipment in good condition. When trouble occurs, the operator may have to borrow tools from his own car or from some kind neighbor until he can get the municipal officials to approve funds for the procurement of tools.

A similar situation exists as to spare repair parts and paint for keeping up the appearance of the plant. A reasonable supply of essential spare parts for all equipment should be available at all times, as should any special tools that may be required. Without them, it is impossible to repair and maintain equipment properly. Manufacturers will gladly furnish a list of spare parts that should be kept on hand.

Specifications on new work should require the contractor to furnish spare parts and any special tools recommended by the manufacturer.

BARK FROM THE DAILY LOG

By Walter A. Sperry

Superintendent, Aurora (Illinois) Sanitary District

Sunday Afternoon, December 16—John Charles Thomas has just sung the last note of "The Open Road" and that is the theme of this log. Mr. George Thon, our new engineer-trained trustee and your Logger climbed into the faithful Dodge one Friday morning late in October and for three days enjoyed the thrill of open road travel. It was one of our few adventures beyond the city limits since the war and was a delightful and stimulating experience that every operator should enjoy occasionally. Renewed friendships, exchange of ideas, comparison of methods and the learning of new tricks all act as vitamins do on the body, to challenge our own ways of working.

Clinton, Iowa

About noon we arrived at Clinton, Iowa, and called on Mr. Robert Kerr, Chief Engineer and Mr. R. C. Boyd, Service Manager of the Climax Engineering Company. Aurora bought in 1936 the first Climax engines ever sold for sewage works service. This was our first opportunity to see these engines in the making and our reception was most cordial. We spent an hour crammed with interest going about the plant where we saw a new line of single horizontal cylinder, heavy flywheel engines of 40 to 50 h.p., surprisingly rugged and easy to start.

We also examined a new type of plow that is expected to be manufactured by the thousands. The plow is mounted on a rugged frame with a 12- to 14-in. steel screw some 4 ft. long and driven by a tractor power take-off. It "stirs" the soil but does not turn the sod under as with the common share plow. Such equipment is part of the new soil conservation program and should interest every operator since his contribution of sludge for fertilizer is also an important part of this same program.

We dined with our hosts in the company canteen and started west again.

Cedar Rapids, Iowa

We arrived in Cedar Rapids by late afternoon and found Supt. J. C. McIntyre in a reflective mood, looking over the rail into his pump room pit. He had just lately returned from service in the Aleutian Islands and his face appeared still flushed from the 72° below zero temperature he had experienced there, although he said it seemed colder, at times, in Iowa. We spent a crowded hour of talking and plant inspection. The Cedar Rapids plant is financed by a sewer rental plan in co-operation with the city water department, supplemented by industrial waste fees based upon volumes of flow and B.O.D. strengths.

Of especial interest here was the responsibility of the sewerage department for pumping storm water to avoid flooded basement damage in the downtown districts and the pretreatment plant for handling packinghouse wastes. We particularly envied Supt. McIntyre his "4-ply" facilities for dewatering digested sludge. The plant offers a choice of lagooning, sludge drying beds, Oliver filter equipment and a Bird centrifuge—what more could one ask? Besides all this, the city garbage incinerator is next door giving him the opportunity to burn surplus sludge.

The chemical engineering works to be found in many small Iowa cities is amazing. The key to it is King Corn, who first does his part to fatten the cattle for the meat packing plants. The rest of the corn goes direct to chemical processing. The result is that large volumes of industrial wastes are produced and these, in turn, give rise to complicated sewage treatment plants. Very high gas production is common in these plants; the Fort Dodge plant, for instance, was said to sell enough gas produced current back to the local utility that the revenue received is more than equal to the entire operating cost. Gas production at Cedar Rapids is about 3 cu. ft. per capita per day; at Marshalltown it is about 4 c.f.

Marshalltown, Iowa

We reached Marshalltown, the real objective of our travels, about six in the evening and found comfortable rooms reserved for us at the Tall Corn Hotel. Saturday morning we shook hands for the first time with Supt. T. R. Lovell with whom we had corresponded at length concerning the protection of exposed iron and steel in sewage works by metallizing with zinc. While the Aurora plant was probably the first one in the U. S. in which experiments were made on the effectiveness of zinc coatings, Supt. Lovell was the first man in our field to invest in complete equipment to metallize his entire plant. We stayed till high noon and Lovell was more than generous in the time and effort necessary to demonstrate for us the entire process.

Due to the washing out of an entire section of W. P. A. built interceptor during a flood period, the plant was forced to shut down for several weeks. During this outage, which Mr. Lovell foresaw, the metallizing protection was applied to most of the underwater air piping of the activated sludge tanks. These pipes consist of thin steel tubes about 4 in. in diameter and some 10 or 12 ft. long. All of them were badly pitted and there was no imminent possibility of replacement.

The metallizing equipment of Marshalltown consists of a supply of zinc wire, tanks of acetylene and oxygen gas, the special metallizing gun and air compressor equipment to supply about 100 cu. ft. of free air per min. at 80 to 100 p.s.i. In addition, there is a supply of several tons of crushed flint or chert—called "Joplin chat"—that is used for sand blasting. Ordinary sand is much too smooth for this purpose and the sharp edged flint, screened to 8- or 10-mesh size, may be used several times before losing its effectiveness.

Generally speaking, the parts to be metallized must be dismantled

FIGURE 1.—Sandblasting metal equipment parts prior to zinc metallizing at the Fort Dodge, Ia., sewage treatment plant.

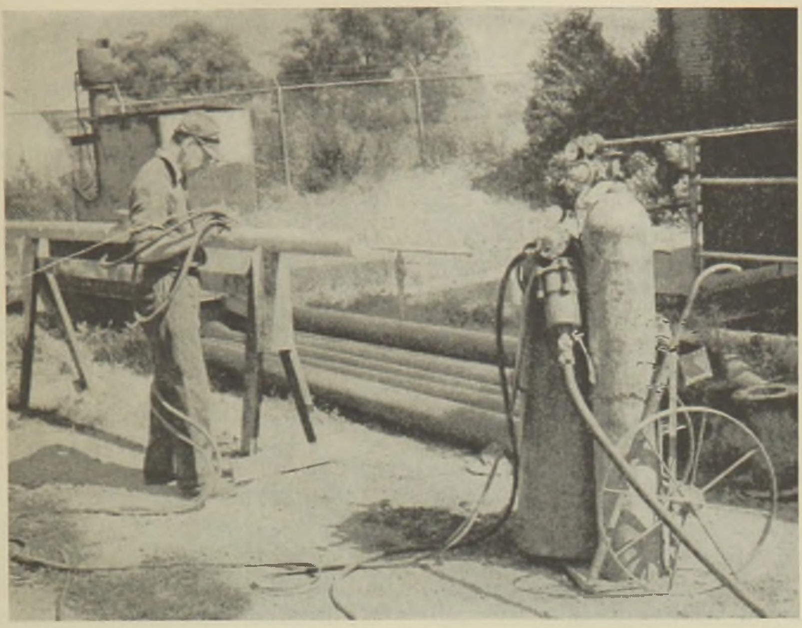

FIGURE 2.—Application of zinc protective coating to metal equipment parts at Fort Dodge, Ia.

and cleaned by sand blasting in a special room set aside for this purpose. The operator must be amply protected by a special hood, heavy gloves and an outside source of air for breathing (Figure 1). The enamel brick and window panes of this room were completely frosted from the flying sand. In an eight-hour working day the sanding of the pieces requires about five hours to three hours for their metallizing. The pieces must be completely cleaned to a virgin metal state. Great care is taken, after cleaning, not to touch the pieces with the bare hands or other soiling contacts before applying the zinc. The sand blasting accounts for fully half the cost of the work and more than half the time.

The manipulation of the metallizing gun is not difficult (Figure 2). About one third of the zinc is lost to the air while spraying and a coating of 0.003 to 0.004 in. of zinc is applied per pass of the gun over the work. Four passes of the gun is considered to add a zinc thickness of 0.012 in., believed to be good for 20 years of protection. Supt. Lovell states, however, that the cost so far has been higher than anticipated and amounts to approximately 42¢ per sq. ft. exclusive of the cost of labor and the original equipment investment. He further states the cost of the blasting sand to be over half this figure. Because of this high cost he seems inclined to reduce the thickness of the zinc applied to the equivalent of a ten-year protection. This cost may be further reduced by cleaning and coating the Tow-Bro equipment in the secondary settling tanks in place by using a canvas covering —weather permitting.

Needless to say, we spent a most instructive morning and noon came all too soon. In fairness to Mr. Lovell, further details should be reserved for inclusion in the paper he plans to write. We are greatly indebted to him for the many courtesies and valuable information secured during our visit.

An amusing experience resulted from the same flood that damaged the interceptor in connection with the washing out of the sludge lagoon at the plant. Thousands of cubic yards of sludge, loaded with pumpkin seeds from a local cannery, were deposited on neighboring farm lands. Instead of a hearty "thank you" for the gift of a generous and valuable layer of rich earth, the plant received full blame for the rank growth of pumpkin vines that resulted!

Iowa City, Iowa

About four in the afternoon of Saturday we drove into Iowa City, easily located the plant and received a hearty welcome from Supt. Mott. Believe it or not, we found him not only sitting down but actually reading the Aurora Annual Report!

After a brief chat we called up Prof. Earl Waterman for an exchange of greetings but he was just ready to leave for a sewage works meeting and could not get out to the plant.

While walking about the plant we were interested to observe on the filter walls the heaviest swarm of psychoda flies that we have ever seen. They seem to be a special problem at this plant.

While looking at the sludge beds we entered upon a discussion of weed control and Supt. Mott gave us an excellent idea. He uses a high wheeled garden push plow with two winged scraper blades to keep weeds sheared off while they are small. We have since tried it at Aurora and it works. Some months ago this hint would have saved us an immense amount of effort.

Davenport, Iowa

Sunday morning we called at the Davenport plant, signed the visitor's register and walked about with the operator on duty. It was too early to disturb Supt. J. L. Strelow, whom we would have liked to meet. The plant and grounds were spic and span. Mr. Thon and I were much surprised and pleased to find an exact copy of the Aurora tipping bucket sludge meter [**This Journal, 6,** 797 (July, 1934)], built to somewhat smaller dimensions and placed in the sludge pumping room between the two digesters.

Rock Island, Illinois

We crossed the Mississippi River on a beautiful new toll bridge and soon found the Rock Island plant All the doors were locked except one We entered, walked down a dark stairway and found a light switch which, when snapped on, startled the operator on duty considerably. He proved to be good natured, however, and did a fine job of showing us about. We hesitated to call Supt. Carl Durkee for we were anxious to get home and remembered how long sewage works men can talk.

This plant was especially impressive to us because of its substantial construction of hard burned brick with Bedford limestone trim and the attractive enameled brick walls inside. Fifty years from now this plant will look durable and clean cut and very little painting will be required. Another high spot of interest at Rock Island is the large, light and airy pump room with its complement of nine engines and their accessories.

We arrived home early in the afternoon, armed with two large boxes of candy to pacify our better halves. So ended a most instructive and worthwhile trip.

INTERESTING EXTRACTS FROM OPERATION REPORTS

CONDUCTED BY LEROY W. VAN KLEECK

The question for each man to settle is not what he would do if he had means, time, influence and educational advantages, but what he will do with the things he has.

—*Hamilton Wright Mabie*

Fourth Operation Report on the Sewage Treatment and Garbage Disposal Plant of Marion, Indiana, for the Year 1944 *

BY DAVID BACKMEYER, *Superintendent*

Collection of Garbage

The disposal of garbage by grinding and digestion with sewage sludge has probably provoked more comment and inquiry from sources outside Marion than any other single treatment operation. The collection of the garbage, which is supervised by the sewage works superintendent, has at the same time caused more headaches in the past year than would ordinarily be encountered in three of four normal years. With labor conditions as they are at the present time, it is extremely difficult to maintain an uninterrupted schedule of garbage collections for any reasonable length of time. The total amount of garbage collected in Marion is far below that collected in the average city of comparable size. Only in the month of August did the monthly production of garbage reach the 200-ton mark. This amount of garbage should be collected every month in the year if the total production is to reach the figure set by other cities.

Handling Garbage

Many improvements have been made in the method of handling the garbage after it reaches the treatment plant. Our experience seems to indicate that the ground garbage can be put in the sludge digesters in a more profitable manner by keeping it in a separate well and not mixing it with the sewage flow. The single piston plunger pump installed at the plant is used for the transfer of the garbage from the well to the digestion tanks. Several changes have been made in the design of the garbage well bottom since the well was first constructed, and all of the kinks have not yet been removed.

Gas Produced by Garbage

The gas recovered from the garbage is valuable as a fuel when used in the plant gas engines. Our data would indicate that 260 lb. of volatile material from a ton of green ground garbage should produce 2,600 cu. ft. of gas when properly digested with sewage sludge. This volume of gas has an aproximate value of one dollar when used as fuel. The garbage department is reimbursed at the rate of $1.00 per ton for the garbage delivered at the sewage treatment plant. Laboratory scale research work is being continued in an effort to determine what proportion of the gas generated should be credited to garbage solids, and what proportion to sewage solids.

Increased Air Requirements from Canning Wastes

During September and October the local Birdseye-Snider Division of General Foods packed a record crop of tomatoes. More than 11 m.g. of waste from this plant was metered during one six-weeks period. For the first time since the plant was first put in operation four years ago, the aeration

* For previous extracts see *This Journal*, **14**, 722 (May, 1942) and **16**, 1,000 (Sept., 1944).

air volume from the two gas engine driven blowers had to be augmented by a third blower unit which is electric motor driven. This condition was a direct result of the high oxygen demand of the tomato canning waste. Except during the two-month canning season, two blowers give sufficient air for the remainder of the summer load, and one blower unit supplies the air during the winter months.

Liquid Sludge Disposal

The disposal of the liquid sludge as fertilizer by trucking to farm land in the vicinity of the treatment plant has been carried on for more than a year. A total of 6,641 truck loads repre-

TABLE 1.—Summary of 1944 Operating Data, Marion, Indiana

Item	Average
Sewage flow, m.g.d.	4.32
Estimated population served, persons	26,700
Compressed air data:	
Cu. ft. air per gal. sewage for aeration	0.77
Pounds B.O.D. removed per 1,000 cu. ft. air	1.18
Cu. ft. air per lb. B.O.D. removed	887
Per cent of air from sewage gas	85.2
Physical data:	
Digester temperature, ° F.:	
Primary	97.0
Secondary	85.0
pH:	
Raw sewage	7.9
Plant effluent	7.7
Detention, hrs.:	
Primary tanks	1.69
Final tanks	2.61
Digester gas:	
Cu. ft. per capita per day	1.97
Per cent total power from gas	74.6
Raw primary sludge data:	
Thousand gals. pumped, total for year	9,192.3
Solids (dry), per cent	5.61
Volatile dry solids, per cent	54.3
Grit removed from sewage and garbage, cu. ft., yr.	3,925.0
Suspended solids data:	
Raw sewage, p.p.m.	229.0
Primary effluent, p.p.m.	107.0
Final effluent, p.p.m.	11.0
Per cent removal:	
Primary tanks	52.0
Over all	95.2
B.O.D. data:	
Raw sewage, p.p.m.	172.0
Primary effluent, p.p.m.	119.0
Final effluent, p.p.m.	12.0
Per cent removal:	
Primary tanks	31.0
Over all	92.9
Mississinewa river above plant, p.p.m.	5.0

Item	Average
Mississinewa river below plant, p.p.m.	7.0
Activated sludge data:	
Detention, hrs.	4.19
Mohlman index	57.0
Suspended solids, p.p.m.	3,220.0
Flow in m.g.d. of return sludge	1.22
Per cent of raw sewage flow (return sludge)	28.7
Suspended solids in return sludge, p.p.m.	12,385.0
Ash in return sludge, per cent	43.1
Digested sludge data:	
1,000 gals. removed, year	6,831.2
Dry solids, per cent	4.75
No. of truck loads hauled, year	6,641.0
Tons dry solids removed, year	1,311.6
Labor cost of sludge removal, year	$3,276.84
Truck fuel and maintenance cost, year	$ 826.20
Revenue from sludge sale, year	$ 949.80
Garbage disposal data:	
Thousand gals. ground garbage pumped, year	685.1
Solids, per cent	4.43
Volatile solids, per cent	86.6
Thousand lbs. volatile solids digested, year	2,427.1
Cu. ft. gas per lb. volatile solids*	8.04
Tons green garbage, year	1,049.6
Thousand cu. ft. gas from garbage, year	1,702.0
Per cent of total gas from garbage	8.9
Treatment costs data, dollars:	
Cost per m.g.	17.91
Cost per capita per month	0.086
Cost per 1,000 lb. B.O.D. removed	14.13
Payroll for year	18,314.75
Materials and maintenance for year	4,787.76
1944 budget for treatment, new equipment and construction, billing, etc. but excluding principal payments and interest on bonds, dollars	50,724.00

* Includes sewage volatile solids.

senting 6,831,000 gal. of liquid were hauled in the twelve-month period covered by this report. Many farm orders cannot be filled because of limited delivery facilities, but it is hoped that some time in the near future the proper government officials will give us a release for another truck.

Annual Report of the Buffalo Sewer Authority for 1943–1944 *

The Buffalo Sewer Authority, a public benefit corporation, was created by an Act of the Legislature passed in the spring of 1935. To it was delegated the responsibility for providing an effectual means of relieving the Niagara River and other tributary streams from pollution by sewage and wastes. The Authority has accepted and discharged its responsibility in full conformity with the intent and spirit of the mandate of the New York State Department of Health to discontinue pollution of the Niagara River.

Report on the Sewage Treatment Works

By John W. Johnson,

Works Superintendent

Pumping

Inspection of the wet wells indicated that the concrete mats and deflectors installed to fill worn spots beneath the suction of the main pumps were giving good service. At the same time it was discovered that timber baffles in the channel throat on one side had eliminated the settlement of grit deposited at the rear of the well, but had caused a deposit to form under the suction bells of the idle pumps. The structure was dismantled and relocated, and further studies will be made of this problem.

Primary Sewage Treatment

Transfer of skimmings or scum and its final disposal has always been a major operating problem. Lines and pumps which handle this material seldom work at rated capacity and incinerating units do not efficiently consume it. For a time during early spring all skimmings were raked by hand from scum boxes at the clarifiers into portable carts. The skimmings wheeled to an outside hearth were readily incinerated. With the advent of warmer weather the oils and greases became more fluid causing spillage in transportation and difficulty in retention on the grates of the incinerating hearth. Because of these hindrances and due to the fact that about two tons were removed each day, the project was temporarily abandoned.

Disinfection

Chlorine was added to the sewage based on the determination of hourly demands. Close co-operation was effected between the chlorine station and the final effluent station to maintain 0.1 p.p.m. residual. Dosage averaged 4,280 pounds per day with a total of 1,567,650 lbs. of chlorine being added to the flow for the current year. The daily presumptive coliform bacterial kill averaged 97.9 per cent, which was equal to the six-year average. (*Abstractor's note:* Reporting bacterial results by the percentage kill is frequently misleading. Later in the report it is stated that complete chlorination is not attempted during the period of storm flows and for comparative purposes the dry weather average data for bacterial content were calculated to show the relationship to the over all average. The calculations, it is stated, showed the raw sewage to have a content of 112,000 per ml. during such periods, whereas that of the effluent averaged 1,500 per ml., resulting in an average kill of 98.7 per cent. It

* For previous extracts see *This Journal*, **11**, 6, 1,083 (Nov., 1939); **14**, 2, 455 (March, (1942); **13**, 3, 592 (May, 1941); **16**, 6, 1,239 (Nov., 1944).

can readily be seen that while the per cent of kill is high there are still substantial numbers of coliforms still present in the effluent. For conditions in the Niagara River this count may be perfectly acceptable but is far, for example, from the standard of the Interstate Sanitation Commission of New York, New Jersey and Connecticut, which allows not over 1 coliform per ml. in more than 50 per cent of the bacterial samples collected.)

Early in the year experimental work with the potential cell and recording apparatus for the measurement of chlorine demands of sewage was interrupted. Further refinement in the unit must be made before work can be resumed.

Control of Scum in Digestion Tanks

Monthly sludge inventories indicated a range in scum solids varying from 60 to 80 per cent by weight, averaging at times 20 per cent dry solids and 70 per cent volatile matter. During periods when dry solids concentration was high, recirculation of supernatant liquor was used to break down the deep mass, facilitating removal of the material, improving the digestion process and increasing the rate of gas production. In a further effort to digest this accumulation, which averaged 12 ft. in depth, quantities of ammonium sulphate were fed into one tank. After the introduction of this chemical, containing 25 per cent available ammonia, there was a noticeable increase in tank activity and gas production within a short time. It was also possible to withdraw top material more readily than with recirculation alone. Additions of this chemical were made in small amounts compared to the total tank contents. This was done to prevent any overflow of the active material. Later in the year the volume of scum was greatly reduced by the ability to increase the load to the sludge incinerators, and further additions of ammonium sulphate were withheld until such time as the grease may become stiffened again.

Additional Comments on Sludge Disposal

Benefits derived from revision of the raw sludge inlet line and provision of a larger gas take-off line in one of the digestion tanks last year warranted similar changes to the others. During the current year a second tank was emptied to a point where all of the sludge, supernatant liquor, heating coils and gas lines were exposed. This time, because the material remaining in the lower part of the tank was soft, it was not possible to work from float stages on the surface. Suspended working platforms had to be erected but, fortunately, no work was necessary on the heating coils, which made this installation less extensive than before. The original 4-in. gas line was left in place and was connected to the recirculating equipment. This was done to provide an integral and protected system, which does not exist in the exposed exterior riser and hoses used to carry supernatant liquor into the domes of the digesters. It has been found that raw sludge at the full pumping rate can now be taken by either one of these tanks and metered gas production from them is double that of the other two tanks, which have not as yet been revised.

During an interim of periodic inspection, the wood roof deck of one of the floating covers began to disintegrate. Although the planking is untreated, this was perplexing as the other three roofs were sound. Temporary repair and support to the weakened members were made until materials can be secured that will be resistant to the humid conditions prevailing between the steel bottom and the decking above. Louvered ventilators were immediately provided for use during the warmer months to aid in relief of this condition.

Dictated by safety requirements, the

flame and moisture traps on the gas supply lines and the pressure-vacuum relief valves at the gas domes were cleaned and adjusted twice during the year. For a time the pressure release on the latter was reduced so that the weight of the covers might aid in submergence of top sludge, but it was found that higher pressure under the cover gave greater assistance in the removal of the material.

Disposal of sludge was scheduled according to the results obtained from monthly sludge inventories made on the digestion tanks.

Emphasis on raising the volume of scum to be incinerated caused increased use of conditioning chemicals, as much of the lime was lost to the grease particles in the sludge cake. Near the end of the year the supply of pre-war filter cloths purchased in 1941 became depleted. Several new cloths subsequently used, which were purchased last year and were available only in lighter weight Canton flannel, had a much shorter life. This one item alone increased the cost of operation of this department several hundred dollars. Two of the bucket elevators, which carry digested sludge to the conditioning tanks, were rebuilt. By eliminating two sharp bends on the return travel of the buckets and by shortening the total length of the conveyor, greater speed was provided and a longer operating life insured.

The lower sections of the tile-lined cyclones of one unit were renewed after having operated 24 months with a minimum of repair. This service, compared with the operating life of three months for steel plate liners, has proved the worth of the tile.

Endeavoring to find an outlet for the sludge, contact was made in the local fertilizer market and as a consequence 50 tons of dried sludge were drawn off the furnace surge bins, bagged and sold to a local fertilizer company. The material was used as a filler in a standard type of commercial fertilizer. Final report as to the value of this addition has not yet been obtained.

Report on Activities of the Laboratory

By George F. Fynn, *Chief Chemist*

Sludge Digestion Tank Inventories

For the purpose of calculating sludge loadings and to schedule incinerator operations, an inventory of the sludge digestion tanks was made each month. This work involved sampling at 2-ft. intervals throughout the depth of each tank, and laboratory analyses were conducted on composites for solids and volatile matter content, pH, and volatile acids. Due to the accumulation of scum encountered a revision to the sampler was made by constructing a bullet-shaped piece of steel, which might be attached to the sampler for added weight when abnormal conditions were experienced. The efficacy of this addition has been notable especially during the winter months.

The industrial waste program was furthered during the year by analyzing the discharge from several concerns. This work was conducted in cooperation with the Engineering Division, which scheduled the programs of sampling. Grab samples were collected by the division and, if preliminary tests indicated a condition which should be given further study, a sampling procedure was inaugurated to cover the period of operation in the plant under investigation. Analyses were made to determine concentrations of suspended solids and chlorine demand for comparison with the average strengths of the sewage as received at the treatment plant. During the year the laboratory conducted analyses on the wastes of various industrial establishments including tanneries, rubber reclamation plants, breweries, a gas company, several meat packing plants, a milk and dairy products concern and several industrial and household laundries.

TABLE 2.—Summary of 1944 Operating Data, Buffalo, New York

Item	Average	Item	Average
Sewage flow, m.g.d.	136.0	Per cent volatile solids	64.2
Population served, approx.	590,400	pH	6.3
Analytical data:		Sludge digestion tank operation:	
Suspended solids, raw sewage, p.p.m.	207.0	Digested sludge:	
Lbs. per cap.	0.39	Per cent dry solids	8.7
Grit free, p.p.m.	199.0	Per cent volatile solids	59.3
Effluent, p.p.m.	121.0	Supernatant liquor:	
Per cent removal	41.4	Per cent dry solids	3.3
Settleable solids:		Per cent volatile solids	53.6
Influent, p.p.m.	93.0	pH	7.0
Per cent removal by settling tanks	48.7	Tank temperatures, ° F.	94.0
pH of raw sewage	7.1	Gas production:	
B.O.D.:		1,000 cu. ft. per day	472.3
Raw, p.p.m.	136.0	Per cent CO_2	35.3
Effluent, p.p.m.	101.0	Cu. ft. per cap.	0 79
Per cent removal	25.7	Incineration of sludge:	
Chlorine demand:		Sludge cake:	
Raw, p.p.m.	5.0	Wet tons per day	81.0
Supernatant liquor, p.p.m.	324.0	Per cent dry solids	36.4
Total demand, p.p.m.	5.43	Per cent volatile solids	50.3
Presumptive Coliform bacteria:		Ash:	
Raw, 1,000 per ml.	105.0	1,000 lbs. dry solids per day	23.4
Effluent, 1,000 per ml.	2.18	Per cent volatile matter	4.3
Per cent kill	97.9	Per cent CaO	9.74
Grit:		Per cent $FeCl_3$	2.05
Cu. ft. per m.g.	2.45	Total miles sewer, June 30, 1944	759.03
Per cent dry solids	54.5	Employees in sewage treatment works	127
Per cent volatile solids	41.8	Cost of operation of plant, dollars	409,351.64
Raw sludge:		Cost of operation per m.g. treated, dollars	8.23
Per cent dry solids	7.3		

Among other problems that demanded the attention of the staff were studies of the grease content of the sewage and sludge, a consideration of the suitability of the ground water at one location for possible use as plant water, the fertilizer value of the digested sludge from the nitrogen, phosphorus and potash content, the effect of ammonium sulphate additions on the digestion tanks, and the possibility of the utilization of a waste lime slurry for conditioning.

Report of the Sewers Department

By Carl L. Howell, *Supt. of Sewers*

Operation of Sewer Patrol

Regular inspection of siphons, intercepting and overflow chambers and manholes, and other appurtenances has been continued by the Sewer Patrol, consisting of three men with an adequately equipped truck. There are now 244 such points of inspection in addition to 16 gauging stations in trunk sewers. A total of 7,274 such inspections have been made during the past year. In these inspections, connections to the intercepting system have been found completely stopped on 285 occasions, with sewage overflowing the weirs to the overflow outlet, and on 56 occasions connections have been found partially clogged. On many other occasions points of interception have been found to have small accumulations of debris which, if not removed, would have caused further accumulation and eventually clogged the connections. Wherever possible, all connections of the above character have been cleaned and kept in good working condition by the Sewer Patrol. (*Abstractor's note:* This cleaning and inspection of sewer appurtenances deserves much more than passing notice. Many communities, especially the smaller cities and towns, fail to provide men or funds for such work with the result that stoppages occur at the most inopportune times, lawsuits sometimes are instituted against the community, and in particular the overflow of raw sewage occurs during dry weather flow when all sewage should be reaching the treatment plant. In view of the funds appropriated and the effort expended for the treatment of sewage, it is illogical that all the sewage that should reach a sewage treatment plant for treatment does not do so because of inadequate supervision of overflow chambers and sewers. Congratulations, Buffalo, for setting this good example!)

During the year, 1,017 sewers with a total aggregate length of 745,217 lineal feet have been cleaned. The sewer cleaning cost was 7.1 cents per lineal foot. Of interest is the fact that throughout the city are some sewers which have never been cleaned and upon inspection year after year continue to remain in the best condition.

Industrial Wastes Survey

The making of special charges for treatment of industrial wastes of unduly high concentrations, which cause increased treatment expense, has now become an established practice with the Authority. These special charges, which are for the purpose of reimbursing the Authority only for the cost of chlorine consumption and of chemicals and power used for the disposal of solids in excess of normal sewage requirements, are determined from the adopted rate formula set forth in the annual report for the previous fiscal year (see *This Journal*, 16, 6, 1,239 (Nov., 1944)).

Special charges are now regularly being made to a number of concerns whose wastes are particularly strong. The types of industry in which these concerns are engaged are rubber reclaiming, tanning, slaughtering, industrial laundering, etc. The cost of cleaning certain sewers is being directly assessed against two concerns whose wastes continue to cause blockages in these sewers.

Considerable work has been done during the past year toward determining the effect upon the chlorine demand and suspended solids content of wastes from rubber reclaiming processes when diluted with normal sewage. A decrease in chlorine demand and an increase in suspended solids has been noted. Studies of laundry wastes have indicated a marked difference in strength of wastes from those places laundering industrial garments and cloths and those devoted exclusively to laundering domestic articles. The wastes of launderies devoted to domestic work have not appeared of sufficient concentration to warrant special charges. Studies have been continued of the wastes from breweries with indications that such wastes are not excessively strong.

Efforts have been continued during this year to restrict the entrance of oil and grease into the sewer system. Where oils and greases have appeared in sewers, the concerns believed to be responsible for the same have been contacted and have in general readily agreed to co-operate in this effort. The accumulation of grease in certain sewers has continued, however, to be a major problem.

TABLE 3.—Summary of 1944 Operating Data for Gary Sanitary Distict Main Sewage Treatment Plant, Gary, Indiana

Item	Average
Population served, estimated	100,000
Sewage pumped, m.g. total for year	6,892
Average daily sewage pumpage, m.g.	18.83
Suspended solids removed, lbs. for year	18,173,772
5-Day B.O.D. removed, lbs. for year	9,734,489
Gas production, cu. ft. for year	56,502,200
Average daily gas production, cu. ft.	154,378
Value of gas used, dollars	22,661.08
Air blown, million cu. ft. for year	3,195.72
Reduction in suspended solids, per cent	98.4
Reduction in 5-day B.O.D., per cent	96.4
Total cost of operation, dollars for year	80,230.71
Cost per m.g.	11.64
Cost per capita	0.80
Cost per 1,000 lbs. B.O.D. removed	8.24
Per cent of sewage pumped with sludge gas, year	88.08
Cu. ft. air used per gal. sewage treated	0.48
Per cent air blown with sludge gas	99.97
Lbs. B.O.D. removed per 1,000 cu. ft. air	1.40
Cu. ft. gas produced per capita	1.54
Gas produced per lb. solids added	3.1
Gas produced per lb. volatile solids added	6.2
Screenings removed in cu. ft. per m.g.	0.24
Grit removed in cu. ft. per m.g.	8.99
Lbs. solids removed daily, dry basis	49,655
Lbs. solids removed per m.g.	2,782
Settling period in hrs.	2.18
Lbs. B.O.D. removed daily	26,597
Lbs. B.O.D. removed per m.g.	1,412
pH:	
Raw sewage	7.0
Final effluent	7.3
Raw sludge	6.9
Return sludge	7.2
B.O.D., 5-day:	
Raw sewage, p.p.m.	175.55
Settled sewage, p.p.m.	83.78
Per cent reduction by settling	52.22
Final effluent, p.p.m.	6.29
Per cent reduction, over all	96.42
Suspended solids:	
Raw sewage, p.p.m.	321.22
Settled sewage, p.p.m.	108.26
Per cent reduction by settling	66.29
Final effluent, p.p.m.	5.13
Per cent reduction, over all	98.40
Aeration data:	
Suspended solids, mixed liquor, p.p.m.	1,221
Sludge index	78.1
Suspended solids, return sludge, p.p.m.	4,203
Per cent return sludge	34.66
Aeration period, hrs.	4.68
Secondary settling period, hrs.	3.34
Secondary area loading, gals. per sq. ft.	666
*Raw sludge pumped, gals. daily	139,736
*Raw sludge dry solids, per cent	5.04
*Raw sludge dry volatile solids, per cent	51.51
Gas analysis†:	
Carbon dioxide, per cent	28.3
Oxygen, per cent	0.1
Methane, per cent	65.2
Hydrogen, per cent	5.2
Nitrogen, per cent	1.4
Hydrogen sulphide, raw, grains per 100 cu. ft.	5.32
Hydrogen sulphide, scrubbed, grains per 100 cu. ft.	4.04
Gross heat value, B.T.U.	674.1
Digested sludge:	
Per cent dry solids, all digesters	5.64
Per cent volatile solids, all digesters	44.2
Drawn to drying beds, gals., total	8,776,585
Dried sludge cake produced, total tons	4,685.75
pH digested wet sludge	7.0
Average number of beds filled per month	15.35
Bacterial analysis:	
Total bacteria per ml.:	
Raw sewage	762,000
Final effluent	41,200
B. Coli, M.P.N. per 100 ml.:	
Raw sewage	2,400,000
Final effluent	96,000
Grand Calumet River Survey:	
Dissolved oxygen, p.p.m.:	
$\frac{1}{4}$ mile upstream	4.53
$\frac{1}{4}$ mile downstream	4.65
$1\frac{1}{4}$ miles downstream	4.83
5-Day B.O.D., p.p.m.:	
$\frac{1}{4}$ mile upstream	4.14
$\frac{1}{4}$ mile downstream	4.26
$1\frac{1}{4}$ miles downstream	3.12

* Mixture of primary and waste activated sludge, plus solids in supernatant liquor.
† Averages of one sample per month.

Fourth Annual Report on the Gary, Indiana, Sewage Treatment Works for 1944

By W. W. Mathews, *Supt.**

This plant is an activated sludge, diffused air type with separate sludge digestion. Garbage grinding equipment is included as part of the plant but has not been used to date. The design is based on a flow of 40 m.g.d. and 170,000 population. The plant was placed in operation on August 23, 1940.

Table 3 is a summary of 1944 operating data. Additional comments on 1944 operations will be found in *This Journal,* 17, 5, 1,064 (Sept., 1945).

TIPS AND QUIPS

Columned at Columbus during the Nineteenth Annual Meeting of the Ohio Conference on Sewage Treatment on October 31 and November 1, 1945 . . . a better than average registration of 90 . . . a program distinguished by the spontaneity, technical caliber and spiritedness of the discussion from the floor . . . the instructive and entertaining narrative of the experiences and observations of Lt. Col. F. D. Stewart during his service in the Sanitary Corps of the army, while stationed in Iran . . . and the interesting recitation by E. E. Smith (back at Lima after military service) of his observations of sewage works practices in Italy . . . the paper on synthetic rubber wastes by C. C. Ruchhoft, who displayed samples of the wastes and created an olfactory atmosphere of unquestioned authenticity . . . the illustrated lecture given by Dr. A. J. Fischer in which he revealed the stark and complete destruction wrought upon Germany during the war, as observed by Dr. Fischer during his 3-month tour of inspection last summer . . . the unveiling of the mind of an acknowledged politician in the banquet address of State Senator Roscoe R. Walcutt of Ohio, whose remarks were punctuated by frequent gems of humor . . . the enjoyable assignment of presenting the Federation's 1945 Kenneth Allen Award to F. H. Waring, Chief Engineer of the Ohio State Department of Health . . . and Mr. Waring's revelation of the pollution abatement activity of his office, the effectiveness of which is proved by Ohio's hundred million dollar backlog of sewage works construction in the design stage . . . the threatened imposition of the old Ohio Conference rule that any member who errs in his use of sewage works terminology is fined one dime per violation . . . which is indicative of the desire of this group to achieve perfection . . . and the conviction at the end of the meeting that "Buckeye Sludge" will bulk and foam only rarely so long as the valves are manipulated by these indomitable operators!

Unusual indeed is the sewage treatment plant at Richmond, Ind., where hard working Ed Ross superintends. Located in a beautiful natural setting, advantage is taken of the rough topography to utilize the 30-odd feet of head to supplement air application at the activated sludge units. The aeration tanks are in three sections with a difference of about 15 ft. between the water surface elevations; "Aero-mix" aerators are utilized in the second and third sections to augment the diffused air supply to the extent of about 700 cu. ft. of air per minute. The plant

* For previous extracts see *This Journal,* 16, 3, 637 (May, 1944); 17, 5, 1064 (Sept., 1945).

has no raw sludge pumps, sludge discharge from the sedimentation tanks to the digesters being by gravity—another unusual feature.

The operation problems of principal concern at the moment are manpower and chrome plating wastes. Supt. Ross is anticipating the day that he will have sufficient men to catch up on painting and other general maintenance work. In the meantime, he finds occasional diversion in the periodic batches of chrome wastes that turn the activated sludge to a light yellow color and cause the flocs to break up and lose their density. No trouble during the "Corner's" visit, however; the sludge index was about 75, according to the pulchritudinous Mrs. Miller, plant chemist.

And, as the crowning item of individuality of this plant, it is the first one in our experience to boast a fireplace in the superintendent's office!

Charted at Charlotte at the time of the 25th Annual Joint Conference of the North Carolina Sewage Works Assn. and North Carolina Section, A. W. W. A. on November 5–7, 1945 . . . about 300 registrants—not good, but very good! . . . the snappy and punctual job of presiding turned in by Chairman E. M. Johnson at all technical sessions and by J. R. Purser at the banquet . . . the down-to-earth round table discussions on sewage works problems, ably led by S. R. Kin and D. York . . . an impressive demonstration of southern hospitality in the general conduct of the meeting as arranged by G. S. Rawlins, J. L. Greenlee, J. R. Purser, W. E. Vest, H. F. Davis and numerous others . . . the opportunity to visit and compare notes with dynamic Harry Jordan, Secretary of A. W. W. A. . . . the verbal and visual trip to Brazil with Dr. H. G. Baity, who headed some of the recent work of the Institute of Inter-American Affairs in that nation—a presentation that was on a par in photographic technic, language and subject matter with the offerings of the best geographical publications . . . enhanced by the paper given by Col. H. B. Gotaas, President of the Institute of Inter-American Affairs, in which he described the work of that agency in promoting environmental sanitation in eighteen Latin-American nations . . . the designation by the N. C. S. W. A. of Col. Gotaas as the recipient of the 1946 Kenneth Allen Award . . . the technical papers by Capus Waynick of North Carolina and R. D. Farrell of Tennessee, from which it was evident that these two states are on the high road and in high gear in the initiation of sound, practical pollution abatement programs . . . the brief but instructive tour of the Sugar Creek and Irwin Creek sewage treatment plants at Charlotte, where a good practical job is being performed by 17-year-old plants that are heavily overloaded . . . and then back home via the airways, with a stop-over in Washington, to conclude a most pleasant and profitable trip!

A stop at Decatur, Ill., at dusk one dark November day found Supt. W. D. Hatfield poring over tabulations of operating data. And his time was being well spent, for the Decatur plant is one that receives and handles a heavy flow of tricky industrial wastes in units that are loaded far beyond conventional limits. The main plant comprises grit chambers, Imhoff tanks, activated sludge units and trickling filters. At the time of visit the settled sewage flow was being divided between the two secondary treatment processes —only one of several flow sequences that is possible in the layout.

Imhoff tanks loaded at rates of 1.5 to 3.5 lb. solids per cu. ft. per month, filter loadings from 400 to 875 lb. per acre-ft. daily, final settling rates up to 3,300 gal. per sq. ft. per day—these are characteristic of the burden imposed by starch manufacturing and metal plating wastes and others. As regards the unusual digestion efficiency of the Imhoff tanks, it is significant that the raw sewage temperature is 85° to 90° F.

The starch wastes are the major problem and their control involves a striking story of the practical application of laboratory data in the achievement of close co-operation between industry and municipality. A separate hourly grab sample of raw sewage is taken at the times the portions are collected that make up the daily composite. The first laboratory operation is to make an oxygen consumed determination on the composite and if the result is low the grab samples are discarded because it has been established that the starch wastes are of normal character. If the oxygen consumed result on the composite is high, chlorine demand, oxygen consumed and a simple sugar test are determined on each hourly grab sample.

The starch manufacturing losses are either in the form of general process water or of a specific waste having a high sugar content. The process water has a high chlorine demand and B.O.D. while the sugar losses have a high oxygen consumed, low B.O.D. and little, if any, chlorine demand. Thus, the sugar waste does not affect the plant loading as reflected by population equivalent but does have a marked influence on the activated sludge. Quick and convenient pH determinations, made by use of a glass electrode, were formerly indicative of process water loss when in the low range. This has been nullified as a control, however, by metal plating wastes contained in the sewage in recent years.

The above procedure gives a rapid picture of the content of the flow received during the previous day. A telephone call to the chemist at the starch plant informs him of the nature and approximate time of any losses so that he may trace and eliminate the source. The industry values the service because it assists them in achieving maximum production efficiency by reducing waste.

A secondary advantage of the preliminary spot tests is that they serve as a guide in the selection of B.O.D. dilutions. This is quite helpful at Decatur because of the wide daily variation.

Operators of other plants receiving wastes from nickel plating processes may be interested to know that concentrations of nickel as high as 50 p.p.m. in the raw sewage have not been detrimental to the sewage treatment methods employed at Decatur.

Atoms from Atlanta, where the Georgia Water and Sewage Assn. held its Fourteenth Annual Meeting on December 4, 1945 . . . with 138 registrants, a satisfactory figure considering that this was just a one-day meeting, hurriedly arranged . . . the address of welcome by President Blake R. Van Leer of Georgia Tech in which he (1) admonished operation administrators to emphasize public relations functions if they expect to secure public appreciation of their efforts and (2) pointed out the association's great responsibility toward the advancement of public health in Georgia, as a prerequisite to the industrial development of the state . . . the remark by President Grady Wylds, in his pleasing Georgia drawl, as he introduced State Sanitary Engineer W. H. Wier: "Fifteen years ago we operators looked upon these state engineers as we would a 'revenuer'; today we welcome them because we know they come to help us" . . . one of the best "Blueprint Now" talks we have as yet heard, by W. H. Wier . . . the discussion on the chlorination paper by N. S. Chamberlain that went right on through the luncheon hour . . . and then was revived later in the day . . . the extra-curricular dinner that was arranged so that we could get better acquainted with 34 leaders in sanitation in Georgia . . . and the tale, told during the ensuing "story hour," of the youthful burglars who robbed the home of Atlantan W. J. Houston of several items, including a copy of the Federation's book *Modern Sewage Disposal.* When apprehended and questioned as to why this precious tome (now out of print) was taken, one of the errant boys said that he "thought its was a mystery story" . . . which conclusion has more than a little foundation in fact! . . . as well as the narrative by Consulting Engineer L. R. Singleton about the intermittent sand filter plant he designed during the Florida boom for the municipality of Haines City, where only a small fraction of the design population was realized and none of the sewage that has been received for treatment has ever been discharged at the plant outlet as effluent! . . . the unbounded courtesy and favors extended by Georgians G. R. Frith, Van P. Enloe, M. B. Nixon, Henry Knapp and many others, who put a true southern accent upon their hospitality . . . and, throughout, the apparent observation that the Georgia Water and Sewage Assn. may not be the largest, but is certainly one of the strongest units of the Federation!

A visit to three of the five sewage treatment plants serving Atlanta and environs made the "Corner's" trip to that beautiful city complete. The administrative set-up here is similar to that of a sanitary district in that the Atlanta plants serve seven adjacent smaller municipalities. An unusual note is that the 800-mile sewage collection system has only one pumping station—and that is a temporary one. M. B. Nixon, City Engineer of Sewage, is in charge of all collection and treatment works.

The first stop was at the R. M. Clayton plant, where the genial V. P. Enloe functions as superintendent. This 42-m.g.d. plant is of the separate sludge digestion type and is equipped for chemical treatment when outlet stream conditions are critical. It has not been necessary to apply chemicals since the plant was built in 1938, when it replaced what were said to be the first Imhoff tanks constructed in the U. S. (1911).

The old Clayton plant also lays claim to being the first sewage treatment plant in the U. S. in which sewage gas (collected at the Imhoff tank gas vents) was utilized for fuel. During the time that Chas. C. Hommon, now of Columbus, Ohio, was superintendent, this gas was used for lighting the plant grounds, for cooking in the superintendent's house and for laboratory purposes. The old gasometer used for storage at that time has been kept for exhibit as an historical item.

The plant is located adjacent to the city's raw water pumping station on the Chattahoochee River, and the excess digester gas is piped across for use in the water works boilers. This excess flow of gas amounts to 200,000 to 250,000 cu. ft. per day and is equivalent in fuel value to about 6 tons of coal daily.

An interesting application of comminutors as separate screenings grinders has been incorporated into the Clayton plant. Screenings are removed from the sewage by mechanically cleaned screens and the screenings dropped into a trough, whence they are flushed by a continuous flow of river water to a 15-in. comminutor where they are shreaded and returned to the sewage. Thus, two 15-in. comminutors (one of them a standby unit) suffice to grind the screenings from a sewage flow of 30 m.g.d.

At the top of a hill near the plant, overlooking the junction of Peachtree Cr. with the Chattahoochee, are some of the original breastworks used by the Army of the South in its gallant defense of Atlanta during the Civil War. Historic soil, indeed!

The attractive South River plant, giving complete treatment by separate sludge digestion and trickling filters to 6 m.g.d., was the next stop. Two tiny Continental truck engines, alternately operated, generate all the power required here. Considerable trouble has been experienced by scum formation in the digesters as a result of grease and fiber contained in the wastes from a tributary wool scouring plant. Co-operative work with the industry has eliminated much of the trouble but the heavy scum accumulation in both digesters has had to be removed manually—no small project! Of interest here was the original idea (to us, at least) of Supt. Henry Knapp in regard to the wearing surfaces of the flight shoes of the grit collectors. The use of built-up rubber pads made from old automobile tires instead of the metal shoes has reduced the frequency of required attention to less than half, has reduced wear on the rails and has eliminated the purchase of replacement shoes. The scheme has been applied to the grit chamber equipment of all other Atlanta plants.

The final stop on the tour was the Intrenchment Creek plant, also superintended by Mr. Knapp. This plant was rebuilt in 1938 by conversion of the old Imhoff tanks (installed in 1911 as the first in the U. S., with those in the old Clayton plant) to separate sedimentation units, construction of additional trickling filters dosed by spray nozzles, installation of a circular final sedimentation tank with peripheral magnetite filter, and other improvements. A flow of 14 m.g.d. is received.

The automatic backwashing equipment of the magnetite filter was inoperative during the visit because of the difficulty of securing certain electrical repair parts. The magnetite was in place and in service as a filter, however, the practice being to by-pass the tank for three hours each week while the sand is washed manually.

Of particular interest here was the pilot plant used during the experiments by John A. Carollo on the efficacy of DDT in the control of *psychoda* flies, which work is reported elsewhere in this issue.

Except for minor control tests, all of the laboratory work for the Atlanta plants is done at the Clayton works under the supervision of Chemist W. Norris Harris.

Reconversion Short Story:

''Blueprint Now''
produced the
plans.
Now labor
must provide the
hands!

Editorials

FILTER FLY CONTROL BY DDT

Since the day that the fame of DDT as an insecticide emerged from the enveloping cloak of military secrecy, operators of trickling filter plants have been avidly awaiting information as to the efficacy of this wondrous substance in controlling that vexatious varmint and pestiferous invader of eyes, ears, nose and throat—*Psychoda,* the unwanted filter fly. It is with considerable satisfaction that we present in this issue the results of two basic and conclusive studies in which DDT was tried and proven as a control measure. Trickling filter operators (and, perhaps, some neighbors to such plants) are indebted to Capt. Carollo and Lt. Brothers and to the Sanitary Corps of the Army for the practical research reported here.

Although the two investigations were conducted independently in plants distantly located from each other, there is excellent agreement in the findings. Both workers arrive at the conclusion that DDT treatment is most effective when directed at the larvae, the chemical being applied with the sewage flow; control of the flies in the adult stage by application of the DDT to contact surfaces was found to be incomplete. There is some divergence of opinion of the authors as to the effective dosage of DDT when it is applied to the entire sewage flow for 24-hour periods but, in both cases, these studies were limited to small filter areas and should be supplemented by further plant scale work.

The batch method of application suggested by Lt. Brothers appears to have merit as an efficient and positive procedure. Attention is directed to the fact, however, that the recommended dosage of DDT (1 p.p.m.) is based on the total daily flow of sewage to the filter, whereas the actual application rate is much higher in the batch procedure. For example, if the sewage is allowed to flow to the filter for, say, 15 minutes after the batch of DDT emulsion is dumped, and is then shut off to allow for the contact period, the actual rate of application would be greater than 100 p.p.m. It is suggested that the batch dosage might better have been stated in terms of filter volume than in terms of sewage flow, *e.g.,* as pounds of DDT (in 5 per cent emulsion) per acre-foot of filter volume. On this basis, an application of about 15 lb. of DDT per acre-foot would be equivalent to the 1 p.p.m. dosage as computed by Lt. Brothers.

Neither of the papers refer to the costs involved. On the basis of approximate current prices, with DDT at 50 cents per lb., Xylene at $1.10 per gal. and Triton X-100 at $9 per gal., the cost of applying 1 p.p.m. of DDT to 1,000,000 gal. of sewage for 24 hours would be about $36. A flow of 1 m.g.d. would be the normal rate of application to a standard filter of about 0.5 acre in area. The effective period of a DDT dosage of 1 p.p.m. applied for 24 hours is somewhat indefinite but should be at least 15 days. The cost of a batch dosage of DDT, as recommended by Lt. Brothers, applied to a 6-ft. deep filter of 0.5 acre area would be about $93, but such a treatment is shown to be effective for 30 days. These cost estimates are conservatively high and it is quite likely that the unit prices of the ingredients of the emulsion will become much more favorable as time passes.

The work of Capt. Carollo, an engineer, and Lt. Brothers, an entomologist, recalls attention to the great range of scientific interest that is represented in the art of sewage treatment. Problems of entomological character are sufficiently common and perplexing in the sanitary engineering field in general to suggest that more attention should be invited from specialists in entomology. The Army Sanitary Corps recognized this fact during World War II and profited greatly thereby.

These studies show definitely that DDT has promise as a positive control of the filter fly problem and it is hoped that further plant scale work will proceed from the excellent experimental foundation that has been laid by Lt. Brothers and Capt. Carollo. Elimination of the need of provision for flooding of trickling filters would remove design complications and reduce construction costs; the flooding procedure is in itself most objectionable from an operation standpoint and will be gladly dismissed from standard practice at the first opportunity. Before DDT can be accepted as the final answer, however, there must be certainty that the dosages used will not be hazardous to aquatic life or to downstream users of outlet watercourses. The costs involved may also be a deterrent but it is believed that this factor is of only temporary significance.

Then too, there are already rumors that even more efficient insecticidal chemicals than DDT are on the way. Mr. *Psychoda*, your future is indeed dubious!

FEDERAL POLICY ON PUBLIC WORKS

One of the most important obstacles confronted by municipal officials in their planning of public works has been the lack of a definite Federal policy as to Federal subsidization of such construction. The following extracts from President Truman's "Message on the State of the Union," presented to Congress on January 21, are pertinent:

"In resuming public works construction, it is desirable to proceed only at a moderate rate, since demand for private construction will be abnormally high for some time. Our public works program should be timed to reach its peak after demand for private construction has begun to taper off. Meanwhile, however, plans should be prepared if we are to act promptly when the present extraordinary private demand begins to run out. . . .

"State and local governments also have an essential role to play in a national public works program. In my message of September 6, 1945, I recommended that the Congress vote such grants to State and local governments as will insure that each level of government makes its proper contribution to a balanced public construction program. Specifically, the Federal Government should aid State and local governments in planning their own public works programs, in undertaking such projects related to Federal programs of regional development, and in constructing such public works as are necessary to carry out the various policies of the Federal Government.

"Early in 1945 the Congress made available advances to State and local governments for planning public works projects and recently made additional provision to continue these advances through the fiscal year 1946. I believe that further appropriations will be needed for the same purpose for the fiscal year 1947. . . . *It* (Congress) *is now considering legislation which would expand Federal grants and loans in several other fields, including construction of airports, hospital and health centers, housing, water pollution control facilities, and educational plant facilities.* I hope that early action will be taken to authorize these Federal programs.

"*With respect to public works of strictly local importance, State and local governments should proceed without Federal assistance except in planning.* This rule should be subject to review when and if the prospect of highly adverse general economic development warrants it. . . . Our long-run objective is to achieve a program of direct Federal and Federally assisted public works which is planned in advance and synchronized with business conditions. . . ."

The key to the present situation as it applies to Federal financial aid to municipal sewage works projects is in the two sentences above that we have italicized for emphasis. The final answer depends upon the action of Congress on the Federal pollution control legislation now under consideration; if this legislation fails of enactment, or if the loan and grant provisions are deleted before passage, municipal sewage works projects will be among those "of strictly local importance" to which the President makes reference in the last paragraph of the quotation.

W. H. W.

Proceedings of Member Associations

CANADIAN INSTITUTE ON SEWAGE AND SANITATION

Twelfth Annual Convention

Windsor, Canada, November 5–6, 1945

The Twelfth Annual Convention of the Canadian Institute on Sewage and Sanitation was held November 5 and 6, 1945, at the Prince Edward Hotel, Windsor, Ontario. Registration reached 300, slightly less than last year but a more representative figure.

The meeting was called to order by President R. J. Desmarais at 10:00 A.M. for the first contribution, which was a discussion guided by Nicol MacNicol on "Construction and Maintenance of Private Drain Connections." Other papers presented in this session were: "Sludge Disposal Practices," by Clarence W. Hubbell, Consulting Engineer, Detroit, Mich., with discussions by R. A. Greene, Chemist of the Jackson, Michigan, sewage treatment plant, and L. V. Garrity, Asst. Supt., Dept. of Water Supply, Detroit, Mich.; "Sewage Pumping Stations," by W. S. Lea, Consulting Engineer, Montreal; "Certification of Water and Sewage Plant Operators," by W. F. Shephard, Chief of the Division of Sewerage and Sewage Treatment, Michigan Department of Health; and a discussion guided by W. L. McFaul on "Personnel Problems in Municipal Administration."

Immediately following the President's Reception and Banquet, Dr. A. E. Berry presented the Federation's Membership Award, a $100 Series E. Victory Bond, to B. F. Lamson, St. Catharines, Chairman of the Membership Promotion Committee, who received the award on behalf of the Institute, which recorded an increase of 72 members and boosted its position in the Federation from sixth to fourth largest Member Association in size. The entertainment that followed was under the auspices of the Canadian Sanitation Equipment Association.

The Tuesday business session was opened with a report by Secretary-Treasurer Berry. Officers elected to serve during 1945–46 were:

President: H. S. Nicklin, Guelph

Vice-President: Nicol MacNicol, Forrest Hill

Trustees: C. G. R. Armstrong, Windsor; G. H. Richards, Brantford; David Jack, Kingston; T. M. S. Kingston, Chatham

F.S.W.A. Director: Stanley Shupe, Kitchener

At the luncheon an interesting and informative address on the construction of the Alaska highway was given by J. Lance Rumble of General Motors of Canada, Limited.

The meeting was concluded with an inspection trip to the Detroit sewage treatment plant.

A. E. Berry,
Secretary-Treasurer

GEORGIA WATER AND SEWAGE ASSOCIATION

Fourteenth Annual Meeting

Atlanta, Ga., December 4, 1945

The Fourteenth Annual Meeting of the Georgia Water and Sewage Association was held at the Georgia School of Technology, Atlanta, on December 4, 1945. The Georgia Department of Public Health was a co-sponsor of the meeting with the association and the college. The program was limited to one day only, instead of the 3-day short course ordinarily held, because of the hotel situation in Atlanta. Total registration was 138.

Col. Blake R. Van Leer, President of the Georgia School of Technology, welcomed the association with a brief address in which he urged water and sewage works personnel to give additional emphasis to public relations activities, toward the end that they may assume positions of leadership in their communities. He pointed out that such leadership in public health functions was of utmost importance in Georgia because the high incidence of disease in the state has been a strong deterrent to economic development. In responding, association President Grady Wylds acknowledged the sponsorship and cooperation of the state and school officials in advancing the interests of the association and pointed to the technical advancement and improved relationship between state and municipal officials as evidence of the value of the annual meetings.

In his address "The Water Works and Sewerage We Want—and Will Have," W. H. Weir, Chief Engineer of the Georgia Department of Public Health, outlined the individual steps essential to the development of water and sewage facilities and discussed each step in detail. He submitted a general check list for the guidance of those concerned with immediate and future planning. In discussion of Mr. Weir's remarks, H. S. Sanders of the Atlanta office of the Federal Works Agency described the provisions made for loans to municipalities for public works planning under the Reconversion Act and outlined the details of procedure in filing of applications.

N. S. Chamberlain of Wallace and Tierman Company, Inc., spoke on "Chlorination of Water and Sewage," discussing in detail the newer concepts of chlorine residual and the differentiation between free available chlorine, chloramine residual and false color in the orthotolidine reaction. There was intense interest in this topic and a long and informative discussion followed.

In the afternoon, the subject "Present Trends in the Sewage Works Field" was presented by W. H. Wisely, Executive Secretary-Editor of the Federation of Sewage Works Associations. Mr. Wisely referred to the influence of the war on administrative and technical progress in the field and urged that the experience gained during the public works boom of the 1930's be drawn upon for guidance in the impending period of unprecedented activity in stream pollution abatement and control.

The technical session closed with open forums on water and sewage works operation problems, Messrs. N. M. DeJarnette and G. R. Frith of the State Department of Health serving as leaders of the respective discussions.

At the annual business meeting, the following officers were elected to serve for 1945–46:

President: W. D. Bryant, Griffin
First Vice-President: Comer Turley, Lindale
Second Vice-President: B. L. Coburn, Fitzgerald
Secretary-Treasurer: Van P. Enloe, Atlanta

Van P. Enloe,
Secretary-Treasurer

NORTH CAROLINA SEWAGE WORKS ASSOCIATION

Twenty-Fifth Annual Meeting

Charlotte, N. C., November 5–7, 1945

The 25th Annual Joint Conference of the North Carolina Sewage Works Association and North Carolina Section of A. W. W. A. was held at the Hotel Charlotte, Charlotte, N. C., on November 5–7, 1945. Total registration was about 300.

With Chairman E. M. Johnson presiding, a diversified technical program was offered on November 6 and 7 after the conference opened with an informal smoker on the evening of November 5. Two round table discussion periods were provided, during which water works and sewage works problems were considered in separate groups with R. E. Stiemke of Raleigh and H. E. Thompson of Chapel Hill leading the water works sessions and S. R. Kin of Camp Butner and D. Y. Brannock of Rocky Mount presiding over the sewage works discussions. A panel discussion on "Immediate Postwar Problems" in cluded presentations by Secretary H. E. Jordan of A. W. W. A. on "Disposal of Surplus War Property"; W. W. Brush, Editor of *Water Works Engineering,* and L. H. Enslow, Editor of *Water and Sewage Works,* who spoke on the postwar situation in general, and by W. H. Wisely, Executive Secretary of F. S. W. A., who discussed "Training of Operation Personnel."

At the banquet on November 6, announcements were made of the 1945 Kenneth Allen Award of F. S. W. A. to Col. Harold Benedict Gotaas and of the George W. Fuller Award of A. W. W. A. to James Wiliford Kellogg, Asst. Director, North Carolina State Laboratory of Hygiene. The accompanying citations were read by W. H. Wisely and H. E. Jordan, representing the respective national organizations. The feature of the banquet program was the address and pictorial presentation by Prof. H. G. Baity of the University of North Carolina in which he described the work of the Institute of Inter-American Affairs in developing public health and sanitation facilities in Brazil.

Vice-President W. R. LaDue of A. W. W. A. was the speaker at the luncheon on November 7, when the national officers of A. W. W. A. and F. S. W. A. in attendance at this meeting were honored. Mr. LaDue spoke of the current problems facing the water and sewage works fields and stressed the importance of public relations activity in each community.

Officers elected at the business meeting on November 6 were:

Chairman: L. I. Lassiter, Wilmington

Vice-Chairman: J. A. English, Salisbury

Secretary-Treasurer: Geo. S. Moore, Albermarle

F.S.W.A. Director: Geo. S. Rawlins, Charlotte

The following papers were included in the technical program:

"Cleaning of Cast Iron Water Mains," by J. L. Greenlee, Asst. Supt., Charlotte Water Dept.

"Plans for Developing the Division of Sanitary Engineering of the North Carolina State Board of Health," by J. M. Jarrett, Director

"Preliminary Work on Fluorescence of Drinking Water as Evidence of Sewage Pollution," by Miss Ruth McLean N. C. State Laboratory of Hygiene.

"Preliminary Report on North Carolina Plan for Fluorine Investigation and Control in Water Supplies," by L. G. Maddry, Sr., N. C. State Laboratory of Hygiene

"Modern Trends in the Sewage Works Field," by W. H. Wisely, Executive Secretary, F. S. W. A.

"Advantages of Cement Linings for Cast Iron Pipe," by Thos. F. Wolfe, Chief Engr., Cast Iron Pipe Research Assn.

"Chlorination Terminology," by A. E. Griffin, Technical Service Div., Wallace and Tiernan Co., Inc.

"Co-operative Health and Sanitation in the Americas," by Col. Harold B. Gotaas, President, Inst. of Inter-American Affairs

"Stream Pollution Control in North Carolina," by Capus Waynick, Member N. C. State Stream Sanitation and Conservation Committee

"Stream Pollution Control in Tennessee," by R. D. Farrell, Director, Div. of Sanitary Engineering, Tennessee Dept. of Public Health

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NORTH DAKOTA WATER AND SEWAGE WORKS CONFERENCE

Seventeenth Annual Convention

Fargo, N. D., November 8–9, 1945

The 17th Annual Convention of the North Dakota Water and Sewage Works Conference was held November 8 and 9, 1945, at the Gardner Hotel, Fargo, North Dakota, with 125 members and guests attending. President Floyd Pinney of Fargo presided.

Following the opening business session on Thursday morning, Col. George Toman, Consulting Engineer, Mandan, North Dakota, had his paper "Observations of England's Water and Sewage Systems" read by Mr. K. Piper.

During the afternoon and the next morning, the following papers of interest to the sewage works field were presented:

Mr. John B. Kleven, Sewage Works Superintendent, Grand Forks, North Dakota, discussed the design and operation of clarifiers.

"Future Water Developments in North Dakota" was discussed by Lewis T. Orlady, Member of the North Dakota Water Conservation Commission, in which he brought out clearly the water needs of the State, not only from the point of water supply but sewage disposal as well.

Major Glen Hopkins, Sanitary Engineer, U. S. Public Health Service, Kansas City, Missouri, discussed the U. S. Public Health Service Sanitation Facilities Survey, which is now being conducted.

Professor A. M. Cooley, University of North Dakota, Grand Forks, presented a paper on "Phenol Limits in Sludge Digestion," covering the research work done in this field at the University. A pilot plant for the production of hydrogen from lignite coal discharged phenol concentrations into the Grand Forks municipal sewer, causing difficulties in operating the digesters at the sewage treatment plant and resulting in the necessity of the above research work.

"Planning Water and Sewage Systems" was discussed by Mr. L. W. Burdick, Consulting Engineer, Lium and Burdick, Grand Forks, in which he covered in considerable detail the ground work necessary for any municipality that contemplates water and sewage improvements.

The noon luncheon on November 9, followed by the business session at which it was recommended that the election of a director to the Federation representing the Dakota Section be left to the South Dakota Water and Sewage Works Conference.

Officers elected by the North Dakota Water and Sewage Works Conference for 1946 were: *President,* S. K. Svenkeson, Minot; *Vice-President,* John Kleven, Grand Forks; *Secretary-Treasurer,* J. H. Svore, Bismarck; *Directors,* Harley Quam, Lisbon; R. J. Lockner, Cooperstown; George Toman, Mandan; and M. O. Thomas, Minneapolis, Minnesota.

Jerome H. Svore,
Secretary-Treasurer

OKLAHOMA WATER AND SEWERAGE CONFERENCE

1945 Annual Meeting

Norman, Oklahoma, November 1–3, 1945

The annual meeting of the Oklahoma Water and Sewerage Conference was held November 1, 2 and 3, 1945, at Norman, Oklahoma, with 40 members and guests attending. President Frank S. Taylor presided.

After an address of welcome by Hon. Verne Thronton, Mayor of Norman, the first day was dedicated to the following papers pertaining to the water works field: "The Importance of Survey and Testing for New and Established Well Water Supplies," by E. W. Reed, Engineer with the U. S. Geological Survey at Norman, in which he indicated that extensive study should be made before trying to locate productive water wells; "Potential Value of Surface Waters of Oklahoma for Industrial and Municipal Supplies," by Clarence Burch, Director of the Division of Water Resources of the Oklahoma Planning and Resources Board; "Laying out the Water Distribution System," by M. Elbert Mills, Professor of Civil Engineering at the University of Oklahoma; "Water Supply in the Navy," by Lt. C. M. Roberts, N. A. T. T. S., gave an interesting insight to military water problems; and "Relationship of U. S. Public Health Service with the Municipal Water Supplies," by C. H. Atkins, U. S. P. H. S. Sanitary Engineer of Kansas City. The day's program ended with moving pictures from the Oklahoma University Extension Library which were shown at a dinner held in the Woodruff Room of the Union Building.

The Friday program was opened with the paper "Unaccounted for Water," by C. E. Bretz, Consulting Engineer with V. V. Long and Company at Oklahoma City, followed by "The Transformation of Hydraulic Energy," by Edward R. Stapley, Acting Dean of the Engineering School at Oklahoma A. & M. College at Stillwater.

The paper "Fresh Water Algae" was presented by Glen C. Couch, Professor of Plant Sciences at the University of Oklahoma, and Dr. M. E. Griffith, Sanitary Engineer, U. S. P. H. S., followed by "Army Sewage Treatment," by Kenneth Cash, Plant Supervisor of the Fort Sill sewage treatment plant. The session ended with a description of the Norman sewage treatment plant by Tony Morrow, Plant Operator.

Inspection trips were made to the South Base, Norman Naval Air Technical Training Station and the water and sewage treatment plants of Norman in the afternoon of the second day of the conference.

The Saturday morning program included the papers "Fundamental Water Chemistry" by Dr. O. M. Smith, Professor of Chemical Engineering, Oklahoma A. & M. College; "The Importance of Sanitation in Society," by Dr. Gertrude Nielson, Cleveland County Health Department; "Personnel Supervision Training," by Perry Norris, State Supervisor of the Oklahoma State Department of Education; and "Cross Connections," by J. H. Highfill, City Chemist of Muskogee, with demonstrations by Ralph DeVore, Superintendent of the Norman Water Department.

Officers elected to serve during 1946 were:

President: Cecil Harrison, Enid

Vice-President: Ralph DeVore, Norman

Secretary-Treasurer: H. J. Darcey, Oklahoma City

Director: Edward R. Stapley, Stillwater

H. J. Darcey,
Secretary-Treasurer

SOUTH DAKOTA WATER AND SEWAGE WORKS CONFERENCE

Eleventh Annual Meeting

Mitchell, South Dakota, December 7, 1945

The Eleventh Annual Meeting of the South Dakota Water and Sewage Works Conference was held at the Lawler Hotel in Mitchell, South Dakota, on December 6–7, 1945. There was a total of 75 members and guests in attendance.

In the absence of President M. J. Hoy the meeting was called to order by W. F. Cochrane for the address of welcome and the technical program. The conference was welcomed to Mitchell by Judge Fred D. Shandorf.

The first contribution on the program was a message from the American Waterworks Association by Leonard N. Thompson, President.

Technical papers presented in the program were as follows:

"Recent Developments at the Sioux Falls Sewage Treatment Plant," by Leland Bradney, Supt.

"The Rapid City Sewer Extension Program," by V. L. Rugg of the office of Julian Stavens, Consulting Engineer.

"Notes on the Design and Operation of Small Sewage Treatment Plants," by Jerome H. Svore, formerly Director, Division of Sanitary Engineering, North Dakota State Dept. of Health.

"Surplus Property Utilization," Major Glen J. Hopkins, District 7, U. S. P. H. S., Kansas City, Mo. (presented by Capt. C. H. Atkins).

At the business meeting, the conference acted to endorse H.R. 4070 and S. 1462 as the most desirable type of Federal pollution control legislation now before Congress. The Secretary was directed to so inform all members of Congress presently concerned with this legislation.

The following officers were elected to serve during the year 1945–46:

President: John W. Emberg

Vice-President: Andrew A. Helgeson

Secretary-Treasurer: Quintin B. Graves

Directors: Don Wessel, Mobridge; Howard Connolly, Wall; C. J. Holborn, Mitchell; Leo Ney, Madison; P. S. Steffenson, Aberdeen; Leland Bradney, Sioux Falls

Federation Director: Quintin B. Graves

Quintin B. Graves,
Secretary-Treasurer

MEMBER ASSOCIATION MEETINGS

New Jersey Sewage Works Association	Stacy-Trent Hotel, Trenton, N. J.	March 20–22
Montana Sewage Works Association	Finlen Hotel, Butte, Mont.	April 12–13
Arizona Sewage and Water Works Association	Tuscon, Ariz.	April
New England Sewage Works Association	Hotel Pickwick Arms, Greenwich, Conn.	May 17
Pacific Northwest Sewage Works Association	Gearhart Hotel, Gearhart, Ore.	May 22
Florida Sewage Works Association	Gainsville, Fla.	June 5–8
Central States Sewage Works Association	Purdue University, Lafayette, Ind.	June 13–14
Ohio Conference on Sewage Treatment	Hotel Mayflower, Akron, Ohio	June 20–21

Reviews and Abstracts*

Conducted by
GLADYS SWOPE
Mellon Institute of Industrial Research,
Pittsburgh 13, Pennsylvania

TNT Wastes from Shell-loading Plants—Color Reactions and Disposal Procedures. BY C. C. RUCHHOFT, M. LEBOSQUET, JR., AND WILLIAM G. MECKLER. *Ind. Eng. Chem.*, 37, 937–43 (October, 1945).

The problem of disposing of the waste waters from TNT melting kettles arose at several shell-loading plants. The waste is neutral, and contains α-TNT up to 100 p.p.m. and may contain up to 2 p.p.m. nitrotoluene sulfonates. Water containing 5 p.p.m. of TNT will kill fish and is considered unfit for human consumption.

The fact that TNT solutions in drainage ditches at shell-loading plants was red, while fresh TNT solutions are uncolored suggested that the waste was reacting or decomposing. This study, which was made to assist in the safe and economical disposal of the waste, was begun by studying the factors which cause the solution to develop a red color.

The intensity of the color produced in dilute solutions of α-TNT in natural waters is dependent on the following factors: concentration of TNT, concentration of normal carbonate or alkaline constituents of the water which raise the pH, temperature, and light conditions. The colored complex seems more stable than the α-TNT, and it is difficult to reverse the reaction, once the colored complex is formed. All water samples containing colored TNT must be examined for TNT in both forms. α-TNT solutions in tap waters of low alkalinity or polluted waters will remain uncolored for 100 days and longer in the dark at 20° C. α-TNT solutions in distilled water can be exposed to sunlight for long periods with the formation of only a trace of colored complex and without other decomposition. With relatively pure or polluted surface waters, from 40 to 55 per cent of α-TNT is converted to the colored form in 80 days at ordinary temperatures in intermittent sunlight. The percentage of colored TNT formed can be increased to 90 per cent or more in one day or less by increasing the alkaline constituents of the water and/or the temperature.

The conversion of α-TNT to the colored form is considered the principal reaction during prolonged storage of TNT solutions. During this reduction, however, there is a slow reduction of total TNT which depends to a large extent upon carbonate concentration or pH and light conditions. In the surface and polluted water samples tested, 65 to 75 per cent of the original TNT remained in one form or the other after 80 days in intermittent sunlight. In water containing 300 to 1,000 p.p.m. of normal carbonate 53 to 55 per cent of the TNT remained (largely in the colored form) after 36 days in intermittent sunlight. This decomposition reaction is considered too slow for practical application.

Concentrations of α-TNT above 1.0 p.p.m. have a retarding effect on the biochemical oxidation of sewage. There is little biochemical removal of TNT as the result of biochemical oxidation in dilute sewage. Colored TNT was equally as inhibitive as α-TNT to normal biochemical oxidation of organic matter during the carbonaceous stage. The study of colored TNT wastes indicated that no reduction of the color can be expected by natural biochemical oxidation in streams.

Raw domestic sewage at pH values of 7.2 to 7.8 removed concentrations of α-TNT

* It will be appreciated if Miss Swope is furnished all periodicals, bulletins, special reports, etc., which might be suitable for abstracting in THIS JOURNAL. Publications of public health departments, stream pollution control agencies, research organizations and educational institutions are particularly desired.

up to about 35 p.p.m. from solution in a 24-hour period. The quantity of TNT removed seems to depend upon the suspended organic matter in the sewage. The rate of anaerobic digestion of sewage solids is decreased considerably by the TNT absorbed. It was more difficult to remove colored TNT from solution during primary treatment of sewage than α-TNT.

Even with concentrations of α-TNT as low as 30 p.p.m. in sewage, activated sludge treatment requires aeration periods up to 24 hr. for 90 per cent removal of both TNT and B.O.D. Although colored TNT did not inhibit the process as much as alpha, it was not removed so readily.

Filtration experiments indicated that a black garden soil was best for removing TNT. Such soils might be expected to remove a total amount of TNT up to about 0.1 per cent of their weight. Colored TNT is removed more effectively by all soils than α-TNT. Alkalinizing the waste slightly with soda ash to convert the TNT to the colored form is advantageous for soil percolation. As the absorption capacity of the soil becomes exhausted, fresh water removed some of the absorbent TNT.

Dosing and mixing activated carbon into the waste were more effective in removing TNT than filtration through carbon. α-TNT was removed from solution more readily than the colored derivative. A satisfactory chemical treatment of TNT from shell-loading plants would involve holding the TNT in the alpha form, followed by treatment with activated carbon to remove it from solution. In practice the carbon may easily be mixed with the waste by a 15–30 minute contact period in a diffused air aeration tank. The carbon-treated waste would not have to be filtered but could be passed through a plain tank with a 24-hr. detention period, or into settling ponds of still larger capacity. Settling in this manner would remove 97 per cent of the carbon from the waste. The small amount of carbon lost in this manner would not be objectionable. The settled carbon sludge could be periodically removed from the settling basin for disposal on burning grounds. This procedure is considered practical for the volumes of waste discharged from shell-loading plants.

Richard D. Hoak

Treatment and Disposal of Waste Waters from Paper Mills. By B. A. Southgate. *The Paper Maker and British Paper Trade Journal,* **109**, TS 43–46 (June, 1945); **110**, TS 1–3 (July, 1945).

These two papers, the one in July being a continuation of the one in June, are valuable to the industrialist who may not be aware of the various methods of sewage treatment and of its application to industrial waste treatment.

Dr. Southgate devotes about one-half of his first paper to a résumé of the polluting effects of waste waters and to the general method of treating industrial waste waters. In this latter section, he takes up the various methods of sewage treatment such as sedimentation, chemical treatment, anaerobic digestion, activated sludge, and percolating filters, and considers where each of these processes may be applied to certain types of industrial wastes.

The chief pollutants of industrial wastes are (1) those which are toxic to fish life, (2) those which deplete the oxygen in the stream to which they are discharged, and (3) those which, when discharged into a stream, make it impossible to use the water of the stream as a source of water supply, (4) those which deposit large quantities of suspended matter on a bed of a stream, (5) those which cause growth of "sewage fungus" on a stream, and (6) those which cause discoloration and frothing in a stream.

"The chief polluting effects from the discharge of waste waters from paper mills are due to (1) organic matter, (2) suspended matter, and (3) alkali arising from the washing of the digested raw material. . . ."

The Royal Commission on Sewage Disposal in 1915 recommended that such waste waters should be treated to yield a liquid containing not more than 60 p.p.m. of suspended solids. In some parts of Great Britain, a more exacting standard is required: suspended matter not to exceed 30 p.p.m., biochemical oxygen demand (B.O.D.) not over 20 p.p.m.

In an industrial waste problem it is advisable to make a thorough survey of the various processes and of the volume and composition of the waste waters to which they give rise. Certain of these liquids can be treated more advantageously and cheaply when separated from the others. The author cites various examples to bring out this point. He suggests also the possibility of re-using some waste waters. All possible means of reducing the volume of polluting materials should be taken and then study the best method of treatment.

Under the heading, "Methods of Treatment of Waste Waters from Paper Mills," the sub-headings are:

Character of Waste Waters
Re-use and Recovery of Soda from Washing Waters
Re-use of Back Water
Treatment of Mixed Waste Waters

"The paper industry is one in which conditions and methods of operations differ considerably from mill to mill, and there are corresponding variations in the volume and character of the waste waters discharged. . . ."

During the war, straw and wood were substituted for esparto (used generally in England). The Water Pollution Research Laboratory investigated one mill in 1944 in which they were allowed to quote figures:

"At this mill, in 1944, the weight of raw materials used per day was about 9 tons of straw, 7½ tons of wood, 1¼ tons of rags, making a total of about 18 tons. Straw and wood, after digestion, were washed once with hot water, which was then mixed with the spent lye for evaporation. Subsequent washings with cold water were discharged with the waste waters. None of the spent lye or washings from the digestion of rags with caustic soda was evaporated. The waste waters could be divided into three groups:

(a) Spent liquors and washings from digestion of rags, and cold washings from straw and wood. The total volume of these liquids was about 18,000 gal. per day. The mixed liquor contained nearly one per cent of alkali (as Na_2CO_3), and had an average B.O.D. of about 4,600 p.p.m. . . .

(b) Waste waters mainly from potchers and concentrators. . . ." Volume about 100,000 gal. per day, substantially neutral and had an average B.O.D. of 250 p.p.m.

(c) "Waste waters from paper-making machines. These liquids were neutral or slightly alkaline in reaction and had a B.O.D. of from 30–190 p.p.m.; the volume was large (about 6,000–19,000 gal. per hr.), but this was partly due to a breakdown, a large proportion of the liquid usually being circulated."

"The total volume of waste waters at the time of the survey was thus about 540,000 gal. per day, equivalent to 30,000 gal. per ton of raw materials. This liquid, after receiving a certain amount of treatment by sedimentation, had an average B.O.D. of about 230 p.p.m. . . ."

The spent lye and washings of the digested material was the most alkaline and most difficult to treat.

The alkaline liquors from the washing of digested material should be re-used in the mill.

American literature is cited for the re-use of back-water.

Treatment of mixed waste waters is usually by settling in tanks or lagoons.

"Typical results from mills in Lancashire are given in Table I."

TABLE I.—Results of Treatment by Sedimentation of Waste Waters from Paper Mills (p.p.m.)

Type of Paper Manufactured	Total Suspended Solids		Volatile Dissolved Solids		Oxygen Absorbed from $KMnO_4$ in 3 min.	
	Crude Liquid	After Sedimentation	Crude Liquid	After Sedimentation	Crude Liquid	After Sedimentation
White paper	1390	16	270	140	48	4
Brown paper	370	4	110	120	24	4
Brown paper	2060	28	660	390	89	27
Brown paper	590	68	160	480	40	23
Wallpaper	480	50	280	370	25	20
Wallpaper	1090	130	580	420	47	22

TABLE II.—Effect of Treatment by Sedimenttaion of Waste Waters from a Paper Mill (results, except pH value, in p.p.m.)

	Crude Liquid	After Sedimentation
Suspended Solids	260–310	100
Total Volatile Solids	130–180	40
Biochemical Oxygen Demand	135–190	100–130
Oxygen Absorbed from $KMnO_4$ in 4 hr. at 26.7° C.	51– 64	47– 56
pH Value	7.1–8.1	7.6–7.7

In Table II are shown results obtained by the Water Pollution Research Laboratory from samples collected "from the inlet and outlet system of lagoons in which waste waters, mainly from paper machines, were retained for an average period of about 11 hours."

The concentration of suspended solids was reduced by about two-thirds, but there was comparatively little reduction in either the biochemical oxygen demand or in the value for oxygen absorbed from permanganate.

Chemical treatment has been used in England, the usual coagulant being alumino-ferric. Other substances have been tried such as lime, "plastic-clay," lignite ash, alum, ferric chloride, and treated starch. One plant used ferrous sulfate, the "washings from digested esparto and rags, from the preparation of bleach liquor, and from pulp after bleaching were mixed and were aerated and agitated in three tanks in series. . . ." About 30 p.p.m. of ferrous sulfate was added between the first and second tanks. Sludge was pumped back from a later stage in the process to help flocculation. Effluent from the tanks was settled in sedimentation tanks for 10 hours with the waste waters from the paper machines. Sludge from this settling tank was dewatered on a rotary vacuum filter. The final effluent from this settling tank, over a year, contained 26–66 p.p.m. suspended solids and 3–20 p.p.m. B.O.D. B.O.D. removal was attributed partly to the oxidizing influence of the free chlorine in the bleach liquors.

The results of tests made by the Water Pollution Research Laboratory on washings from the digestion of rags, wood, and straw, and including the washing from the potcher and concentrator are shown in Table III.

Treatment of paper mill wastes by percolating filters has been in use for a long time in England. Typical results are shown in Table IV.

"The liquid treated was from a mill making high-class paper from esparto, rag, and wood pulp. All the waste waters, with the exception of back-water from the machines, which was treated separately, were mixed and were passed through settling ponds (total capacity, 500,000 gallons) and then through two settling tanks (total capacity 230,000 gallons). The settled liquid (about

TABLE III.—Results of Treatment of Waste Waters from a Paper Mill by Addition of Coagulants and Sedimentation

Coagulant	Amount of Coagulant Added p.p.m.	Volume of Sludge (per cent)	pH Value of Supernatant Liquor	Oxygen Absorbed from Acid Permanganate in 4 hr. p.p.m.	Purification Based on Oxygen Absorbed from Permanganate (per cent)
None	—	—	>11	470	—
Ferrous sulfate	450	4	> 9.6	432	8
($FeSO_4 \cdot 7H_2O$)	900	13	8.8	290	38
	1800	23	7.1	245	48
Ferric sulfate	450	1	9.4	463	1.5
($Fe_2(SO_4)_3 \cdot 9H_2O$)	900	2	7.0	438	7
	1800	38	4.8	118	75
Ferric chloride	450	2	9.4	490	—
($FeCl_3$)	900	3	7.2	468	0.5
	1800	10(18*)	6.0	135	71
None	—	—	>11.0	448	—
Sulfuric acid (H_2SO_4)	1000	2(5*)	4.4	273	39

* Figures in brackets indicate additional volume of sludge risen to surface of liquid.

TABLE IV.—Results of Treatment of Settled Mixed Waste Waters from a Paper Mill in Percolating Filters*

Sample No.	Suspended Solids (p.p.m.)		Oxygen Consumed from N/8 $KMnO_4$ at 80° F. in 4 Hr. (p.p.m.)		5-Day Biochemical Oxygen Demand (p.p.m.)	
	Settled Crude Liquid	Liquid After Filtration	Settled Crude Liquid	Liquid After Filtration	Settled Crude Liquid	Liquid After Filtration
1	106	52	126	50	139	24
2	156	124	135	117	181	119
3	94	48	129	103	98	84
4	108	25	113	90	121	76

TABLE V.—Results of Treatment by Alternating Double Filtration in Small Fibers of Residual Washings from Digestion of Straw

(From Figures Supplied by Messrs. John Dickinson & Co., Ltd.)

Period of Experiment (Days)	Liquid Treated	Rate of Treatment (Gal. per day per cu. yd. of medium in 2 filters together)	Liquid Supplied to Filters	Effluent from First Filter	Final Effluent from Second Filter	Purification Effected (per cent)
38	9.5 vol. waste waters 0.5 vol. sewage	90	472	339	145	69
7	9.5 vol. waste waters 0.5 vol. sewage 10.0 vol. water	75	270	209	124	54
140	Ditto	50	263	115	35	87
27	Ditto	75	318	170	54	83

276,000 gallons per day) was then distributed in flushes on to percolating filters, each 51 ft. in diameter and 8 ft. deep. The filtering medium was clinker. The average rate of flow from the filters was about 120 gallons per cubic yard of medium per day. The degree of purification effected was not very high and the effluent was still comparatively polluting in character."

Another mill which used percolating filters but whose ponded effluent before passage to the filters had an alkalinity of over 2,000 p.p.m. showed substantially no reduction in suspended solids or B.O.D.

Results obtained by treating waste waters by alternating double filtration were much more gratifying. Analyses and reductions obtained are shown in Table V.

"It appears that fully satisfactory methods of treatment of waste waters from paper mills employing digestion, which would be applicable under the different conditions met with in the industry, have not yet been developed. The most hopeful line of attack appears to be first in developing methods for recovery of a greater quantity of soda from the comparatively strong liquors in the early stages of washing and thus reducing both the strength and alkalinity of the mixed waste waters. For the liquid necessarily discharged, the most promising methods of treatment at present available would appear to be sedimentation, possibly with use of coagulants, followed by biological filtration, or some system of aeration."

Gladys Swope

Industrial Waste Treatment and Control. By Loring F. Oeming. *American Journal of Public Health,* 35, 722–27 (July, 1945).

Experience in Michigan with industrial pollution and control measures applied in certain instances may be of value in solving problems elsewhere. Michigan's large brine resources has led to the manufacture of many products. After the extraction of the desired products the brine becomes a waste product, with chlorine in concentrations in excess of 200,000 p.p.m.

The problems created by disposal into streams are well known. Limited quantities have been injected into underground formations where a porous stratum can be found. The brine has also been used for laying dust on country roads. However, the greatest portion still finds its way into the streams. The most effective means at present for minimizing brine pollution is impounding and controlling the discharge during high stream flows.

Plants for the extraction of magnesium were constructed during the war at Ludington and Marysville, Michigan. At Ludington the waste brine is pumped through 12 miles of 14 in. pipe to an isolated region along the Lake Michigan shore. The material is discharged into the lake 600 ft. from shore in 16 ft. of water. Surveys of the lake area by means of a conductivity cell indicates that the brine did not diffuse, though the location of the outlet did provide the protection originally contemplated. The material has a specific gravity of 1.18 and appears to remain on the bottom in its original concentration. The brine layer has a thickness of one to three feet.

At Marysville large volumes of hydrochloric acid wastes are produced by the extraction of magnesium by electrolysis of the magnesium chloride produced at Ludington. These are discharged through a submerged multiple outlet pipe into the St. Clair River. Only a small part of the 200,000 c.f.s. discharge of the stream is needed for neutralization of the acid wastes. Breaks which have occurred in the diffuser line from time to time caused unequal distribution and zones of high acid concentration. Good results were obtained when the line was in good repair. Protection for downstream water supplies was provided at all times.

Phenolic wastes are objectionable because of taste and odor effects on the receiving water. In 1937 a large chemical plant at Midland, Michigan, constructed works for treatment of phenolic wastes by clarification and filtration trough blast furnace slag. With increased production extensions to the works were added two different times and by 1943 4,500 pounds of phenol were removed daily from an average daily flow of 15 m.g.d.

Synthetic rubber manufacture has given rise to additional pollution problems. Experimental treatment of thiokol wastes by aeration with diffused air and recirculation of sludge has met with some success. Cracking of alcohol to styrene produced wastes which are odor producing and toxic to fish life. The wastes have been studied at the Institute for Fisheries Research at Ann Arbor. Wastes resulting from the polymerization of butadiene and styrene to produce Buna S have been found to be the source of an odor problem in the water supply of Detroit.

Cyanide wastes are a constant threat to animal and aquatic life. Fish life is completely snuffed out at concentrations above 0.5 p.p.m. of CN. Impounding of wastes is an ineffective method of control. Removal of cyanide from solution as hydrocyanic acid gas by decomposition with sulfuric acid has been found a successful method. A recent process converts cyanide to non-toxic cyanate by the reaction with sulfur compounds. However, chlorination of such wastes reverses the reaction and restores toxic properties.

Chromium removal has been accomplished by application of ferrous sulfate, neutralization with lime, and removal of the precipitated chromium hydroxide.

Pollution control in the paper industry has been largely limited to fiber recovery and reuse of waste waters. It has been shown that fiber losses can be reduced to 1 per cent of paper production and waste flows to 20,000 gal. per ton of product. As a means of waste control the benefits are offset by opening up closed systems for discarge of wastes during mill cleanups and changes in grade and color of product. In some cases satisfactory stream conditions cannot be maintained by internal mill improvements alone and treatment of wastes by settling with or without chemical precipitation becomes necessary.

A good effluent in the case of board mill wastes has been obtained by flocculation with alum followed by sedimentation. Flotation methods have been employed at mills working with higher grade pulp. Further research is desirable on mill effluents containing de-inked and straw pulp wastes.

The paper industry is still faced with a serious problem in the treatment and disposal of sulfate and sulfite pulping process liquors. A research program covering all waste problems in the pulp and paper industry is being formulated by the National Council for Stream Improvement under sponsorship of the industry.

Wastes resulting from food dehydration have caused injury and odor nuisances in some locations. Potato dehydration wastes have been troublesome in Michigan. In one instance lye peeling and starch washer wastes were segregated and treated at the municipal treatment works. Fine screening and sedimentation was sufficient for the balance of the wastes. Disposal by seepage and evaporation is practicable in some climates.

T. L. Herrick

Current Developments in Waste Utilization. By Harold R. Murdock. *Ind. Eng. Chem.*, 37, 97–8 (advertising section, September, 1945).

This paper inaugurates a new department in *Industrial and Engineering Chemistry.* One or more phases of waste treatment and utilization will be discussed each month. The first four contributions are abstracted below.

Industry will always have the problem of disposing of its waste materials. New processes will produce new wastes as obsolescence overtakes older processes and their wastes. Wherever possible it is desirable to utilize wastes in the plant producing them because, in many cases, former wastes have become important by-products.

The rubber industry is cited as one which consumes its own wastes. Originally, as large piles of used tires accumulated, only the rubber tread was processed as reclaim and the carcasses were burned. Research, however, gradually developed methods whereby all of the used tire components could be reprocessed.

That industries not employing chemical processes can utilize wastes is illustrated by a phosphate rock mining company which prepares its product by wet-screening. The wash water, containing sand and fine phosphate particles, was formerly discharged to large lagoons to provide clarified water for reuse. Recently a mineral oil-oleic acid flotation agent was applied to the accumulated sediment and it was found that it would be economical to recover the wasted phosphate fines on flotation tables.

The utilization of wastes by industries other than those producing them has possibilities which are frequently overlooked. This application requires ingenuity, resourcefulness, insatiable curiosity, and a broad understanding of the processes used by other industries.

The successful operation of a mill for producing kraft wood pulp depends upon the efficiency of its chemical recovery process. Salt cake (anhydrous sodium sulfate) is the make-up chemical which is reduced to sodium sulfide for the pulp cooking liquor, and a company which was planning a new plant sought a cheap source of this substance. Oil refineries use caustic soda to remove hydrogen sulfide and organic sulfides from crude oil. The residual liquor is a dark, tarry solution containing an appreciable proportion of sodium sulfide. It has a foul odor and a high B.O.D.; where discharged to streams it causes serious pollution. It was found that this evil waste could be substituted for salt cake in the charge to the furnace in which the black liquor from the pulp digesters is incinerated to recover sodium carbonate and to reduce the sodium sulfate to sodium sulfide for preparation of fresh cooking liquor. In actual pulp mill operation the refinery waste served admirably; this experience suggests that similar opportunities exist in other industries.

Ind. Eng. Chem., 37, 105–6 (advertising section, October, 1945).

Disposal is not synonymous with pollution—it is improper disposal which causes pollution. Where an industry disposes of its waste prudently only the management of the plant is concerned; but where the surroundings are polluted the rights of others are affected and management cannot escape liability.

Disposal on land. Dumps serve a variety of industries for disposal of inert solid wastes which do not contain substances which will be leached into streams or ground water. Often it is prudent to store solid or liquid wastes and await an economical use for them.

Huge piles of calcium hydroxide have

accumulated from the manufacture of acetylene and in many localities this material has found profitable applications. Synthetic phenol plants produce enormous quantities of waste sodium sulfite and some manufacturers have stored this by-product in anticipation of an eventual market. The vast dumps of niter cake from the manufacture of nitric acid during the first World War were finally purchased by the kraft industry as a substitute for salt cake. In the same period, the process which was used to make acetone by fermentation also yielded twice as much butyl alcohol for which no important use was known. The alcohol was stored in tremendous quantity and many thought it foolish not to use it as a fuel, but when it was found to be a excellent solvent for quick-drying lacquers the foresight of management was vindicated.

Disposal into the air. Organic wastes which cannot be dumped without creating a nuisance are best burned under boilers or in incinerators. Refineries have constructed special steam generators to utilize high sulfur hydrocarbon sludges as fuel.

Ten per cent of the forests become sawdust before they become lumber, and the furniture industry wastes 25 per cent of its lumber as sawdust. Usually this waste is burned in open piles or under boilers but technology has developed a process whereby over 50 gal. of ethyl alcohol can be made per ton of sawdust. Lignin is a by-product, however, and without a use for this material the postwar economics of the process are questionable.

Spent gases are usually vented directly to the atmosphere but objectionable constituents can be removed by dust collectors, electrical precipitators, and suitable gas washers.

Disposal into streams. The increasing volume of pollutional matter discharged to streams frequently places an excessive burden upon them; but industry is a vital part of our economy and it must be given an opportunity to continue. Until satisfactory processes for waste treatment are developed, "it is advisable that an existing plant use the stream as the final disposal medium for liquid wastes from muncipality as well as industry."

Four classes of streams are delineated:

Class 1. Suitable for public water supplies with minimum treatment (disinfection).

Class 2. Suitable for recreation and to maintain healthy fish life. Normal filter

TABLE I.—Standards for Waters of Classes 1, 2, and 3

Stream Conditions	Class 1	Class 2	Class 3
Oil scum, floating solids or debris, except from natural sources	None	None	Moderate, localized
Color, p.p.m.	20	Amount of color and turbidity which can be removed by standard practice	Amount of color and turbidity which can be removed by advanced practice
Turbidity, p.p.m.	20		
5-day B.O.D., p.p.m.			
Monthly average	1.0	2.0	4.0
Maximum value	2.0	4.0	6.0
D.O., p.p.m.			
Monthly average	<7.0	6.5	5.5
Minimum value	7.0	5.0	4.0
Coliform group, monthly geometric av. M.P.N. per ml.			
Swimming	0.5	10	not approved
Water supply	0.5	50	200
pH	6.5–8.6	6.5–8.6	5.0–9.5

(*Abstractor's note:* The source of this classification is not given.)

plant operation will produce a satisfactory water supply.

Class 3. Not desirable for public water supply but can be treated by advanced methods. Not considered safe for swimming; will support acquatic life, but most desirable types of fish may be absent.

Class 4. Unsuitable for industrial or public water supply. Unfit for swimming and desirable acquatic life absent.

Ind. Eng. Chem., 37, 97–8 (advertising section, November, 1945).

This paper presents a brief discussion of Purdy's investigation, in 1916, of the efficiency of the tidal flats of the Potomac River in sewage purification and draws an analogy between that natural phenomenon and man-made processes.

All of the sewage of Alexandria, Va., flowed over the Huntington flat, a tidal region with an area of about 1.3 sq. miles. Two of the three streams entering the upper end were heavily polluted with sewage but the water leaving the area showed little evidence of pollution. As the tide rose, the sewage flowed over the flat, and, as there was no disturbance from wind or river currents, clarification was rapid. Deposition of organic matter provided food for acquatic plants and microscopic organisms, and the sunlight stimulated their growth, producing the oxygen which transformed the sewage into stable, nontoxic compounds. Purdy's work showed oxygen values of 103 per cent of saturation on sunny days, and 75 per cent on cloudy days. Values of 128 per cent were recorded on particularly favorable days. Water leaving the flat on the ebb tide in the morning was 83 per cent saturated.

Here, evidently, was an efficient natural waste disposal plant in which all the factors necessary for carrying out the growth cycle were present. The sewage was the fertilizing agent for the vegetation; the flat comprised a reaction chamber; the sunlight was the energizing force which ultimately transformed the decaying organic matter; and the tides served as automatic pumps to move the water in and out of the reactor.

The activated sludge and the trickling filter processes simulate the natural phenomenon. Although these are not utilization processes more attention should be given to actual utilization of the organic chemicals which result from the biological conversion of sewage. New adsorption chemicals and developments in organic chemistry in the war should be combed carefully with this purpose in mind; the field is almost unexplored.

The case of a steel plant is cited in which the necessity for a larger industrial water supply led to the construction of a plant for processing 50 m.g.d. of trickling filter effluent from a nearby city. Other industries are similarly using sewage plant effluents, but real opportunity lies in utilization of the chemicals in processed sewage.

Ind. Eng. Chem., 37, 97–8 (advertising section, December, 1945).

Lagoons frequently serve as a useful means for disposal of industrial wastes. A depth of five feet is considered to be the maximum to take full advantage of sunlight. Such lagoons offer the possibility of complete treatment at relatively low operating costs for wastes containing low percentages of soluble substances. Disposal of certain organic wastes in lagoons has been hindered by the nuisance of insect pests which propagate in the wastes, but new chemicals, such as DDT, for control of insects herald a new interest in this type of treatment. Sodium nitrate, sodium chlorite, and other chemicals have recently been found effective for odor control.

Retention lagoons are the simplest type and they are used merely as storage basins for untreated wastes which are purged into streams during high water freshets. Wastes should always be screened through 20–40 mesh screens to remove bulky solids, but if the suspended matter is finely divided it should be settled out in a tank ahead of the lagoon. Purging of lagoons should be frowned upon in the interest of riparian rights.

Absorption lagoons are employed where the soil is sufficiently porous to permit percolation of the liquors into the earth. The sandy soil of the citrus belt in Florida is excellent for absorption lagoons, but in many other localities such installations eventually fail through clogging of the soil or the appearance of outcrops of the liquor at some distance from the lagoon. Where the wastes can be given a preliminary chemical treatment before discharge to the lagoon, operating efficiency is often improved.

Where a high degree of purification is required, processing lagoons, which provide both chemical and biological treatment, are often quite satisfactory where adequate land is available.

The most important specifications for material to be discharged to a stream are that it must not be toxic to plant or animal life, and that it must be chemically stable to the stream environment. Stability has been attained in processing lagoons handling cannery wastes through addition of sodium nitrate. This salt provides oxygen for aerobic decomposition; it stimulates the growth of chlorophyll-containing organisms; and it maintains a mild alkalinity in the lagoon. The amount of sodium nitrate used is equivalent, in terms of oxygen, to 20–25 per cent of the 5-day B.O.D. of the waste.

The Sulphite Pulp Manufacturers' Committee recently reported on the reaeration of rivers used for the disposal of waste sulfite liquors. Large amounts of air were diffused into the river to supply the oxygen deficiency; in this case the entire river served as a processing lagoon. The use of liquid oxygen for this purpose is suggested.

Sodium chlorite has been used to the extent of 28 per cent of the B.O.D. of screened pea waste with outstanding results. Economically the process fails, but with a lower cost for this chemical it will find increasing use. The use of chemicals in solving difficult waste disposal problems is entering a new era. Processing lagoons will be found useful for this type of treatment.

RICHARD D. HOAK

Treatment of Camp Sewage and Laundry Waste Water by Alternating Double Filtration. BY E. V. MILLS, J. T. CALVERT AND G. H. COOPER. *The Surveyor,* 104, Feb. 9–16, 1945 (79–81, 97–100).

This article discusses the conversion of a single stage trickling filter plant to an alternate double filtration plant. The change was necessitated to deal with an increase in the quantity of sewage and laundry wastes at a military camp.

The plant originally consisted of four upward-flow sedimentation tanks with sludge hoppers, a dosing tank, four filters, each 95 ft. in diameter and containing 5 ft. of clinker 1½ to ¾ in. in size and equipped with 4-arm revolving distributors, two humus tanks, and 1,600 sq. ft. of sludge drying beds. Provision was not included for sludge digestion. The flow to the original works was about 250,000 gal. per day, about one-fourth of which was delivered by gravity, the remainder being pumped to the plant.

The plant treated a strong and greasy camp sewage.

The filters were loaded at the rate of about 45 gal. per cu. yd. per day. Spot samples of the effluent on three occasions gave B.O.D. values of 25, 126 and 30 p.p.m.

After eight months of operation, a portable laundry was installed at the camp. From this laundry about 10,000 gal. per day of waste water were discharged to the sewage works. The permanent base laundry was expected to discharge 10,000 gal. per hour. This increase in the volume of liquor to be treated at the sewage works necessitated modifications to the plant. It was decided that conversion of the plant to alternating double filtration would be more economical than increasing the filtration capacity.

The alterations consisted of adding a fifth upward-flow sedimentation tank of the same size and design as the four existing tanks and two additional sludge drying beds. The feed pipes to the filters were increased in size. The distributors were replaced by larger distributors with two arms. A pumping station, housing three centrifugal pumps operating from float switches, was constructed to pump settled effluent to the two pairs of filters. The final sedimentation tanks were not increased in capacity.

In starting up the converted plant, it was found that the underdrains of the filters were inadequate in capacity. They flowed full and ponded the filter to a depth of about 9 in.

The converted works were placed in operation in February and built up to the full efficiency within three months.

Analyses of the waste water from the laundry, as indicated by grab samples, showed suspended solids ranging from 540 to 1,860 p.p.m., B.O.D. ranging from 220 to 410 p.p.m., and ammonia nitrogen ranging from 2 to 10 p.p.m. The average volumetric load on the filters during the winter months was 71 gal. per day per cu. yd. of filtering medium. Results for an eight months period, from October through May, are shown below.

From October through February the filters were handicapped by poor ventilation from the underdrains. The results for March, April and May indicate the performance with the improved underdrainage.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
B.O.D., p.p.m.								
Primary Filter Influent	335	335	315	320	255	360	310	330
Settled Primary Filter Effluent	22	35	34	44.5	20	22	29	138
Settled Secondary Filter Effluent	10.5	6	12	7	6	2	6	5
Suspended Solids, p.p.m.								
Primary Filter Influent	83	139	161	125	143	146	198	96
Primary Filter Effluent	74	57	104	146	73	65	128	60
Secondary Filter Effluent	30	59	70	52	53	27	83	100
Ammonia Nitrogen, p.p.m.								
Primary Filter Effluent	45.5	43	41	44	37	42.5	47	55
Settled Primary Filter Effluent	15	18.5	19	16.5	17	15	12	22
Settled Secondary Filter Effluent	2	8	9	5	6.5	4	12.5	3
Nitrate and Nitrite, p.p.m.								
Settled Primary Filter Effluent	3	2.5	1	1.5	2.5	1	.5	3.5
Settled Secondary Filter Effluent	17	8.5	2.0	4.0	8.5	5.5	6.5	10.5

K. V. Hill

Efficient Detritus Settlement at Comparatively Small Sewage Treatment Works. By L. B. Escritt. *The Surveyor*, 104, 635–38 (October 26, 1945).

The writer points out that detritus removal, especially at small plants, has been a difficult process for a long time. Mechanisms are not usually included in small installations and the tanks suffer from neglect. In general, the tanks are designed of too large capacity. To meet these deficiencies the writer discusses in considerable detail the design of detritus tanks utilizing a constant velocity.

The principle involved in the constant velocity detritus channel is that at a velocity of ⅔ to 1 f.p.s. grit will settle and be washed by the scouring action of the sewage. To maintain a constant scouring velocity, C. B. Townsend, one of the early workers on detritus channel design, provided that the depth of flow should be controlled by a simple rectangular standing wave flume and then so formed the cross-section of the channel that at all depths of flow the velocity remained constant. This required the cross-section of the channel to have the shape of a parabola, the invert being level with the invert of the flume. The width of the parabola at water level at any rate of flow could be determined from the formula $X = 3Q/2H$, where Q equals the flow in c.f.s., H equals depth of flow in feet above the channel invert and X equals the width in feet at the water level.

Having determined the channel dimensions for maximum flow, the cross-section was then checked for daily peak flows. If the cross-section were too great and one which would permit solids to strand near the edges, conditions could be improved by forming the invert as two or more parabolic channels of the same depth as before, but with a total width equal to that required for one channel.

In the past detritus tanks and channels were designed for a capacity of one-fiftieth daily dry-weather flow. This basis of design frequently resulted in oversized tanks. The capacity of the constant velocity channel, being the product of the cross-sectional area and the length, varies from site to site; while the cross-sectional area depends on the rate of flow, the length depends upon such variables as the depth of flow, velocity of incoming sewage and detritus storage capacity.

Sewage should be screened before entering the detritus channel, the screens being proportioned to prevent the settling of grit.

Some additional length should be provided in the detritus channel to compensate for the turbulence of the incoming sewage. No accurate information is available on the length required. The length of channel required to settle the detritus is not subject to exact determination. After the turbulence of entry has subsided time must be allowed for the smallest particles to settle. At Mogden it was assumed that the smallest particle to be settled would subside at the rate of 1 ft. in 10 sec. For a velocity of flow of 1 f.p.s., the channels should not be shorter than 10 times their depth.

Additional channel length must be provided for storage of grit. The bulk of settlement occurs toward the inlet end of the channel. Continued deposit here tends to restrict the cross-sectional area, creating scouring velocities which eventually deposit an even depth of silt the whole length of the channel and any further settlement will be prevented. If the channel is long its capacity for storing silt is increased.

Sumps or catchpits are not desirable because they are contrary to the principle of constant velocity flow and there is always danger of settling organics at times of slack flow.

For the usual run of grit the writer suggests a detritus channel whose length is 32 times its maximum working depth. The depth of flow should always be sufficient to transport the largest organic solids and the channels should be designed to permit efficient cleaning with shovels or scoops.

The author cites numerous examples of detritus tank designs such as those at West Middlesex, Mogden, Wandle Valley and Chigwell which utilize parabolic or modified parabolic channels.

K. V. Hill

Intermittent Sand Filter Found Useful in Rural Sanitation. By Paul M. Holmes. *Civil Engineering,* 15, 284–85 (June, 1945).

The war program necessitated speedy construction of sewage treatment facilities for the huge industrial plants and for shifting population. In Ohio places of minor congestion had for many years been cared for satisfactorily by primary sedimentation and secondary treatment, usually intermittent sand filtration. It was felt that the efficiency of these devices could be greatly improved by a better method of applying the settled sewage.

The final design composed rectangular tanks with 8 hr. detention, a dosing chamber, and a circular sand filter equipped with a rotary distributor as used in trickling filter installations. Using a five-day B.O.D. of 180 p.p.m. the rotary distributor type of sand filter was assumed capable of operating at a daily load of 200,000 gal. per acre, as against 100,000 gal. per acre for the old-type filter.

Filter shells were constructed of wood, masonry, or earth embankment. Floors were unpaved and sloped to 4-in. tile underdrains spaced on 10-ft. centers. A depth of 12 in. of coarse media was placed on the floor, and over this 30 in. of sand was provided. Originally a sand size of 0.30 to 0.45 m.m. was specified, but this was later revised to 0.35 to 0.50 m.m. Where flooding tendencies were encountered it was found that the sand size was actually 0.18 to 0.22 m.m. Best results were obtained with sand having an effective size of 0.45 m.m. and a uniformity coefficient of about 2.75.

The following table shows results obtained at five typical plants.

	No. 1	No. 2	No. 3	No. 4	No. 5
5-day B.O.D.					
Applied	425	666	319	555	326
Final	6.7	26	4	18	2
Dissolved Oxygen					
Applied	0.0	0.0	1.9	0.0	0.0
Final	7.9	2.8	8.1	6.5	7.5

At plants where the applied sewage was high in suspended solids more labor was required to maintain the high efficiency of the filters. Excessive deposits required bimonthly removal. Usually occasional hand raking was required to keep the filters in good working condition.

T. L. Herrick

The Evaluation of the Toxicity of Industrial Wastes, Chemicals and Other Substances to Fresh-water Fishes. By W. Brégy Hart, Peter Doudoroff and John Greenbank. The Atlantic Refining Company, Waste Control Laboratory, 8144 Passyunk Avenue, Philadelphia. June 12, 1945. 317 pp. + 14.

At the present time, considerable attention is being given to problems relating to stream sanitation and the conservation of wild life, particularly fish. In the minds of a great many sportsmen and other people, the principal evil of stream pollution is its adverse effect upon the aquatic fauna; and as an outgrowth of this concept, a great deal of work has been done from time to time in the study of the effect of certain constituents of industrial wastes and other types of wastes on fish life. An examination of the literature on this subject indicates that there is considerable dissimilarity in results reported by different investigators. It is apparent, in many instances at least, that these dissimilarities arise from a lack of uniformity of methods and test materials employed by the various investigators. That is to say, there has been a failure on the part of some workers to recognize the importance of such factors as temperature, pH, hardness of test water, and other phenomena in their effect on the results of the tests. It is apparent to the student of this particular phase of stream pollution investigation that it is very desirable that there be adopted a uniform method of testing and that this uniform method be carried out under as nearly as possible uniform conditions.

The book "The Evaluation of the Toxicity of Industrial Waste, Chemicals, and Other Substances to Fresh Water Fishes" is an attempt on the part of its authors to introduce such methods. As such, it may be regarded as a valuable contribution to the literature on the subject.

The authors of the book recognize that their project might be beset with certain difficulties caused by various reasons. In their foreword, it is stated that "The procedures for the evaluation of the toxicity of industrial wastes, various chemicals, and other substances is not presented without some trepidation. This should be understandable to all to whose attention it may come. We do not consider ourselves to be 'last word' authorities on the subject. Instead, we believe that we have perceived an urgent need, and, fortunately, we have been in a position to make a start in its fulfillment. We are convinced that just as any given chemical analysis must be performed in a certain specified manner and under stipulated conditions in order that the results may be recognized as valid in standard, so also must a bioassay, such as the biological evaluation of toxicity."

The essence of the authors' proposal is that there be adopted a standard procedure. It is stated that "A uniform method of expressing toxicity is essential if the values reported are to be comparable in any sense. That variations of procedure also may influence test results greatly has been demonstrated by researches of various investigators. Many of these variations not only interfere with some comparability of the test results but also may cause them to be unreliable. These variations can be restricted profitably without decreasing the usefulness of the test results in the solution of practical and other problems. Nor will compliance with these limitations involve any great difficulty. In those details of procedure, conditions, and equipment in which variation is without known influence upon the results, considerable freedom may be permitted."

It is proposed that in conducting toxicity or tolerance tests that one of two general procedures be followed. The first of these is the *standard evaluation.* It would require certain *standard requirements* as to test animals, experimental water, physical factors, etc. The second procedure is called a *reference evaluation* and is to be carried out under more highly standardized conditions than the standard evaluation. For example, a reference evaluation requires the use of "one of a limited variety of fresh-water teleost fishes designated as *reference test animals* at an experimental temperature which is not outside a *limited reference temperature range* and with experimental water which conforms with certain requirements and is designated as *reference water.*" The size of the reference test animals also is restricted within a specified range.

It is pointed out that a moderate amount of variation in results may be expected in using the standard procedure; the use of the reference procedure will decrease but not entirely eliminate such variations. Apparently the authors believe that the reference technique will eliminate causes for variation in results except those inherent in the test animals resulting from physiological or other biological factors over which, of course, there is no control.

In most cases the standard evaluation would be sufficient to cover the desired study. A few reference evaluations made in parallel to the standard test would serve to link the latter with similar tests conducted in the same or other laboratories.

It is further proposed that the toxicity of industrial waste, etc., be based on the determination of *"median tolerance limit* for samples of test animals under standardized conditions (and) for fixed time periods." This median tolerance limit, symbolized as TL_m is "that concentration of the substance under investigation at which just 50 per cent of the test animals used are able to survive for a specified period of time under the conditions of the experiment." The time periods used in the standard testing procedure may be 24 hrs., 48 hrs., or 96 hrs. The values to be determined, therefore, are the 24-hr. TL_m, 48-hr. TL_m, and 96-hr. TL_m. Of these, the 24-hr. TL_m is to be regarded as the basic index of relative toxicity while the 48-hr. TL_m and occasionally the 96-hr. TL_m may be determined in addition for the purpose of describing the toxicity more accurately and for suggested application to certain practical problems or when the 24-hr. TL_m may be found to be unsatisfactory.

After this preliminary presentation of their objectives, the authors discussed practically every aspect of the general problem, with suggestions as to procedure, treatment of material, etc. The more pertinent of these aspects follow:

Kind of test animal. A list of species of fish suitable for making standard evaluations and a second list for making reference evaluations are given. Generally speaking, those included in the second list are less tolerant inherently than those in the first list. It should be noted that in the extensive appendix, adequate information for the identification of all species of fish listed is given. The size of the test animals in relation to the size of the test container is discussed.

Water supply. Workers in toxicity studies know that the test waters to be used may constitute one of the most troublesome problems of any of those associated with such studies. The authors have discussed in considerable detail the nature and desirability of the various types of test waters to be used. The characteristics of suitable waters are described, and comment is made on the various characteristics.

Dissolved oxygen and carbon dioxide tension. Suggestions for maintaining a suitable dissolved oxygen level in the test waters are made. Oxygen requirements for standard tests and other types of tests are described. There is a short discussion of the problems relating to carbon dioxide tension.

Temperature. This factor, of course, is one of the most easily controlled of all factors affecting the results. The temperature levels for the standard test requirements are described as are those for the reference evaluations. There is a section on the acclimatization of test animals prior to their use.

Pertinent properties of the substance to be tested. There is a somewhat extensive discussion in which it is suggested that the substance to be tested be subjected to a critical preliminary examination before any toxicity tests are made. In this section, it is suggested that the nature of the toxic action, the volatility of the material to be tested, its stability, its oxygen-depleting characteristics, its latent toxicity, and other characteristics be examined.

Test solutions. There are extensive directions given for the collection and storage of samples to be tested, the expression and calculation of concentrations to be tested, the preparation of solutions, the methods of compensating for oxygen deficiency, and other problems.

Performing toxicity tests. This section is devoted to a description of the actual mechanics of conducting the tests.

Evaluation of toxicity. The authors discuss in great detail the methods which may be employed in interpreting test results. Suggestions are given which would insure a uniform method of reporting the results. Formulae for the calculation of safe biological concentrations of any particular waste on the basis of test results are given.

There is an extensive bibliography.

In conclusion, it is pertinent to quote another portion of the book's foreword: "We not only expect criticism and controversy; we invite it; for it is only in the light of critical thought that a project such as this can reach its full development. What we do not wish is either a blind acceptance or a dogmatic rejection of the proposed methods. Instead, we hope for a fair examination and trial producing comment and suggestions for improvement, out of which, we believe, will come the means for revision and true standardization."

WILLIS M. VAN HORN

Federation of Sewage Works Associations

1945

Annual Directory

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MEMBERSHIP SUMMARY

DIRECTORY OF MEMBERS

FEDERATION OF SEWAGE WORKS ASSOCIATIONS, INC.

325 Illinois Building, Champaign, Ill.

1945–46 OFFICERS

President: John K. Hoskins

Vice-President: Francis S. Friel

Treasurer: W. W. DeBerard

Executive Secretary-Editor: W. H. Wisely

Advisory Editor: F. W. Mohlman

PAST PRESIDENTS

Name	*Period Served*
Charles A. Emerson	1928–41
Arthur S. Bedell	1941–42
George J. Schroepfer	1942–43
A. M. Rawn	1943–44
Albert E. Berry	1944–45

HONORS AND AWARDS

Honorary Members

The qualifications for Honorary membership in the Federation are set forth in Article II, Section 4 of the By-Laws. Honorary Members are elected upon recommendation by a committee comprising the President and four latest Past Presidents, the senior Past President as chairman, in accordance with a policy adopted by the Board of Control on October 23, 1943. Honorary Members elected to date are as follows:

Charles Alvin Emerson	1941
Arthur S. Bedell	1942
Julius W. Bugbee	1942
Langdon Pearse	1942
Charles Gilman Hyde	1943
Howard Eugene Moses	1943
Floyd William Mohlman	1944
Willem Rudolfs	1945

The Harrison Prescott Eddy Medal

The Harrison Prescott Eddy Medal is awarded annually to a member of any Member Association of the Federation "for outstanding research contributing in important degree to the existing knowledge of the fundamental principles or processes of sewage treatment, as comprehensively described and published during any stated year in SEWAGE WORKS JOURNAL." The award commemorates Harrison Prescott Eddy, a famous engineer and a pioneer in the art of sewage treatment.

Past recipients of the award are:

Harry Willard Gehm	1943
John Raymond Snell	1944
Lloyd R. Setter	1945

The George Bradley Gascoigne Medal

The George Bradley Gascoigne Medal is awarded annually to a member of any Member Association of the Federation "for outstanding contribution to the art of sewage treatment works operation through the successful solution of important and complicated operational problems, as comprehensively described and published during any stated year in SEWAGE WORKS JOURNAL." This award is in memory of George Bradley Gascoigne, a prominent consultant from 1922 to 1940, who demonstrated an unusual interest in matters of sewage works operation.

Past recipients of this award are:

Kerwin L. Mick	1943
James T. Lynch and Uhl T. Mann	1944
John D. McDonald	1945

The Charles Alvin Emerson Medal

The Charles Alvin Emerson Medal is awarded annually to a member of any Member Association of the Federation "for outstanding service in the sewerage and sewage treatment works field, as related particularly to the problems and activities of the Federation of Sewage Works Associations in such terms as the stimulation of membership, improving standards of operational accomplishments, fostering fundamental research, etc." This award honors Charles Alvin Emerson, who served as President of the Federation from 1928 to 1941 and holds the distinction of being its first Honorary Member.

Past recipients are:

Floyd William Mohlman	1943
Willem Rudolfs	1944
Harold Warner Streeter	1945

The Kenneth Allen Award

Each Member Association of the Federation is privileged once in each three years to designate one of its members to receive the Kenneth Allen Award "for outstanding service in the sewerage and sewage treatment works field, as related particularly to the problems and activities of any Member Association." The award commemorates Kenneth Allen, an eminent engineer who made notable contributions to the creation of the Federation and the New York State Sewage Works Association.

Recipients of this award have been:

1943

Name	*Member Association*
Harry Thornton Calvert	I. S. P. (England)
Edward F. Eldridge	Michigan
John Kurtz Hoskins	Federal
Fred Merryfield	Pacific Northwest
Edward P. Molitor	New Jersey
Robert S. Phillips	North Carolina
Alfred Henry Weiters	Iowa
William Homer Wisely	Central States

1944

Name	*Member Association*
Alfred Edward Berry	Canadian
Van Porter Enloe	Georgia
Albert Legrand Genter	Maryland-Delaware
F. Wellington Gilcreas	New England
Charles A. Holmquist	New York
Dana Ewart Kepner	Rocky Mountain
Leon Benedict Reynolds	California
Wilson Waldo Towne	Dakota

1945

Name	*Member Association*
Howard Eugene Moses	Pennsylvania
George S. Russell	Missouri
Dario Travaini	Arizona
Frederick Holman Waring	Ohio
Joe Williamson, Jr.	Florida
Murray Alderson Wilson	Kansas

Convention Attendance Award

The Convention Attendance Award is in the form of a trophy which is presented annually to the Member Association which is credited with having aggregated the greatest number of man-miles in attending each Annual Meeting of the Federation. Permanent possession of the first trophy was won by the Central States Sewage Works Association in 1943, that organization having won the award for three consecutive years.

Central States Sewage Works Association	1941
Central States Sewage Works Association	1942
Central States Sewage Works Association	1943
Central States Sewage Works Association	1944

Membership Prizes

Prizes for membership activity in its various Member Associations have been awarded by the Federation since 1943. The following Member Associations have received these prizes:

Association	*Year*
Federal Sewage Research Assn. and Central States Sewage Works Assn.	1943
Missouri Water and Sewerage Conf. and Central States Sewage Works Assn.	1944
Arizona Sewage and Water Works Assn. and Canadian Institute on Sewage and Sanitation	1945

Quarter Century Operators Club

The Quarter Century Operators Club is an informal group comprising Active or Corporate Members of any Member Association who had been engaged in sewage treatment works operation, on a full-time resident basis, twenty-five years prior to the date of their admission into the Club. The Club was created in 1941 under the sponsorship of Frank Woodbury Jones, who serves as its registrar. The roster:

Reuben A. Anderson
Harry M. Beaumont
George C. Behnke
Julius W. Bugbee
Stuart E. Coburn
John R. Downes
Almon L. Fales
Wm. C. Hamm
Charles C. Hommon
Frank W. Jones
Roy S. Lanphear
John V. Lewis
C. D. McGuire
Paul Molitor, Sr., (*Dec.*)
Wm. M. Piatt
Theodore C. Schaetzle
Glenn Searls
John S. Simmerman
H. W. Streeter
S. L. Tolman

ANNUAL MEETINGS AND CONVENTIONS

Annual Meeting Number	*Location*	*Date*
1	Chicago, Illinois *	October 16, 1928
2	New York, New York *	January 18, 1929
3	New York, New York *	January 14, 1930
4	New York, New York *	January 22, 1931
5	New York, New York *	January 22, 1932
6	New York, New York *	January 19, 1933
7	New York, New York *	January 18, 1934
8	New York, New York *	January 18, 1935
9	New York, New York *	January 16, 1936
10	New York, New York *	January 22, 1937
11	New York, New York *	January 21, 1938
12	New York, New York *	January 20, 1939
13	New York, New York *	January 18, 1940
	Chicago, Illinois †	October 3–5, 1940
14	New York, New York *	January 15, 1941
	New York, New York †	October 9–11, 1941
15	Cleveland, Ohio ‡	October 22–24, 1942
16	Chicago, Illinois ‡	October 21–23, 1943
17	Pittsburgh, Pa. ‡	October 12–14, 1944
18	Chicago, Ill.*	October 17–18, 1945

DIRECTORY OF COMMITTEES

1945–46

Constitutional Committees

(*See Article VI of By-Laws*)

EXECUTIVE COMMITTEE OF THE BOARD OF CONTROL

J. K. Hoskins, *Chairman*

F. W. Lovett
F. S. Friel
Clyde C. Kennedy
Charles A. Emerson

GENERAL POLICY COMMITTEE

The General Policy Committee studies and recommends to the Board of Control upon all matters of policy affecting the well-being and usefulness of the Federation and its Member Associations; matters of public relations; the advancement of and the professional and social status of members, and such other matters of similar nature as may be referred to it by the Board.

A. E. Berry, *Chairman*

A. H. Niles
J. H. Brooks
A. S. Bedell
R. E. Fuhrman
M. LeBosquet
D. E. Bloodgood

* Annual business meeting of Board of Control.
† Convention of membership-at-large.
‡ Annual business meeting of Board of Control and convention of membership-at-large.

Publications Committee

The Publications Committee arranges the technical programs for the annual conventions of the Federation and has general supervision of all publications of the Federation.

F. W. Gilcreas, *Chairman*

Rolf Eliassen
Carl M. Green
C. C. Larson
F. W. Mohlman
F. M. Veatch
W. H. Wisely

Organization Committee

The Organization Committee examines and reports to the Board on applications for membership in the Federation and endeavors to encourage the formation of new regional associations or conferences eligible for membership.

Earnest Boyce, *Chairman*

C. R. Compton
R. H. Suttie

Sewage Works Practice Committee

The Sewage Works Practice Committee reviews and directs for publication any resolution, report or publication which establishes professional or technical standards in the name of the Federation.

Morris M. Cohn, *Chairman*

D. E. Bloodgood
J. H. Brooks, Jr.
R. F. Brown
J. R. Downes
G. P. Edwards
F. W. Gilcreas
H. F. Gray
K. V. Hill
C. E. Keefer
L. W. Van Kleeck
F. W. Mohlman
A. H. Niles
Langdon Pearse
W. H. Wisely
J. J. Wirts
Willem Rudolfs

Sub-Committee on Use of Sludge for Fertilizer

This sub-committee of the Sewage Works Practice Committee has the duty of compiling a Manual of Practice on "The Use of Sewage Sludge for Fertilizing Purposes." The manual is in a late stage of preparation and should be published in 1946.

A. H. Niles, *Chairman*

F. W. Gilcreas
Langdon Pearse
W. Rudolfs
T. C. Schaetzle
L. W. Van Kleeck

Sub-Committee on Occupational Hazards

This sub-committee of the Sewage Works Practice Committee has been assigned to compile a Manual of Practice on "Occupational Hazards in the Operation of Sewage Works." The manual has been completed and was distributed to the membership in December, 1944.

L. W. Van Kleeck, *Chairman*

S. H. Ash
Reuben F. Brown
Joseph Doman
Fred R. Ingram
L. L. Langford
L. E. West

Sub-Committee on Air Diffusion

This sub-committee of the Sewage Works Practice Committee has been charged with the duty of producing a Manual of Practice on "Air Diffusion in Sewage Treatment." The manual is in an early stage of preparation.

John J. Wirts, *Chairman*

W. A. Allen
A. J. Beck
A. A. Birger
H. A. Faber
C. T. Mickle
P. E. Morgan
F. C. Roe

Sub-Committee on Sewer Maintenance

This sub-committee of the Sewage Works Practice Committee has been directed to develop a Manual of Practice on "Maintenance of Sewers and Appurtenant Structures." The manual is in an early stage of preparation.

R. F. Brown, *Chairman*

Thos. B. Garry
W. H. Brown, Jr.
G. E. Fink
Grant Olewiler
R. L. Patterson
Henry Fitch
B. H. Grout
Roy E. Phillips
Richard Pomeroy
Robert P. Shea
John H. Brooks, Jr.
Forest Weber

Sub-Committee on Chlorination of Sewage

This sub-committee of the Sewage Works Practice Committee has been assigned the development of a Manual of Practice on "The Use of Chlorine in Sewage Treatment."

F. W. Gilcreas, *Chairman*

N. S. Chamberlain
A. E. Griffin
H. A. Faber

Sub-Committee on Standardization of Units

This sub-committee of the Sewage Works Practice Committee has been assigned to develop an approved schedule of units to be used in the reporting of plant operation and laboratory data. A committee of about forty members is at work.

Willem Rudolfs, *Chairman*

Sub-Committee on Trickling Filters

This sub-committee of the Sewage Works Practice Committee is engaged in the development of a Manual of Practice to be entitled "Trickling Filters—Their Characteristics and Loadings."

Kenneth V. Hill, *Chairman*

B. F. Hatch
W. S. Mahlie
Wm. E. Stanley
P. W. Riedesel

Sub-Committee on Sewer Ordinances

This sub-committee of the Sewage Works Practice Committee has been assigned the preparation of a Manual of Practice concerning the regulation and control of the usage of public sewers. The sub-committee is now in the process of organization.

D. E. Bloodgood, *Chairman*

Research Committee

The Research Committee has the function of stimulating research work among the various Member Associations, and of co-operating with other organizations in the promotion of research.

Willem Rudolfs, *Chairman*

H. E. Babbitt
D. E. Bloodgood
G. P. Edwards
H. A. Faber
A. J. Fischer
H. Heukelekian
A. L. Genter
H. J. Miles
F. W. Mohlman
C. C. Ruchhoft
L. R. Setter
L. W. Van Kleeck

Special Committees

Committee on Awards

The Committee on Awards was created by the Board of Control on October 11, 1941. Functions of the committee are to advise the Board on matters of award procedures and to make recommendations as to the annual winners of the Eddy, Gascoigne and Emerson Awards.

L. F. Warrick, *Chairman*

E. S. Chase
G. M. Ridenour
H. W. Streeter

Honorary Membership Committee

Authorized by the Board of Control on October 24, 1942, this committee comprises the President and four latest, living Past Presidents with the senior Past President as chairman. The committee reviews nominations for election to the grade of Honorary Member and makes recommendations to the Board on such nominations.*

A. S. Bedell, *Chairman*

G. J. Schroepfer
A. M. Rawn
A. E. Berry
J. K. Hoskins

Finance Advisory Committee

The Finance Advisory Committee was created by the Board of Control on October 11, 1941, and has the duty of advising the Board and officers of the Federation in financial matters.

W. J. Orchard, *Chairman*

A. E. Berry
J. K. Hoskins

* See *This Journal*, 16, 1, 196 (January, 1944).

Operation Reports Committee

The Operation Reports Committee was created by the Board of Control on October 11, 1941, to provide for Federation recognition of outstanding operation reports. The committee is now engaged in developing the mechanics of an annual award for such outstanding reports.

H. E. Babbitt, *Chairman*

Wm. A. Allen
W. F. Shepherd

Operator's Qualifications Committee

Authorized by the Board of Control on October 11, 1941, the Operator's Qualifications Committee is assigned to "establish minimal qualifications for operators of various classes of treatment works." The committee also has the duty of collecting and compiling data on present procedures in the licensing and certification of operators, for reference to Member Associations.

L. W. Van Kleeck, *Chairman*

Wm. A. Allen
E. P. Molitor

Industrial Wastes Committee

The Industrial Wastes Committee was created by the Board of Control on October 23, 1943, for the purpose of developing interest in this important field and to direct a program whereby the Federation may be of service in industrial waste problems.

F. W. Mohlman, *Chairman*

D. E. Bloodgood
H. W. Gehm
L. F. Oeming

Joint Committees With Other Associations

Committee on Standard Methods of Sewage Analysis

Created by the Board of Control on January 22, 1931, the Committee on Standard Methods of Sewage Analysis has functioned with committees of the American Water Works Association and American Public Health Association in the production of the Eighth Edition of the volume *Standard Methods of Water and Sewage Analysis.* The section on sewage analysis for the Ninth Edition was completed by the committee in 1943.

W. D. Hatfield, *Chairman*

G. E. Symons
S. E. Coburn
D. E. Bloodgood
A. J. Fischer
F. W. Gilcreas
R. D. Hoak
E. F. Hurwitz
Keeno Fraschino
W. S. Mahlie
H. Heukelekian
G. P. Edwards
E. W. Moore
M. Starr Nichols
Richard Pomeroy
C. C. Ruchhoft
Willem Rudolfs
T. C. Schaetzle
H. W. Gehm
R. F. Weston

Committee on Sewage Works Nomenclature

The Committee on Sewage Works Nomenclature was created by the Board of Control on January 22, 1937, to function with similar committees of the American Society of Civil Engineers and American Public Health Association. This Joint Committee on Definition of Terms Used in Sewerage and Sewage Disposal Practice is now engaged in the compilation of a "Glossary of Water and Sewage Control Engineering," in conjunction with the Joint Committee on Definition of Terms Used in Water Works Practice, which comprises the American Society of Civil Engineers, American Public Health Association and American Water Works Association.

C. J. Velz, *Chairman*

C. E. Keefer — C. A. Emerson

Committee on Water and Sewage Works Development

The Committee on Water and Sewage Works Development was organized in 1943 to promote the planning of water and sewage works and to encourage the inclusion of such projects in postwar planning programs. The committee comprises representatives of the Water and Sewage Works Manufacturers Association, American Water Works Association, New England Water Works Association and the Federation of Sewage Works Associations. Federation representatives are:

C. A. Emerson — G. J. Schroepfer

Special Convention Committees

Convention Management Committee

The function of this committee is to supervise details of the management of the Annual Meetings of the Federation.

A. E. Berry, *Chairman*

Stanley Shupe
W. H. Wisely
W. J. Orchard
A. T. Clark

Meeting Place Committee

This committee reviews invitations received for the Annual Meetings of the Federation and makes recommendations to the Board of Control in regard to the time and place of such meetings.

J. K. Hoskins, *Chairman*

F. S. Friel
A. E. Berry
W. H. Wisely
W. C. Sherwood
F. W. Lovett
A. T. Clark

Publicity and Attendance Committee

The function of this committee is to prepare publicity releases in connection with the Annual Meetings of the Federation and to direct the distribution of such material.

L. H. Enslow, *Chairman*

E. J. Cleary
M. M. Cohn
W. S. Foster
A. Prescott Folwell
J. P. Russell
J. A. Daly

SUMMARY OF MEMBERSHIP

(As at December 31, 1945)

Federation Members

Honorary Members	8
Associate Members	76
Member Associations	27
Active Members	3214
Alternate Active Members	31
Corporate Members	20

Net Membership of Member Associations*

Member Associations	Honorary	Active	Alternate Active	Corporate	Total
Arizona	—	24	—	—	24
Canadian	—	230	—	—	230
California	1	292	8	—	301
Central States	2	566	—	13	581
Dakota	—	46	—	—	46
Federal	—	98	—	—	98
Florida	—	70	—	—	70
Georgia	—	65	—	—	65
I.S.E. (England)	—	34	—	—	34
I.S.P. (England)	—	106	—	—	106
Iowa	—	43	—	—	43
Kansas	—	28	—	—	28
Maryland-Del.	—	30	—	—	30
Michigan	—	114	16	—	130
Missouri	—	41	—	—	41
Montana	—	29	—	2	31
New England	1	172	—	—	173
New Jersey	1	86	—	—	87
New York	1	499	7	1	508
North Carolina	—	51	—	—	51
Ohio	—	107	—	1	108
Oklahoma	—	10	—	—	10
Pacific Northwest	—	104	—	—	104
Pennsylvania	2	214	—	3	219
Rocky Mountain	—	64	—	—	64
San. Eng. Div. (Argentina)	—	6	—	—	6
Texas	—	85	—	—	85
Totals	8	3,214	31	20	3,273

* Not including Dual Members.

Directory of Members

December 31, 1945

MEMBER ASSOCIATIONS

Arizona Sewage and Water Works Association (Affiliated 1928).

Territory: State of Arizona.
President: E. S. Borquist; *First Vice-President:* Harold Yost; *Second Vice-President:* A. W. Miller; *Director:* G. W. Marx; *Secretary-Treasurer:* G. W. Marx, Division of Sanitary Engineering, Arizona State Department of Health, Phoenix, Ariz.

California Sewage Works Association (Affiliated 1928).

Territory: State of California.
President: Keeno Fraschina; *First Vice-President:* G. A. Parkes; *Second Vice-President:* Harold L. May; *Director:* Clyde C. Kennedy; *Secretary-Treasurer:* Harold H. Jeffrey, 112 City Hall, Sacramento, California.

Canadian Institute on Sewage and Sanitation (Affiliated 1933).

Territory: Dominion of Canada.
President: H. S. Nicklin; *Vice-President:* Nicol MacNicol; *Director:* Stanley Shupe; *Secretary-Treasurer:* A. E. Berry, Ontario Department of Health, Parliament Buildings, Toronto 8, Ontario, Canada.

Central States Sewage Works Association (Affiliated 1928).

Territory: States of Illinois, Indiana, Wisconsin and Minnesota.
President: W. D. Hatfield; *First Vice-President:* Capt. E. J. Beatty; *Second Vice-President:* P. W. Riedesel; *Third Vice-President:* Carl B. Carpenter; *Director:* C. C. Larson; *Secretary-Treasurer:* J. C. Mackin, Nine Springs Sewage Treatment Plant, Route 4, Madison 5, Wisconsin.

Dakota Water and Sewage Works Conference (Affiliated 1936).

North Dakota Section.

Territory: State of North Dakota.
President: S. K. Svenkeson; *Vice-President:* John Kleven; *Director:* Quintin B. Graves; *Secretary-Treasurer:* Jerome H. Svore, Division of Sanitary Engineering, State Department of Health, Bismarck, North Dakota.

South Dakota Section.

Territory: State of South Dakota.
President: John W. Emberg; *Vice-President:* Andrew A. Helgeson; *Director:* Quintin B. Graves; *Secretary-Treasurer:* Quintin B. Graves, Director, Division of Sanitary Engineering, State Board of Health, Pierre, South Dakota.

Federal Sewage Research Association (Affiliated 1930).

Territory: Federal employees wherever stationed.
President: J. H. LeVan; *Vice-President:* R. S. Smith; *Director:* M. LeBosquet, Jr.; *Secretary-Treasurer:* V. G. MacKenzie, U. S. Public Health Service, 2000 Massachusetts Ave. N.W., Washington 14, D. C.

Florida Sewage Works Association (Affiliated 1941).

Territory: State of Florida.
President: J. B. Miller; *Vice-President:* B. F. Borden; *Director:* David B. Lee; *Secretary-Treasurer:* J. R. Hoy, 402 Hildebrandt Bldg., Jacksonville, Fla.

Georgia Water and Sewage Association (Affiliated 1936).

Territory: State of Georgia.

President: W. D. Bryant; *First Vice-President:* Comer Turley; *Second-Vice-President:* B. L. Coburn; *Director:* H. A. Wyckoff; *Secretary-Treasurer:* Van P. Enloe, R. F. D. No. 5, Box 363, Atlanta, Georgia.

Iowa Sewage Works Association (Affiliated 1928).

Territory: State of Iowa.

President: Paul Winfrey; *Vice-President:* Charles Alexander; *Director:* John W. Pray; *Secretary-Treasurer:* Prof. L. O. Stewart, c/o Iowa State College, Ames, Iowa.

Institute of Sewage Purification (Affiliated 1932).

Territory: British Empire.

President: John Hurley; *Director:* John H. Garner; *Secretary:* W. F. Freeborn, 34 Cardinal's Walk, Hampton-on-Thames, Middlesex, England.

Institution of Sanitary Engineers (Affiliated 1932).

Territory: British Empire.

President: Guy Howard Humphreys; *Director:* Guy Howard Humphreys; *Secretary:* Mrs. E. M. Kerry, 118 Victoria St., Westminster, S.W. 1, London, England.

Kansas Water and Sewage Works Association (Affiliated 1935).

Territory: State of Kansas.

President: R. H. Hess; *First Vice-President:* Herman Weigand; *Second Vice-President:* F. D. Elliott; *Third Vice-President:* H. H. Huffman; *Fourth Vice-President:* Rex Reynolds; *Director:* Paul D. Haney; *Secretary-Treasurer:* Paul D. Haney, c/o State Board of Health, Room 2, Marvin Hall, University of Kansas, Lawrence, Kansas.

Maryland-Delaware Water and Sewage Association (Affiliated 1928).

Territory: States of Maryland and Delaware.

President: J. W. Alden; *First Vice-President:* Clarke Gardner; *Second Vice-President:* J. W. Engle; *Director:* Ralph E. Fuhrman; *Secretary-Treasurer:* Miss E. V. Gipe, State Department of Health, 2411 N. Charles Street, Baltimore, Md.

Michigan Sewage Works Association (Affiliated 1930).

Territory: State of Michigan.

President: Paul Stegeman; *Vice-President:* B. A. DeHooghe; *Director:* W. F. Shephard; *Secretary-Treasurer:* R. J. Smith, 545 Elizabeth St., East Lansing, Mich.

Missouri Water and Sewerage Conference (Affiliated 1929).

Territory: State of Missouri.

Chairman: Roscoe R. Howard; *Vice-Chairman:* V. P. Opie; *Director:* George S. Russell; *Secretary-Treasurer:* Warren A. Kramer, c/o State Office Bldg., Jefferson City, Missouri.

Montana Sewage Works Association (Affiliated 1944).

Territory: State of Montana.

Chairman: J. M. Schmit; *Vice-Chairman:* W. M. Cobleigh; *Director:* H. B. Foote; *Secretary-Treasurer:* H. B. Foote, Division of Sanitary Engineering, State Board of Health, Helena, Montana.

New England Sewage Works Association (Affiliated 1929).

Territory: States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut and Rhode Island.

President: George H. Craemer; *First Vice-President:* Thomas R. Camp; *Second Vice-President:* LeRoy W. Van Kleeck; *Director:* LeRoy W. Van Kleeck; *Secretary-Treasurer:* Walter E. Merrill, State Dept. of Public Health, 511A State House, Boston, Massachusetts.

New Jersey Sewage Works Association (Affiliated 1942).

Territory: State of New Jersey.

President: John Simmerman; *First Vice-Presirent:* L. J. Fontenelli; *Second Vice-President:* Edward P. Decher; *Director:* P. N. Daniels; *Secretary-Treasurer:* S. A. Kowalchik, 427 Maple Ave., Trenton 8, N. J.

New York State Sewage Works Association (Affiliated 1930).

Territory: State of New York.

President: Uhl T. Mann; *Vice-President:* Alexander G. Martin; *Director:* E. J. Smith; *Secretary-Treasurer:* A. S. Bedell, State Department of Health, Albany, N. Y.; *Assistant Secretary:* A. W. Eustance; *Assistant Treasurer:* J. C. Brigham.

North Carolina Sewage Works Association (Affiliated 1929).

Territory: State of North Carolina.

Chairman: L. I. Lassiter; *Vice-Chairman:* J. A. English; *Director:* W. M. Franklin; *Secretary-Treasurer:* Geo. S. Moore, P. O. Box 2251, Durham, North Carolina.

Ohio Sewage Works Conference (Affiliated 1932).

Territory: State of Ohio.

Chairman: D. D. Heffelfinger; *Vice-Chairman:* L. C. Hoffman; *Director:* A. H. Niles; *Secretary-Treasurer:* L. B. Barnes, 441 S. Prospect St., Bowling Green, Ohio.

Oklahoma Water and Sewage Conference (Affiliated 1929).

Territory: State of Oklahoma.

President: Cecil Harrison; *Vice-President:* Ralph DeVore; *Director:* E. R. Stapley; *Secretary-Treasurer:* H. J. Darcey, State Department of Health, Oklahoma City, Oklahoma.

Pacific Northwest Sewage Works Association (Affiliated 1933).

Territory: States of Washington, Oregon and Idaho.

President: C. V. Signor; *First Vice-President:* C. M. Howard; *Second Vice-President:* H. C. Clare; *Director:* M. S. Campbell; *Secretary-Treasurer:* Wm. P. Hughes, City Engineer, Lewiston, Idaho.

Pennsylvania Sewage Works Association (Affiliated 1928).

Territory: State of Pennsylvania.

President: L. D. Matter; *First Vice-President:* Wm. J. Murdoch; *Second Vice-President:* N. G. Young; *Director:* F. S. Friel; *Secretary-Treasurer:* Bernard S. Bush, District Engineer, Pennsylvania Department of Health, Kirby Health Center, Wilkes-Barre, Pa.

Rocky Mountain Sewage Works Association (Affiliated 1936)

Territory: States of Wyoming, Colorado and New Mexico.

President: John T. Franks; *Vice-President:* N. P. Nielsen; *Director:* W. V. Leonard; *Secretary-Treasurer:* Carroll H. Coberly, 1441 Welton St., Room 329, Denver 2, Colorado.

Sanitary Engineering Division, Argentina Society of Engineers (Affiliated 1936).

Territory: Republic of Argentina.

President: Emelio E. Sisto; *Director:* E. B. Besselievre; *Secretary:* Julio Cavicchia, Centro Argentino De Ingenieros, Buenos Aires, Republica Argentina, South America.

Texas Sewage Works Section (Affiliated 1928).

Territory: State of Texas.

Chairman: Major R. M. Dixon; *Vice-Chairman:* L. C. Billings; *Director:* W. S. Mahlie; *Secretary-Treasurer:* V. M. Ehlers, State Department of Health, Austin 2, Texas; *Asst. Secretary-Treasurer:* Mrs. E. H. Goodwin.

HONORARY MEMBERS

Bedell, Arthur S. (1942), Div. of Sanitation, State Dept. of Health, Albany, N. Y.

Bugbee, Julius W. (1942), Supt., Sew. Disp. Wks., 25, New York Ave., Providence, R. I.

Emerson, Charles A. (1941), Havens & Emerson, Woolworth Bldg., New York, N. Y.

Hyde, Prof. Charles Gilman (1943), Rm. 11, Engr. Bldg., Univ. of Calif., Berkeley, Calif.

Mohlman, Dr. Floyd W. (1944), 910 S. Michigan Ave., Chicago 5, Ill.

Moses, Howard E. (1943), 1522 N. Second St., Harrisburg, Pa.

Pearse, Langdon (1932), Chicago San. Dist., 910 S. Michigan Ave., Chicago 5, Ill.

Rudolfs, Dr. Willem (1945), Short Course Bldg., Agricultural Experiment Station, New Brunswick, N. J.

ASSOCIATE MEMBERS

Aluminum Co. of America, 2100 Gulf Building, Pittsburgh, Pa., Rep. C. E. Magill.

American Brass Co., Waterbury, Conn.

American Cast Iron Pipe Co., Birmingham, Ala., Rep. E. L. Gilder.

American City Magazine, 470 Fourth Avenue, New York, N. Y., Rep. Edgar J. Buttenheim, Pres. & Mgr.

American Concrete Pipe Assn., 228 N. LaSalle St., Suite 1033, Chicago 1, Ill., Rep. Howard F. Peckworth, Managing Dir.

American Well Works, Aurora, Ill., Rep. J. D. Walker, Sanitary Div.

Ampco Metal, Inc., 1745 South 38th St., Milwaukee 4, Wis., Rep. R. J. Thompson, Sales Mgr.

Armco Drainage Products Assn., Middletown, Ohio, Rep. W. H. Spindler, Publicity Mgr.

Automatic Control Co., 1005 University Ave., St. Paul 4, Minn., Rep. J. S. Williams.

Builders-Providence, Inc., Div. of Builders Iron Foundry, P. O. Box 1342, Providence, R. I., Rep. C. G. Richardson.

Cambridge Instrument Co., 3732 Grand Central Terminal, New York, N. Y., Rep. F. G. Paully.

Carter, Ralph B., Co., 192 Atlantic St., Hackensack, N. J., Rep. J. W. Van Atta.

Chain Belt Company, Milwaukee, Wis., Rep. W. B. Marshall, Sales Promotion Mgr.

Chapman Valve Manufacturing Co., 203 Hampshire St., Indian Orchard, Mass.

Chicago Pump Company, 2300 Wolfram St., Chicago, Ill., Rep. Milton Spiegel, Vice-Pres. & Gen. Mgr.

Clay Products Ass'n, 111 W. Washington St., Chicago 2, Ill., Rep. J. D. Cook, Secy.

Climax Engineering Co., Chicago Office, 111 W. Monroe St., Room 922, Chicago 3, Ill., Rep. E. D. West, Mgr.

Crane Company, 836 S. Michigan Ave., Chicago 5, Ill., Rep. G. W. Hauck, Mgr., Eng. Sales Section.

Dickey, Clay Mfg. Co., W. S., 607 Commerce Trust Bldg., Kansas City, Mo., Rep. A. G. Frerking, Vice Pres.-Sales Mgr.

Dorr Co., Inc., 570 Lexington Ave., New York, N. Y.

Dow Chemical Co., Midland, Mich., Rep. W. A. Melching.

Eimco Corporation, 111 W. Washington St., Chicago 2, Ill., Rep. Paul O. Richter, Mgr. Central Div.

Electro Rust-Proofing Co., 1026 Wayne St., Dayton 10, Ohio, Rep. E. H. Ingle, Gen. Mgr.

Engineering News-Record, 330 W. 42nd St., New York, N. Y.

Everson Manufacturing Co., 214 W. Huron St., Chicago 10, Ill., Rep. R. B. Everson, Pres.

Fairbanks, Morse & Co., 80 Broad St., New York 4, N. Y., Rep. Charles J. Prestler, Manager Pump Sales.

Flexible Sewer-Rod Equipment Co., 9059 Venice Blvd., Los Angeles, Calif., Rep. Peter L. Ciacco, Mgr.

Foxboro Company, Neponset Avenue, Foxboro, Mass.

Gale Oil Separator Co., Inc., 52 Vanderbilt Ave., New York City, Rep. Wm. A. Gehle, Pres.

General Chemical Co., 3357 W. 47th Place, Chicago 32, Ill., Rep. L. I. Birdsall, Technical Service Div.

Glamorgan Pipe & Foundry Co., Lynchburg, Va., Rep. John D. Capron.

General Electric Co., 1 River Road, Schenectady, N. Y., Rep. H. V. Crawford.

Graver Tank & Mfg. Co., Inc., 4809 Tod Ave., E. Chicago, Ind., Rep. G. V. Malmgren, Vice-Pres.

Green Bay Fdy. & Machine Wks., 401 S. Broadway, Green Bay, Wis., Rep. James P. North, Pres.

Gruendler Crusher & Pulverizer Co., 2915 N. Market St., St. Louis, Mo., Rep. Wm. P. Gruendler, Secy-Treas.

Hardinge Company, York Pa., Rep. M. C. Fleming.

Hersey Manufacturing Co., Corner of E and Second Sts., South Boston 27, Mass., Rep. Wm. C. Sherwood.

Homelite Corporation, Port Chester, N. J., Rep. Nelson Thompson.

Infilco, Inc., 325 W. 25th Place, Chicago, Ill., Rep. H. W. Gillard.

Iowa Valve Co., 812 Hubbell Bldg., Des Moines, Iowa, Rep. C. S. Howard, Vice-Pres. & Gen. Mgr.

Jeffrey Manufacturing Co., Columbus, Ohio, Rep. S. L. Tolman.

Johns-Manville Corporation, 22 E. 40th St., New York City, Rep. C. A. McGinnis, Mgr. Transite Pipe Dept.

Josam Manufacturing Company, 1783 E. 11th St., Cleveland, Ohio, Rep. Leo N. Newman.

Lakeside Engineering Corp., 222 W. Adams St., Chicago, Ill., Rep. R. O. Friend.

Limestone Products Corp. of America, Newton, N. J., Rep. Peter J. Kelley, Service Representative.

Link-Belt Company, 2045 W. Hunting Park Ave., Philadelphia, Pa., Rep. William L. Hartley.

Ludlow Valve Mfg. Co., P. O. Drawer 388, Troy, N. Y., Rep. Robert Bischoff.

Lynchburg Foundry Company, Lynchburg, Va., Rep. W. Ray Odor.

McNulty Engineering Co., 200 Old Colony Ave., South Boston, Mass., Rep. A. Donald McCulloch.

Mathieson Alkali Works, Inc., 60 E. 42nd St., New York 17, N. Y.

Mine Safety Applicances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa., Rep. N. R. Chillingworth, Sales Statistical Dept.

Mueller Company, 512 W. Cerro Gordo St., Decatur, Ill.

Munroe, James A. & Sons, 160 N. Washington St., North Attleboro, Mass., Rep. James E. Munroe.

National Water Main Cleaning Co., 30 Church St., New York, N. Y., Rep. Clinton Inglee, Pres. & Gen. Mgr.

Nichols Engineering & Research Corp., 60 Wall Tower, New York, N. Y., Rep. R. W. Rowen, Vice-Pres.

Omega Machine Company, 9 Codding St., Providence, R. I.

Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill., Rep. L. E. Rein, Pres.

Pennsylvania Salt Mfg. Co., 1000 Widener Building, Philadelphia 7, Pa., Rep. L. L. Hedgepeth, Mgr.

Pittsburgh-Des Moines Co., Neville Island Branch, Pittsburgh, Pa., Rep. J. E. O'Leary.

Pittsburgh Equitable Meter Co., 400 N. Lexington Ave., Pittsburgh, Pa., Rep. W. F. Weimer, Advtg. Mgr.

Proportioneers, Inc., P. O. Box 1442, Providence, R. I., Rep. H. E. Hollberg, Vice-Pres.

Public Works Magazine, 310 E. 45th St., New York, N. Y.

Quigley Company, Inc., 527 Fifth Ave., New York City 17, N. Y., Rep. R. A. Trefethen, Adv. Mgr.

Royer Foundry & Machine Co., 158 Pringle St., Kingston, Pa., Rep. S. B. Davies, Pres. & Gen. Mgr.

Sewage Works Engineering, 24 W. 40th St., New York, N. Y., Rep. Karl M. Mann.

Simplex Valve & Meter Co., 68th & Upland Sts., Philadelphia, Pa., Rep. Everett M. Jones, Sales Mgr.

Smith Manufacturing Co., A. P., 545 N. Arlington Ave., East Orange, N. J., Rep. W. P. Baerenrodt, Treas.

Stuart-Brumley Corp., 516 N. Charles St., Baltimore, Md., Rep. Fred E. Stuart.

United States Pipe & Foundry Co., Burlington, N. J.

Vapor Recovery Systems Co., 30 Church St., New York City, Rep. C. T. Stanhope, Eastern Sales Mgr.

Wailes Dove-Hermiston Corp. Westfield, N. J., Rep. W. H. T. Thornhill, Vice-Pres.

Wallace & Tiernan Co., Inc., 11 Mill St., Belleville, N. J., Rep. B. M. Lindsay.

Water and Sewage Works, 155 E. 44th St., New York, N. Y.

Wood, R. D., Co., 400 Chestnut Street, Philadelphia, Pa., Rep. Chas. Becker, Sales Mgr.

Worthington Pump & Machinery Corp., Harrison, N. J.

Yeomans Bros. Co., 1343 Dayton St., Chicago, Ill., Rep. Chas. Yeomans, Pres. & Treas.

MEMBERSHIP OF MEMBER ASSOCIATIONS

Arizona Sewage and Water Works Association

Mr. George W. Marx, *Secretary-Treasurer*, Sanitary Engineering Division, Arizona State Department of Health, Capitol Building, Phoenix, Ariz.

Bejcek, Otto J., Assoc. San. Engr., 4854 Placidia Dr., N. Hollywood, Calif.

Bennett, Richard, City Engr., City Hall, Phoenix, Ariz.

Biggs, Merrill, City Water Dept., Tucson, Ariz.

Borquist, Prof. E. S., Head, Dept. of Civil Engr., U. of Arizona, Tucson, Ariz.

Carollo, John A., 325 Ellis Bldg., Phoenix, Ariz.

Cook, John O., San. Insp., U. S. Dept. of Interior, Grand Canyon Nat'l. Park, Grand Canyon, Ariz.

Cunningham, John J., Clerk, Bd. of Supvrs., County Court House, Kingman, Ariz.

Cushing, Robert, Asst. Engr., 948 Ash Ave., Tempe, Ariz.

Frederickson, A., City Utilities Co., Pima, Ariz.

Johannessen & Girand, Cons. Engrs., Ellis Bldg., Phoenix, Ariz.

Keyes, Harmon E., Consultant, 508 E. Culver St., Phoenix, Ariz.

King, Ed. E., Supt., Upper Verde Public Utilities Co., Clarkdale, Ariz.

Ladlow, John, Box 1784, Phoenix, Ariz.

Luthin, John C., USPHS, 603 B.M.A. Bldg., 215 Pershing Rd., Kansas City, Mo.

Martin, Phil J., Jr., Supt., 224 N. Highland Ave., Tucson, Ariz.

Marx, Geo. W., Dir. San. Engr. Div., State Dept. of Health, Capitol Bldg., Phoenix, Ariz.

Miller, Alden W., Sales Engr., 1833 N. 13th Ave., Phoenix, Ariz.

Northrop, L. E., c/o Neptune Meter Co., Los Angeles 13, Calif.

Padgett, J. W., Litchfield Park, Ariz.

Pearce, H. B., Clayton Mfg. Co., 1812 Lemon St., Alhambra, Calif.

Roberts, A. L., Box 723, Globe, Ariz.

Sherwood, Wm. H., 1018 E. Second S., Salt Lake City, Utah

Travaini, Dario, Supt., 69 W. Wilshire Dr., Phoenix, Ariz.

Yost, Harold W., Cons. Engr., Yost Engr. Co., Heard Bldg., Phoenix, Ariz.

California Sewage Works Association

Mr. H. H. Jeffrey, *Secretary-Treasurer*, 112 City Hall, Sacramento, Calif.

Ackerman, Judson B., CEC., USNR., Lt.(jg), Public Works Dept., 12th Naval Dist., 1182 Market St., San Francisco 2, Calif.

Adams, J. J., Assoc. San. Engr., Corps of Engrs., Camp Haan, 3959 Everest St., Arlington, Calif.

Adolphe, R. C., 1st Lt., A.C., 34th, Air Service Sqn., APO No. 845, c/o P.M., Miami, Fla.

Albers, J. C., City Engr. & Street Supt., 120 N. Howard St., Glendale, Calif.

Aldrich, Lloyd, City Engr., Rm. 600, City Hall, Los Angeles, Calif.

Alexander, Louis J., Designing Engr., 1206 Maple Ave., Los Angeles, Calif.

Allen, T. E., Mgr., Indio Sanitary Dist., Indio, Calif.

Allen, Wm. A., Supt., City Hall, Pasadena, Calif.

Allin, Claud R., Supt. of Water & Sewers, 113 W. 9th St., Buena Park, Calif.

Anaya, Marvin, San. Engr. Designer, 367 City Hall, San Francisco 8, Calif.

Appel, A. A., Asst. Sewer Maint. Supt., City of Los Angeles, 711 W. 123rd St., Los Angeles 34, Calif.

Arnold, G. E., Lt. Col., Regional San. Engr. U.S.P.H.S., 477 Colon Ave., San Francisco, Calif.

Bacon, Vinton W., Asst. San. Engr., USPHS, Malaria Control in War Areas, 605 Volunteer Bldg., Atlanta 3, Ga.

Banks, Harvey O., Major, 1628 N. Roosevelt Ave., Pasadena 7, Calif.

Banta, A. Perry, Major, 159 Sierra View Rd., Pasadena 2, Calif.

Bargman, R. D., Lt.(jg)USNR, Inspector Naval Material, Box 175, Baytown, Tex.

Barnard, Archer F., Cons. Engr., 601 W. 5th St., Suite No. 1000, Los Angeles 13, Calif.

Barrett, J. S., Gen. Contr., 1300 Coast Highway, Newport Beach, Calif.

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Bragg, Robert E., Central States
Bragstad R. E., Dakota (Dual-Central States)
Braidech, Mathew M., Ohio
Brakenridge, Charles, Canada
Brallier, Paul S., New York
Brandenburg, Kenneth B., New York
Brandis, E. E., Montana
Brassey-Edwards, S., England (I.S.E.)
Brennan, Ralph F., Florida
Brensley, A. A., Central States
Brereton, W. P., Canada
Brethour, Herman, Kansas
Brewer, E. E., Pacific Northwest
Brickenden, F. M., Canada
Brigham, John C., New York
Briggs, Raymond J., Pacific Northwest
Brigham, John C., Jr., New York
Britt, C. E., Ohio
Britton, Benj. A., Jr., New England
Brody, James, Central States
Brook, Harry L., Central States
Brooks, John H., Jr., New England
Brower, J. Singleton, New York
Brower, James, Central States
Brown, Beverley J., Canada
Brown, Cleo, Missouri
Brown, Edward S., Jr., New England
Brown, Everett Currier, Florida
Brown, Floyd W., California
Brown, Glenn V., Pennsylvania
Brown, James M., Jr., New York
Brown, Kenneth W., California
Brown, R. F., California
Brown, Stuart, Georgia
Brown, W. Fillingham, England (I.S.E.)
Brown, Wade Gillies, North Carolina
Brown, Walter H., Jr., New England
Browne, F. G., Canada
Browne, Floyd G., Ohio
Brownridge, F. B., Canada
Brug, C. J., California
Brumbaugh, W. V., New York (Dual-Pennsylvania)
Brunn, Philip A., Jr., Pennsylvania
Brunner, Paul L., Central States
Brunstein, Maurice, New Jersey
Brunty, C. E., California
Bryan, A. C., Texas
Bryan, John G., New Jersey
Bryant, C. T., Ohio
Bryant, W. G., Georgia
Buchecker, A. I., Pacific Northwest
Buck, Geo. H., New York
Buck, Robinson D., New England
Buck, Ross J., Central States
Buckley, E. J., Canada
Buckley, Thomas, Pennsylvania
Buckman, Millard E., California
Budd, Edward G. Mfg. Co., (Corporate), Pennsylvania
Bugbee, Julius W., (Honorary) New England
Bugbee, Raymond C., New England
Builders–Providence, Inc., Associate, Att'n: C. G. Richardson
Bulthuis, Herbert, Michigan
Bunker, F. L., North Carolina
Burack, W. D., New Jersey
Burden, Harry P., New England
Burden, J. P., Texas
Burden, Robert P., New England
Burdick, Geo. E., New York
Burdoin, Allen J., New England
Burger, A. A., Ohio
Burger, Arnold W., Central States
Burgeson, J. H., Central States
Burgess, Harold, New York
Burke, C. E., England (I.S.P.)
Burley, Fred H., Michigan
Burn, G. A. H., Canada
Burnett, A. H., Canada
Burnett, J. E., Michigan
Burnson, Blair I., California
Burr, R. S., New England
Burrell, Robert, New England
Burrin, Thos. J., Central States
Burt, G. L., Central States
Burton, L. E., Central States
Bush, A. F., California
Bush, Archie E., New York
Bush, Bernard S., Pennsylvania
Bush, M. M., Canada
Bushee, Ralph J., Central States
Butler, Leo M., Florida
Butrico, Frank, New York
Butterfield, C. T., Federal
Bye, Norval E., Canada
Byxbee, J. F., California

Cadwell, Ivan W., New York
Cahill, Wm. J., Jr., New York
Caird, James M., New York
Calder, Charles L., California
Calderara, O. J., Federal
Caldwell, David H., California
Caldwell, H. L., Central States
Callen, Loy A., Central States
Callon, Harry A., Central States
Calvert, A., England (I.S.P.)
Calvert, C. K., Central States
Cambridge Instrument Co., Associate, Att'n: F. G. Paully
Cameron, A. B., Michigan
Cameron, Geo., New Jersey
Cameron, W. M., England (I.S.P.)
Camp, Cecil S., North Carolina
Camp, Thomas R., New England
Campbell, A. S., Dakota
Campbell, J. L., England (I.S.P.)
Campbell, John, Pennsylvania
Campbell, M. S., Pacific Northwest
Campbell, M. S. A., Central States
Capano, Sam J., New Jersey
Capen, Charles H., Jr., New Jersey
Capone, Domenic, Federal
Capraro, Paul E., Central States
Capwell, Walter, New England
Caracausa, Albert C., New England
Cardwell, Edw. C., Central States
Carey, Wm. N. Central States
Carl, Charles E., Missouri
Carlson, A. J., Canada
Carlson, H. R., Federal
Carlson, Paul R., Central States
Carmichael, David W., New Jersey
Carnahan, C. T., Federal
Carolina Aluminum Co., North Carolina
Carollo, John A., Arizona
Carothers, Chas. H., Florida
Carpenter, Carl B., Central States
Carpenter, Geo. D., New York
Carpenter, Harry C., New York
Carpenter, Howard F., New England
Carpenter, J. D., Pennsylvania
Carpenter, Wm. T., New York
Carrique, Carlos S., Argentina
Carroll, Geo. B., New York
Carson, R. G., Central States
Carter, Alton B., California
Carter, Bruce F., New York
Carter, Earl, Central States
Carter, N. C., Pennsylvania
Carter, Ralph B., Co., Associate, Att'n: J. W. Van Atta
Cary, F. Arthur, New York
Cary, Glen, Rocky Mountain
Cary, W. H., Jr., Federal
Casad, C. C., Pacific Northwest
Case, Raymond G., New Jersey
Casey, Albert E., New England
Casey, John J., California
Cash, Kenneth, Texas
Castello, W. O., California
Caster, Arthur, Central States (Dual-Ohio)
Cater, Thomas J., Jr., Georgia
Caulwell, Wilson B., Pennsylvania
Caverly, D. S., Canada
Cederberg, C. R., Rocky Mountain
Cenicola, Samuel, New Jersey
Cerny, Paul J., New York (Dual-New England)
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Chamberlain, L. H., New York
Chamberlain, Wm. T., New York
Chamberlin, Noel S., New Jersey
Chambers, Grover, Pacific Northwest
Chamier, Albert, Michigan
Champlin, George D., California
Chapman Valve Mfg. Co., Associate
Charlton, David B., Pacific Northwest
Chase, E. Sherman, New England (Dual-New York and Pennsylvania)
Chasick, Abraham H., New York
Chenevert, J. G., Canada
Chesney, C. T., Canada
Chester, Burke, Florida
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Chisholm, D. M., Canada
Chisholm, Henry, New England
Christian, J. A., England (I.S.P.)
Christian, James B., New York
Christianson, A. C., Michigan
Chrysler, K. L., Montana
Chubb, Robert S., Pennsylvania
Chumard, Geary W., New York
Church, Dean F., Central States
Church, H. J., Canada
Chutter, W. H., California
City Water Dept. (Norman Okla.) Att'n: Ralph DeVore, Oklahoma
City Water Dept. (Statesville, N. C.), North Carolina
Claffey, Walter H., New England
Clare, H. C., Pacific Northwest
Clark, Arthur T., Central States, New York
Clark, Boyd H., New York
Clark, H. W., England (I.S.E.)
Clark, J. C., California
Clark, John, Canada
Clark, Kenneth M., Central States
Clark, Lloyd K., Dakota
Clark, M. S., Michigan
Clark, Robert N., New York
Clarke, Samuel M., Central States
Clarke, V. B., New England
Clarkson, G. H., Canada
Classen, Ashley G., Texas
Clawson, Earl M., Florida
Clay, H., England (I.S.P.)

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Cleary, Edw. J., New Jersey
Cleland, R. R., Pennsylvania
Clem, Curtis B., Central States
Clements, G. S., England (I.S.P.)
Cleveland, E. A., Canada
Climax Engr. Co., Associate, Att'n: E. D. West
Clifford, W., England (I.S.P.)
Clinton, Merritt O., Central States
Clore, L. B., Central States
Clouser, L. H., Pennsylvania
Cloyes, W. J., Pacific Northwest
Clubb, William C., Pacific Northwest
Cobb, Edwin B., New England
Coberly, Carroll H., Rocky Mountain
Cobleigh, W. H., California
Cobleigh, W. M., Montana
Coburn, S. E., New England
Cochrane, John C., New York
Cochrane, W. F., Dakota
Cockroft, T. N., England (I.S.P.)
Coffey, Michael J., New York
Coffin, Edwin F., Jr., Federal
Coffin, George W., New England
Cohn, Morris M., New York (Dual-New England)
Colby, William D., Canada
Cole, Arthur F. W., Canada
Cole, Chas. W., Central States
Cole, E. Shaw, New York
Cole, Harvey M., Jr., California
Coleman, Dwight B., New York
Collar, Ira T., Jr., Kansas
Collard, A. E., England (I.S.E.)
Collier, J. D., Canada
Collier, James, Ohio
Collings, Wm. E., New Jersey
Collings, A. J., England (I.S.E.)
Collins, A. Preston, California
Collins, E. B., Texas
Collins, John T., New York
Collins, Rex, Oklahoma
Collins, W. H., Canada
Collison, Okla C., Missouri
Collyer, Joseph C., New York
Colquhoun, Colin, New York
Colsen, Justin, Dakota
Compton, C. R., California
Conant, F. M., Canada
Condrey, Lawrence M., Central States
Connell, C., Texas
Connell, Maurice H., Florida
Connors, Joseph J., California
Consoer, Arthur W., Central States
Cook, John O., Arizona
Cook, Lawrence H., California
Cook, Max E., California
Cook, S. J., Canada
Cooley, E. C., California
Coombs, E. P., England (I.S.E.)
Coope, Albert, Ohio
Cooper, G. F., England (I.S.P.)
Copeland, Kern H., California
Copeland, Wm. R., New England (Dual-New York)
Coplen, Warren W., Rocky Mountain
Copley, Chas. H., New England
Corbett, Walter E., New England
Corcoran, J. D., Canada
Corddry, W. H., Pennsylvania
Corey, R. H., Pacific Northwest
Cornell, R. M., Central States
Cornilson, C. K., Central States
Corpstein, Oswald, Central States
Corrington, C. E., Central States
Corson, B. I., New Jersey
Cortelyou, H. P., California
Cortese, J. R., Montana
Corwin & Company, Inc., (Corporate), Montana
Cory, J. C., Montana
Cosens, Kenneth W., Michigan
Cosner, Lafayette, Pennsylvania
Costello, John J., New York
Cotner, F. B., Montana
Cotta, Maurice L., Pacific Northwest (Dual-Federal)
Cotterell, G. T., England (I.S.E.)
Cotton, Edwin R., New York
Cottrell, H. S., New York
Couch, L. I., Central States
Coulson, C. L., Canada
Cousineau, A., Canada
Covert, Henry Rew, Central States
Covill, R. W., England (I.S.P.)
Cowles, M. W., New Jersey (Dual-New York)
Cox, C. R., New York
Cox, Clifford, B., Central States
Coy, Burgis, Rocky Mountain
Coyne, James J., Missouri
Craemer, George H., New England
Craig, Clifford, Central States
Craig, J. D., Georgia
Cramerton Mills, Inc., North Carolina
Cranch, Eugene T., New York
Crane Company, Associate, Att'n: G. W. Hauck
Crane, H. R., California
Crane, Harlan B., New York
Craun, J. M., Ohio
Crawford, D. E., Canada
Crawford, H. V., New York
Crawford, L. C., Iowa
Crawford, S. S., Texas
Crawford, Sinclair S., Jr., Texas
Creears, T. H., California
Crocker, B. A., Texas
Crocker, Harold S., New England
Crockett, Vernon P., Federal
Croft, H. P., New Jersey
Crohen, W. F., Ohio
Crohurst, Harry T., Federal
Crooks, Howard, Michigan
Cropsey, W. H., Central States
Cross, Russell, Central States
Crow, Harry B., Pacific Northwest
Crundall, S. F. W., England (I.S.P.)
Culley, Walter M., New York
Culli, George O., Jr., Texas
Cullison, Eugene F., New York
Cunetta, Jos., New York
Cunningham, John J., Arizona
Cunningham, John W., Pacific Northwest
Cunningham, M. B., Oklahoma
Currie, Frank S., California
Curtis, Clive W., Central States
Cushing, Robert, Arizona
Cutting, O. S., Pacific Northwest
Cyr, Rene, Canada

D'Aleo, A. R., New York
Dagg, Ralph G., Iowa
Dagger, G. E., Rocky Mountain
Dahl, Arve H., Federal
Daireaux, Carlos F., Argentina
Daley, Charles W., Pacific Northwest
Daley, Stanley J., Central States
Daly, James A., Canada
Damerow, Harry W., Florida
Damon, Nelson A., New England
Damon, Wayne F., New England
Damoose, N. G., Michigan
Daniels, E. W., Kansas
Daniels, F. E., Pennsylvania
Daniels, Hershel, Central States
Daniels, P. N., New Jersey
Darby, George M., New England
Darby, W. A., Pennsylvania (Dual-New York)
Darling, E. H., Canada
Dashiell, Walter N., Federal
Davenport, Llewellyn D., California
Davey, H. W., California
David, Frank J., Ohio
Davids, E. M., California
Davidson, George, Georgia
Davidson, J. F., California
Davis, Charles A., Rocky Mountain
Davis, D. A., Central States
Davis, Earle E., California
Davis, Edward T., Pennsylvania
Davis, Frederick, E., Central States
Davis, G., Jr., Pacific Northwest
Davis, H. A., Central States
Davis, H. F., North Carolina
Davis, P. D., North Carolina
Davis, T. J., Georgia
Davison, Russell, Central States
Dawson, Arthur, New York
Dawson, F. M., Iowa
Dawson, Norman, Central States
Dawson, Thomas T., Pennsylvania
Day, L. A., Central States
Dayton, Alfred E., New York
Deane, Elmer L., New England
Dearmin, Paul E., Texas
DeBerard, W. W., Central States
DeBrito, F. Saturnino, Jr., New York
Debrun, John W., Jr., Central States
Decher, Edward P., New Jersey
Decker, C. D., Ohio
Decker, Herbert M., Federal
Decker, Walter G., Central States
Deckert, Christ, Central States
deGoicoechea, Leandro, Florida
DeGroat, Frank N., New York
DeHaai, Ira, Dakota
DeHaas, Nicholas, New England
DeHooghe, Bernard A., Michigan
Deitch, Meyer, New York
deJarnette, N. M., Georgia
Delaporte, A. W., Canada
DeLeuw, C. E., Central States
Dellasala, John J., New York
DeMartini, Frank E., California (Dual-Federal)
Deming, P. H., California
Demorest, S. L., Michigan
DeMoss, Samuel, Pacific Northwest
DeMunn, E. M., New York
Denise, Wm. D., New York
Dennelly, Philip G., New York
Dennis, Carl E., Michigan
Dent, Harry, New York
DePoy, A. G., Central States
Depp, David, Central States
Derby, Ray L., California
Dermitt, Chas. W., Pennsylvania
Deslauriers, A. J., Canada
Desmarais, R. J., Canada
Des Moines, City of, Iowa
Deuchler, Walter E., Central States
DeVal, Eric, Rocky Mountain
Devendorf, Earl, New York
DeWante, Randolph H., California
Dewart, Donald M., New York
deZevallos, B. Fernando Ortiz, Florida
Dick, Robert, Jr., Central States
Dickey Clay Mfg. Co., W. S., Associate, Att'n: A. G. Frerking
Dickson, D. B., Texas
Diefendorf, Fred G., Pennsylvania
Diehl, F. D., Kansas
Dietz, J. C., Central States
DiIorio, Anthony F., New Jersey
Diller, Walter W., Central States
Dimmitt, Bruce S., Central States
Dion, Clarence K., New England
Disario, G. M., New England
Dixon, F. S., Dakota
Dixon, G. Gale, New York
Dixon, R. M., Texas
Doane, Carroll C., California
Dobson, Wm. T., New York
Dobstaff, Robert, Jr., New York
Dobstaff, Robert W., Sr., New York
Dodd, C. K. S., Florida
Dodge, H. P., Michigan
Doman, Joseph, New England (Dual-New York)
Domke, L. C., Central States
Domogalla, Bernhard, Central States
Donaldson, Wellington, New York
Donnell, Geo. M., Rocky Mountain
Donnelly, R. M., New England
Dopmeyer, A. L., Federal (Dual-California)
Dore, Stanley M., New England
Dorr Co., Inc., Associate
Dorr, Fred, Michigan
Douglas, George F., Pacific Northwest
Douglass, R. M., Pennsylvania
Dow Chemical Co., Associate, Att'n: W. A. Melching
Dowd, Ira, Michigan
Downer, Wm. J., Central States
Downes, John R., New Jersey
Downing, Francis J., New York
Doyle, Thomas J., Michigan
Doyle, Wm. H., Central States
Drake, James A., Central States
Dreier, D. E., Central States
Drew, Samuel T., New England
Drexel, Frederick, New York
Driscoll, Timothy J., New York
Drummond, A. H., England (I.S.P.)
Drummond, C. E., Georgia
Dudley, D. E., Central States
Dudley, Richard E., New England
Duell, Garth H., California
Duffiey, Frank J., New York

Duffy, Ora, Kansas
Dufresne, Paul Ed., Canada
Duncan, J. G., Canada
Duncan, Roland, California
Dundas, Wm. A., Central States
Dunmire, E. H., Central States
Dunseth, R., Central States
Dunstan, Gilbert H., California
Durand, Edwin M., Michigan
Durham Water Dept., (North Carolina), North Carolina
Durr, John J., Jr., Pennsylvania
Durrant, W. K. F., Canada
Dust, Joseph V., Central States
Duvall, Arndt J., Central States
Dyckman, Warren W., New York
Dyer, Samuel, New England
Dyrenforth, Donald, Rocky Mountain
Dyson, R. J. H., England (I.S.P.)

Eager, Vernon, New York
Eagleson, John W., New York
Early, Fred J., Jr., California
Early, Mart, Pacific Northwest
Easdale, W. C., England (I.S.E.)
Easley, G. E., California
Eastburn, W. H., Pennsylvania
Easter, Charles W., New England
Easter, Leonard C., New England
Easterday, Conrad G., Florida
Ebneter, Walter, Central States
Eby, Earl, Montana
Eckbert, Chester A., Pennsylvania
Eckelcamp, Joseph, Michigan
Ecusta Paper Corp., North Carolina
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Edgecombe, G. H., Canada
Edgerley, Edward, Pennsylvania
Edighoffer, Albert, New York
Edmonds, W. R., Canada
Edmondson, J. R., England (I.S.P.)
Edwards, G. H., Pacific Northwest
Edwards, Gail P., New York
Edwards, Harlan H., Pacific Northwest
Edwards, William L., New York
Egan, J. H., California
Egger, Oscar O., Central States
Eglof, Warren K., New York
Ehle, Virgil, New York
Eich, Henry F., New York
Eidsness, Fred A., Florida
Eiffert, William T., Pacific Northwest
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Eldridge, E. F., Michigan
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Eliassen, Rolf, New York
Elkland Leather Co., Inc., (Corporate), Pennsylvania
Ell, Henry T., New Jersey
Ellerbusch, R. P., Michigan
Ellms, J. W., Ohio
Elmendorf, C. E., New York
Elsdon, G. D., England (I.S.P.)
Ely, E. H., England (I.S.E.)
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Evans, James, Pennsylvania
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Evans, S. C., England (I.S.P.)
Everest, Howard, New York
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Everson, R. B., Central States
Eyer, C. E., Montana

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Faget, Walter H., Central States
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Falk, Lloyd L., New Jersey
Fallon, Raymond D., Rocky Mountain
Falls, O. M., Canada
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Farrant, James, New Jersey
Farrell, Wm. F., New York
Fassnacht, Geo. G., Central States
Faulkner, T. G., Esq., England (I.S.E.)
Favreau, R. E., Central States
Fawls, James F., New York
Feierstein, Jacob L., New York
Feild, James W., Maryland-Delaware
Feldhake, C. J., Federal
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Fenchel, Randolph, California
Fenger, J. W., New York
Fenn, Ernest G., New England
Fenton, John V., New York
Ferguson, G. H., Canada
Ferguson, Gerald W., Federal
Ferguson, Marshall E., New York
Ferebee, James L., Central States
Ferris, James E., New England (Dual-New York)
Field, Emerson & Morgan, Inc., New York
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Findlay, Arthur, New York
Finkbeiner, Carlton S., Ohio
Finley, Dexter L., California
Finley, T. R., Florida
Fischer, Anthony J., New York
Fischer, F. P., Ohio
Fischer, Math., Central States
Fish, Raymond S., California
Fishbeck, Kenneth, Michigan
Fisher, Lawernce M., Federal
Fitch, T. A., California
Fittro, Louis L., Federal
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Fitzgerald, J. A., New York
Fitzgerald, Joseph, New England
Five, Helge, New York
Fiveash, Charles E., Florida
Flanagan, Pat, Florida
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Flatt, Truman L., Central States
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Fleming, M. C., Pennsylvania
Fleming, Paul V., New England
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Flood, T. S., Pacific Northwest
Flook, S. E., Canada
Flower, G. E., Ohio
Flowers, E., England (I.S.P.)
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Fontenelli, Louis, New Jersey
Foote, H. B., Montana
Foote, Kenneth E., New England
Ford, J. R., Central States
Fore, Clifford, Central States
Foreman, Merle S., California
Forest City, City of (Iowa), Iowa
Forrest, Glen L., New York
Forrest, Thos. H., Central States
Fort Dodge, City of (Iowa), Iowa
Fort, Edwin J., New York
Fortenbaugh, J. Warren, New York
Fortman, John A., Central States
Forton, R. Gerald, Michigan
Foster, Chas., Central States
Foster, Herbert B., Jr., California
Foster, Norman, Pennsylvania
Foster, Robert F., Rocky Mountain
Foster, William Floyd, California
Foth, Herbert S., Central States
Fowler, G. J., England (I.S.P.)
Fowler, H. D., Pacific Northwest
Fowler, James D., Texas
Foxboro Company, Associate
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Franks, John T., Rocky Mountain
Fraschina, Keeno, California
Fraser, Charles E., Canada
Frasher, Randall L., New York
Fraters, E. W., California
Frazier, Ernest, Central States
Frazier, Leonard H., New York
Frazier, R. W., Central States
Frazier, W. H., Central States
Frederich, Hoyt A., Central States
Frederickson, A., Arizona
Freeborn, W. F., England (I.S.P.)
Freeburn, H. M., Pennsylvania
Freeland, B. H., Central States
Freeman, A. B., Federal
Freeman, A. L., England (I.S.P.)
Freeman, L. H., Central States
Freeman, W. B., Rocky Mountain
Freer, Paul H., California
French, A. H., Maryland-Delaware
French, R. Del., Canada
Fretcher, Karl W., Central States
Freund, J. P., Pennsylvania
Frick, A. L., Jr., California
Frickstad, Walter N., California
Friedman, Wm. M., Jr., New York
Friel, F. S., Pennsylvania
Friendly, Hugo H., New York
Frith, Gilbert R., Georgia
Froehde, F. C., California
Fuchs, Abraham W., Federal
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Fuhrman, Ralph E., Federal
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Funk, John T., Jr., Pennsylvania
Fynn, Geo. F., New York

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Gadomski, Albert J., New Jersey
Gail, A. L., Central States
Gale Oil Separator Co., Associate, Att'n: Wm. A. Gehle
Galimbert, G. M., Canada
Galloway, Robert N., California
Gard, Chas. M., New York
Gardner, Clarke, Maryland-Delaware
Gardner, Geo. W., New York
Gardner, R. T., California
Garland, C. F., Florida
Garlock, Samuel C., New York
Garner, J. H., England (I.S.P.)
Garrett, R. W., Canada
Garthe, E. C., Federal
Garvelink, Frank, Michigan
Garwood, Kirk, Iowa
Gass, George M., Canada
Gatley, H. K., New Jersey
Gaudin, E. L., Ohio
Gaunt, W. C., Texas
Gavett, Weston, New York
Gearhart, J. N., Pacific Northwest
Gehm, Harry Willard, Jr., New Jersey
Gelbke, Arthur W., New York
Gelston, W. R., Central States
General Chemical Co., Associate, Att'n: L. I. Birdsall
General Electric Co., Associate, Att'n: H. V. Crawford
Genter, Albert L., Maryland-Delaware
Gentlemen, Laurence M., New England
Gentsch, Edward, Michigan
George, J. E., Missouri
Gerard, F. A., Central States
Gerdel, W. E., Ohio
Gere, William S., New York
Gerhart, Edgar, Pennsylvania

Getz, Murray A., Central States (Dual-Federal)
Gibbons, E. V., Canada
Gibbs, Frederick S., New England
Gibbons, M. M., New Jersey
Gibbs, R. C., England (I.S.P.)
Gibeau, H. A., Canada
Gibson, Wm. J., New York
Giddens, S. M., Georgia
Gidley, H. K., Pennsylvania
Giesey, J. K., Central States
Gifford, J. B., Central States
Gifft, H. M., New York
Gilbert, J. J., Pennsylvania
Gilbert, J. Miles, Florida
Gilcreas, F. Wellington, New England (Dual-New York)
Gilfrey, Grant S., Rocky Mountain
Giles, J. Henry L., New England
Giles, T. D., Jr., Florida
Gill, Harry J., California
Gill, John B., California
Gill, Paul, Pennsylvania
Gillard, J. E., England (I.S.P.)
Gillespie, C. G., California
Gillespie, Wylie W., Florida
Gilman, Floyd, New York
Gilman, Harry, Georgia
Gilman, N. A., Pacific Northwest
Gisborne, Frank R., New England
Glace, I. M., Pennsylvania (Dual-New York)
Gladding, Charles, California
Gladue, Donat J., New England
Glamorgan Pipe & Foundry Co., Associate
Glasser, Leo M., New York
Glines, Robert A., New England
Gmeiner, Frank, Central States
Godfroy, J. I., Michigan
Godshall, Horace E., Pennsylvania
Goeke, Roscoe H., Federal
Goff, James S., New England
Goff, Wm. A., Pennsylvania
Gohde, Charles H., Central States
Golbert, George M., Rocky Mountain
Goldsmith, Philip, New York
Goldthorpe, H. H., England (I.S.P.)
Gooch, E. W., Pacific Northwest
Goodman, Arnold H., Central States
Goodnight, V. L., Pacific Northwest
Goodridge, Harry E., California
Goodwin, S. E., Canada
Gordon, Arthur, Central States
Gordon, Charles W., Central States
Gorman, Richard C., Jr., New York
Gorman, Wm. A., Pennsylvania
Gotaas, Harold B., North Carolina
Gothard, M. J., Central States
Goudey, R. F., California
Gould, Richard H., New York
Grabbe Construction Co., H. A., Central States
Grabbert, Gilsey R., Central States
Graber, Ralph C., Federal
Gracenin, Sylvester, Pennsylvania
Graden, Paul W., Central States
Graemiger, Joseph A., New England
Graham, E. H., California
Graham, Edward J., New York
Graham, James E., Michigan
Graham, Maynard, Rocky Mountain
Graham, William, California
Gran, John E., Georgia
Granger, George, Michigan
Granger, George M., New England
Grant, Howard L., Texas
Grantham, G. R., Central States
Graul, Leroy H., New Jersey
Graver Tank & Mfg. Co., Inc., Associate, Att'n: G. V. Malmgren
Graves, Carl T., Central States
Graves, Wallace M., New Jersey
Gray, Earl G., Michigan
Gray, Harold F., California
Gray, William, Canada
Greeley, Richard F., New England
Greeley, Samuel A., Central States
Green, Alvin W., Pacific Northwest
Green Bay Fdy. & Machine Works, Associate, Att'n: James P. North
Green, Carl E., Pacific Northwest
Green, Howard R., Iowa
Green, Roy F., Central States
Green, Wingate, Florida
Greenberg, R. J., Michigan
Greene, J. F., Rocky Mountain
Greene, R. A., Michigan
Greenfield, H. C., New Jersey
Greenleaf, John W., Jr., New England
Gregory, The John H. Sanitary & Municipal Reference Library, California
Gregory, L. L., England (I.S.E.)
Gregory, Ted R., California
Gregory, Tom, Central States
Greiff, Victor C., New York
Greig, John M. M., New York
Grelick, David, New York
Griffin, A. E., New Jersey
Griffin, F. T., New York
Griffin, Guy E., New England
Griffin, H. P., Texas
Griffith, Charles R., Central States
Griffith, L. B., Texas
Grimes, Ben L., Jr., Texas
Grimmer, A. K., Canada
Grimsley, J. T., Federal
Grinnell Company, Inc., The, North Carolina
Grinnell, Russell, Michigan
Groen, Michael A., Michigan
Gromada, Stanley T., Georgia
Gross, Carl D., Central States
Gross, Dwight D., Rocky Mountain
Grossart, L. J. H., Pennsylvania
Grosshans, Edw. W., Central States
Ground, Earl H., Kansas
Grover, Robert H., New York
Gruendler Crusher & Pulverizer Co., Associate, Att'n: Wm. P. Gruendler
Gruss, A. W., California
Gruss, John G., Pennsylvania
Gunther, G. A., Central States
Gurton, William S., Canada
Gwin, Thomas M., California

Haag, Gerald, Central States
Habermehl, C. Austin, Michigan
Haddock, Fred R., Pennsylvania
Hadin, Leon A., Pacific Northwest
Hadley, Henry, Canada
Haemmerlein, Victor E., New York
Hagar, C., Kansas
Hager, Everett C., California
Hager, Fred, Central States
Hager, J. William, California
Hagerty, L. T., Ohio
Hagey, C. R., Canada
Haigh, Linell E., Dakota
Haimes, James, Canada
Hale, Arnold H., New York
Hale, Elliott J., New England
Hale, Frank C., Central States
Hale, Harry C., Missouri
Halff, Albert H., Central States
Hall, Frank H., New York
Hall, G. D., Pacific Northwest
Hall, Geo. A., Ohio
Hall, Geo. L., Central States
Hall, Geo. M., Central States
Hall, Harry R., Maryland-Delaware
Hall, John W., Montana
Hall, S. P., Central States
Hall, W. H., North Carolina
Hall, W. N., Canada
Hallam, G. C., Pacific Northwest
Hallgren, R. A., Canada
Hallock, Emerson C., New York
Halpin, John, New York
Halvorson, H. O., Central States
Hambleton, F. T., England (I.S.P.)
Hamilton, G. M., Canada
Hamilton, L. A., Central States
Hamilton, R. C., Central States
Hamilton, R. F., Pacific Northwest
Hamlin, C. H., England (I.S.P.)
Hamlin, F. M., Texas
Hamm, Wm. C., New York
Hammann, Charles G., New England
Hammer, Vernon Benjamin, Iowa
Hammond Bd. of Sanitary Commissioners, (Corporate), Central States
Hammond, Robert H., California
Hanes, Gilbert C., California
Haney, Paul D., Kansas
Hankin & Co., Ltd., Francis, Canada
Hanlon, D. A., Florida
Hansell, Wm. A., Jr., Georgia
Hansen, Alfred E., Michigan
Hansen, Chris A., Federal
Hansford, A. E., Canada
Hanson, Arthur C., Central States
Hanson, George I., New England
Hanson, Harry G., North Dakota (Dual-Federal)
Hanson, John R., New York
Hapgood, E. P., California
Hardenbergh, W. A., New York
Hardenburgh, E. A., California
Harding, C. G., Dakota
Harding, Carl G., Florida
Harding, J. C., New York
Harding, Robert G., Pacific Northwest, (Dual-California)
Hardinge Company, Associate, Att'n: M. C. Fleming
Hardman, Thomas T., Central States
Hardy, C. Asa, New York
Hardy, William G., New England
Hargraves, Z. D., Michigan
Harley, Frank E., New Jersey
Harmon, Jacob A., Central States
Harmon, Judson A., California
Harmon, Ray, Central States
Harper, M. J., New England
Harper, Travis C., California
Harr, Neal, Kansas
Harris, Geo. C., Central States
Harris, H. E., Florida
Harris, I., England (I.S.P.)
Harris, J. F., Pennsylvania
Harris, T. R., Central States
Harris, Thomas, New York
Harris, W. Norris, Georgia
Harrison, Edw. F., New York
Hart, W. B., Pennsylvania
Hartley, G. R., New Jersey
Hartley, John R., New England
Hartline, Wm. C., Florida
Hartman, B. J., Central States
Hartman, Byron K., New York
Hartung, N. E., Central States
Hartzell, E. F., Pennsylvania
Harvey, Carl, New York
Harvey, J. B., England (I.S.P.)
Harwell, G. A., Missouri
Haseltine, T. R., Pennsylvania (Dual-California)
Hasfurther, Wm. A., Central States
Haskins, Charles A., Missouri
Hastie, James, New York
Hastings, W. E., New York
Hatfield, W. D., Central States
Hattery, Chas. E., Central States
Hauck, Chas. F., Ohio
Hauer, Gerald E., Michigan
Haven, John F., Pennsylvania
Havens, William L., Ohio
Hawkins, J. B., Georgia
Haworth, J. V., Pennsylvania
Haworth, W. D., England (I.S.E.)
Hawtrey, R. O., Canada
Hay, T. T., Central States
Haydock, Chas., Pennsylvania
Hayes, John A., New York
Hayes, Walter, California
Hayob, Henry, Jr., Missouri
Hays, Clyde C., Texas
Hayward, Homer J., Michigan
Hazen, John B., Montana
Hazen, Richard, New York
Hazey, George, Michigan
Healy, William A., New England
Hedenstad, Paul C., New England
Hedgepeth, L. L., Pennsylvania (Dual-New York)
Heffelfinger, D. D., Ohio
Heider, Robt. W., Central States
Heim, Mitzi, Central States
Heinrikson, J. J., Kansas
Heiple, Loren R., Central States
Heisig, H. M., Central States
Heiss, Edw. A., Pacific Northwest
Helland, H. R. F., Texas
Heller, Austin N., New York
Heller, C. F., Pennsylvania
Heller, Lloyd J., Central States
Hemblett, W. C., Federal
Henderson, Carl, Rocky Mountain
Henderson, Chas. F., New York
Henderson, E., England (I.S.P.)
Hendricks, Gerald F., Central States
Hendryx, Clarence E., Rocky Mountain
Henley, M. E., Georgia
Henn, Donald E., Central States
Henny, A. L., Pacific Northwest

Henry, Thomas B., Ohio
Hensel, Eugene C., Central States
Herberger, Arthur Henry, New York
Herda, N., Michigan
Hermann, F. X., Central States
Herr, H. N., Pennsylvania
Herrick, T. L., Central States
Hersey Manufacturing Co., Associate, Att'n: Wm. C. Sherwood
Herzig, S. B., Central States
Herzog, Henry, New York
Hesford, L., England (I.S.E.)
Hess, Daniel J., Jr., Pennsylvania
Hess, Edward C., Pennsylvania
Hess, Seth G., New York
Heubi, Thomas, New York
Heukelekian, H., New Jersey
Hewitt, A. C., Pennsylvania
Heyward, T. C., North Carolina
Hibschman, Charles A., Pennsylvania
Hicklin, R. G., Georgia
Hicks, Cyril, Michigan
Hicks, R., England (I.S.P.)
Hicks, R. H., Maryland-Delaware
Higgins, George F., Florida
Higgins, William J., New York
Hilbert, Morton S., Michigan
Hill, G. Everett, New York
Hill, John R. S., Federal
Hill, K. V., Central States (Dual-California)
Hill, Theo. C., Pennsylvania
Hill, W. R., Pacific Northwest
Hiller, Paul W., New England (Dual-New York
Hillis, Leonard, Michigan
Hillsboro, Town of (North Carolina), North Carolina
Hilton, E. M., California
Hinkamp, Grant M., (Corporate), Central States
Hintgen, George W., Federal
Hirn, William C., Michigan
Hirst, J., England (I.S.P.)
Hirtler, William, California
Hiser, F. C., Texas
Hitchner, A. H., California
Hoag, Clarence C., New York
Hoak, Richard D., Pennsylvania
Hobson, Edward, Pacific Northwest
Hodge, W. W., Pennsylvania
Hodges, H. E. W., England (I.S.E.)
Hodgkinson, Jack, California
Hodgson, E., England (I.S.P.)
Hodgson, H. J. N., England (I.S.P.)
Hodkinson, C. T., Central States
Hoeflich, G. C., Pennsylvania
Hoey, A. C., Canada
Hoffert, J. R., Pennsylvania
Hoffman, C. H., Pacific Northwest
Hoffman, Howard F., New York
Hogan, James W. T., New York
Hogan, M. S., Missouri
Hogan, William J., New York
Hoganson, Lester O., Central States
Holderby, J. M., Central States
Holderman, John S., Central States
Holland, Frank H., New York
Hollins, C. D., Central States
Holmes, Glenn D., New York
Holmes, Harry E., New England
Holmes, Kenneth H., New England
Holmquist, Chas. A., New York
Holroyd, A., England, (I.S.P.)
Holroyd, Norman S., New York
Holt, Clayton M., Central States
Holter, A. L., Pacific Northwest
Holtje, Ralph H., New Jersey
Holtz, William, Michigan
Holy, William E., Federal
Homan, Arthur R., Missouri
Homelite Corp., Associate, Att'n: Nelson Thompson
Hommon, Charles C., Ohio
Hommon, H. B., Federal (Dual-California)
Hood, John W., New Jersey
Hoot, Ralph A., Central States
Hoover, C. B., Ohio
Hope, Malcolm C., Federal
Hopkins, E. S., Maryland-Delaware
Hopkins, Glen J., Dakota (Dual-Federal)
Hopkins,-L. S. R., New York
Hopkins, O. C., Federal
Hopper, Allen O., New York
Horgan, John J., New York (Dual-New England)
Horne, Ralph W., New England
Horner & Shifrin, Missouri
Horton, Roland, Missouri
Hoskins, J. K., Federal
Hoskinson, Carl M., California
Hotchkiss, H. T., Jr., New York
Hoth, Fred, Central States
Houser, C. S., Ohio
Houser, George C., New England
Houston, W. J., Georgia
Howard, C. M., Pacific Northwest
Howard, N. J., Canada
Howard, P. F., New England
Howard, R. R., Missouri
Howarth, J. P., England (I.S.P.)
Howe, Ben V., Rocky Mountain
Howe, Harry, Iowa
Howe, J. P., Canada
Howell, Eugene M., California
Howland, W. E., Central States
Howson, J. T., New York
Howson, L. R., Central States
Hoy, J. R., Florida
Hoy, M. J., Dakota
Hoydar, Albert L., Pacific Northwest
Hoyle, W. H., England (I.S.P.)
Hoyt, Clinton W., New York
Hoyt, Earle S., Ohio
Hromada, Frank M., Central States
Hubbell, George E., Michigan
Hubel, J. H., Canada
Huber, Harold J., New York
Huebner, Ludwig, California
Huether, A. D., Canada
Huffman, Fred, California
Huffman, Lloyd C., Ohio
Hufford, L. E., Ohio
Hughes, V. R., Oklahoma
Hughes, W. P., Pacific Northwest
Hume, Norman B., California
Humphreys, G. Howard, England (I.S.E.)
Hunt, Geo. W., California
Hunt, H. S., Michigan
Hunt, Henry J., Central States
Hunt, L. W., Central States
Hunter, A., England (I.S.P.)
Huntress, C. O., Missouri
Hupp, John E., Jr., Central States
Hurd, Charles H., Central States
Hurley, J., England (I.S.P.)
Hurst, Chas., Central States
Hurst, D. H., Georgia
Hurst, Howard M., California
Hurst, W. D., Canada
Hurtado, J. R., Florida
Hurwitz, Emanuel, Central States
Hussong, Ernest W., Central States
Hutchins, Will A., Central States
Huth, Norman A., California
Hutton, H. S., Pennsylvania
Hyatt, Carl, Rocky Mountain
Hyde, Charles Gilman, (Honorary) California

Ignacio, Krause A., Federal
Illinois Dept. of Public Health, (Corporate), Central States
Imbt, M. Russell, Pennsylvania
Indiana State Bd. of Health, (Corporate), Central States
Infilco, Inc., Associate, Att'n: H. W. Gillard (Corporate), Central States
Ingalls, James C., Pacific Northwest
Ingols, Robert S., Michigan
Ingram, Wm. T., California
Iowa City, City of (Iowa), Iowa
Iowa Falls, City of (Iowa), Iowa
Iowa Valve Co., Associate, Att'n: C. S. Howard
Irvine, A. S., Canada
Irwin, Forrest, Ohio
Irwin, G. M., Pacific Northwest
Ivanissevich, Ludovico, Argentina

Jack, David, Canada
Jack, Grant R., Canada
Jackson, R. B., Michigan
Jackson, S., England (I.S.P.)
Jackson, T. L., Michigan
Jacobs, J. R., Georgia
Jacobs, L. L., Georgia
James, Glenn, Central States
James, Norman S., Florida
Janzen, H. A., Kansas
Jarlinski, Alice M., New York
Jarlinski, Thaddeus T., New York
Jeffrey, H. H., California
Jeffrey Manufacturing Co., Associate, Att'n: S. L. Tolman
Jenckes, J. Franklin, Jr., New England
Jenks, Glenn, Rocky Mountain
Jenks, Harry N., California
Jenne, Lyle L., Pennsylvania
Jenner, George L., Missouri
Jennings, A., England (I.S.P.)
Jensen, Emil C., Pacific Northwest
Jerge, Ray, New York
Jerman, Daniel L., New York
Jessup, A. H., California
Jeup, Bernard H., Central States
Jewell, H. W., California
Job, Richard C., Georgia
Johannessen & Girand, Arizona
Johns-Manville Corp., Associate, Att'n: G. A. McGinnis
Johnson, Arthur N., Central States
Johnson, C. Frank, New England
Johnson, Clement, New York
Johnson, Cleo V., Texas
Johnson, Dennis C., Central States
Johnson, E. W., Canada
Johnson, Earle P., Pennsylvania
Johnson, Floyd E., Central States
Johnson, Frank L., Central States
Johnson, Fred D., Canada
Johnson, Gerald F., Central States
Johnson, Henry, Central States
Johnson, Herbert O., New York
Johnson, Ira, Central States
Johnson, Jess B., Central States
Johnson, John W., New York
Johnson, Kenneth R., Dakota
Johnson, L. M., Central States
Johnson, R. J., Central States
Johnson, Robert T., Iowa
Johnson, Russell K., New York
Johnson, Verner C., California
Johnson, W. W., Central States
Johnson, Warren A., Missouri
Johnson, William A., Central States
Johnston, David J., Central States
Johnstone, Alan, New York
Joiner, W. N., Texas
Jonas, Milton R., Central States
Jones, C. B. O., England (I.S.P.)
Jones, Daniel, New York
Jones, E. M., Pennsylvania (Dual-New York)
Jones, Frank O., Central States
Jones, Frank Woodbury, Ohio, (Dual-Pennsylvania)
Jones, Harvey P., Ohio
Jones, John N., Central States
Jones, Martha A., Central States
Jones, S. Leary, Federal
Jones, T. A., Georgia
Jones, Thomas P. B., California
Jones, Wayland, California
Jordan, Harry E., New York
Jorgenson, Homer W., California
Josam Manufacturing Co., Associate, Att'n: Leo N. Newman
Joy, C. Fred, Jr., New England
Junge, Gilbert, Dakota
Jungwirth, Frank, Iowa

Kaar, G. C., Central States
Kachelhoffer, Fred G., Pacific Northwest
Kachorsky, M. S., New Jersey
Kadinger, Fred, Central States
Kafka, John, Central States
Kahn, James M., Georgia
Kaiser, C. T., Georgia
Kaler, P. E., Kansas
Kaltenbach, Albert B., Maryland-Delaware
Kamerling, Lane, Michigan
Kamp, Ewald A., Central States
Kane, R. D., Ohio
Kaplan, Bernard, New Jersey
Kaplovsky, A. J., New York
Kappe, S. E., Pennsylvania (Dual-New England and New York)
Karalekas, Peter C., New England
Kass, Nathan I., New York
Kearney, John J., Central States
Keef, Walter L., Texas

Keefer, Clarence E., Maryland-Delaware
Keeler, J. Harold, New York
Keeler, Russell B., California
Kehr, William Q., Missouri
Keirn, Kenneth A., California
Keis, F. J., New York
Keith, J. Clark, Canada
Kelleher, Joseph A., New York
Keller, Earl D., Ohio
Keller, J., Central States
Keller, Jacob, New York
Keller, L. M., New York
Keller, S. K., Florida
Kelley, R. E., Michigan
Kellogg, James W., North Carolina
Kelly, Clarence, New York
Kelly, Earl M., California
Kelsey, Walter, New York (Dual-Pennsylvania & New England)
Kemp, Harold A., New York (Dual-Federal)
Kempkey, A., California
Kennedy, C. C., California
Kennedy, D. R., California
Kennedy, R. R., California
Kennedy, William, New York
Kenney, Norman D., Maryland-Delaware
Kennison, Karl R., New England
Kent, S. R., Georgia
Kepner, Dana E., Rocky Mountain
Ker, M. F., Canada
Kershaw, Arnold, England (I.S.P.)
Ketcham, Joseph M., New York
Kewer, J. F., Sr., Central States
Keyes, Harmon E., Arizona
Kidd, Carl W., New York
Kieffer, Jos. D., New York
Kielkopf, Frederick J., Pennsylvania
Kiker, John E., Jr., New York
Kilcawley, Edw. J., New York
Killan, E. T., New Jersey
Kimball, Jack H., California
Kin, Stephen R., North Carolina (Dual-New York)
Kinderman, Wm., Pennsylvania
King, Arch L., Texas
King, Earl J., Georgia
King, Ed. E., Arizona
King, Henry R., Central States
King, L. H., Florida
King, L. P., California
King, Richard, Central States
King, William, Central States
Kingsbury, H. N., Central States
Kingston, S. P., Central States
Kingston, T. M. S., Canada
Kingwell, E. G., Pacific Northwest
Kinney, E. F., Central States
Kinney, J. B., Canada
Kinsel, Harry L., New England
Kipp, W. H., Pacific Northwest
Kirchoffer, W. G., Central States
Kirn, Matt, Central States
Kirsner, Chas., New York
Kittrell, F. W., Federal
Kivari, A. M., California
Kivell, Wayne A., New York
Kizler, Wilfred C., California
Klegerman, M. H., New York
Klein, J. A., Central States
Klein, L., England (I.S.P.)
Klein, Lewis, Pennsylvania
Klein, Wm. I., New Jersey
Kleiser, Paul J., Central States
Kleven, John, North Dakota
Klinck, Frank, New York
Kline, H. S., Ohio
Knapp, Chas. A., New York
Knapp, Floyd H., New York
Knapp, Henry A., Georgia
Knechtges, O., Central States
Knight, C. H., Canada
Knittel, E. A., Pacific Northwest
Knoedler, H. A., California
Knollman, Fred, Rocky Mountain
Knowles, Coyle E., New York
Knowlton, W. T., California
Koch, Philip L., Central States
Kochtitzky, O. W., Jr., Federal
Koebig, A. H., Jr., California
Koesterer, Edwin, Central States
Kolb, Fred W., California
Komline, T. R., New Jersey
Konichek, James T., Central States
Koon, Ray E., Pacific Northwest
Koruzo, John E., Georgia
Kozma, Albert B., New Jersey
Kramer, Harrison W., Pacific Northwest
Kramer, Harry P., Central States
Kraus, L. S., Central States
Kressly, Paul E., California
Kreutter, Clarence, New York
Kroeber, Frederick V., Central States
Kronbach, Allan J., Michigan
Kroone, T. H., Ohio
Kropp, George W., Missouri
Kruegel, J. L., Missouri
Krueger, A. L., Missouri
Krum, Harry J., New York
Kuhl, F. A., Central States
Kuhner, Frank G., Central States
Kunowski, Peter, New York
Kunsch, Walter M., Central States
Kunze, Albert T., Michigan
Kussmaul, T. C., Ohio

Lacy, Ilbert O., New York
Ladlow, John, Arizona
Lafferty, Ernest L., North Carolina
Lafferty, W. R., New Jersey
Lafreniere, Theo. J., Canada
Laidlaw, C. T., Canada
Lakeside Engineering Corp., Associate, Att'n: R. O. Friend, (Corporate), Central States
Lamb, Charles, Canada
Lamb, Clarence F., New England
Lamb, Max R., Rocky Mountain
Lamb, Miles, Central States
Lambert, Francis J., New York
Lambert, George, Rocky Mountain
Lamothe, Wilfred, New England
Lamoureux, Vincent B., Federal
Lamping, Leonard L., Pacific Northwest
Lamson, B. F., Canada
Lang, Sheldon, Federal
Langdon, B. J., Federal
Langdon, L. E., Central States
Langdon, Paul E., Central States
Langelier, W. F., California
Langer, Joseph J., North Dakota
Langford, Leonard L., New York (Dual-New England and Pennsylvania)
Langlais, Zachee, Canada
Langmuir Paints, Canada
Langshaw, C. L., England (I.S.E.)
Langwell, Louis, Central States
Lannon, William, New England
Lanphear, Roy S., New England
Larkin, W. H., New York
Lansing, Edward S., New York (Dual-New England)
Larson, C. C., Central States
Larson, Keith D., Central States
Larson, L. L., Central States
LaRue, Luther, Ohio
Lasaga, Andres, Texas
Lassiter, L. I., North Carolina
Latham, Donald S., New England
Lauer, Wm. N., Central States
Laughlin, William G. C., New York
Lauramore, Horace H., Florida
Lauster, K. C., Dakota
Lautenschlager, Hubert, Ohio
Lautz, Harold L., Central States
LaValley, Edward C., New York
Lawrence, John, New York
Lawson, W. S., Canada
Lea, J. E., England (I.S.P.)
Lea, W. S., Canada
Leach, Walter L., Ohio
Leahey, Anthony T., New Jersey
Learn, Henry C., Central States
Leatherland, C. F., Canada
LeBosquet, M., Federal
LeChard, Joseph H., New Jersey
LeClerc, Arthur B., North Carolina
LeClercq, E. P., New York
Ledeen, Rudolph W., Texas
Lederer, K., California
Ledford, George L., New York
Lee, Chas. H., California
Lee, J. Douglas, Canada
Lee, Ming, Central States
Lee, Oliver, Central States
Leemaster, J. F., Michigan
Leggett, F. H., England (I.S.P.)
Leh, Willard, Pennsylvania
Lehmann, Arthur F., New Jersey
Leigh, H. G., England (I.S.P.)
Leinbach, Harry, Pennsylvania
Leist, Ervin F., Ohio
Leithiser, E., Pennsylvania
Leland, Raymond I., Central States
Lemcke, Ewald M., California
Lemieux, R. A., Canada
Lemon, Paul R., California
Lendall, Harry N., New Jersey
Lenox, Jacob L., New Jersey
Lentfoehr, Charles E., Central States
Leonard, O. M., Florida
Leonard, W. V., Rocky Mountain
Leonard, Walter E., Ohio
Leonhard, Harold M., Michigan
Lesher, C. E., Jr., Ohio
Lessig, D. H., Central States
LeValley, Fred, California
LeVan, James H., Federal
Levan, Stephen, Central States
Lewis, Harry C., Texas
Lewis, John V., New York
Lewis, R. K., Central States
Ley, Charles H., Canada
Limestone Products Corp. of America, Associate, Att'n: Peter J. Kelley
Lind, A. Carlton, Central States
Lindell, O. V., Missouri
Linderman, I. E., Central States
Linders, Edward, Federal
Lindsley, R. V., England (I.S.E.)
Lindsten, H. C., Dakota
Link-Belt Co., (Corporate), Att'n: Frank W. Lovett, Central States
Link-Belt Co., Associate, Att'n: William L. Hartley
Lippelt, Hans B., New York
Lium, E. L., Dakota
Livingston, L. E., Texas
Livingstone, Bard, California
Lloyd, G. H., Canada
Lobb, Everett, Dakota
Lobee, Frank A., Jr., New York
Locke, Edw. A., New England
Lockett, W. T., England (I.S.P.)
Lockwood, Bronson E., New England
Loelkes, Geo. L., Missouri
Loftus, Harry P., New England
Logan, Robert P., New Jersey
Long, Chas. A., New York
Long, Frank V., California
Long, George S., Pennsylvania
Long, H. Maynard, Central States
Long, James C., New Jersey
Longbottom, V., England (I.S.P.)
Longley, Paul N., Pennsylvania
Loomis, Harry E., New York
Los Angeles Public Library (California), California
Los Angeles Public Library, Serials Div., (California), California
Losee, James R., New York
Luther, Robt. W., North Carolina
Lovejoy, W. L., Pacific Northwest
Lovell, Clarence, Iowa
Lovell Clay Products Co., (Corporate), Att'n: R. E. Richardson, Montana
Lovell, Theodore R., Iowa
Lovett, F. W., Central States
Lovett, M., England (I.S.P.)
Loving, M. W., Central States
Lovrinch, Louis B., Central States
Lowden, L. J., Central States
Lowe, Robt. P., California
Lowe, Walter M., New York
Lowther, Burton, California
Lozier, Wm. S., New York
Lubratovich, M. D., Central States
Luchtenberg, R. O., Ohio
Ludlow Valve Manufacturing Co., Associate, Att'n: Robert Bischoff
Ludwig, Harvey F., California (Dual-Federal)
Ludwig, Russell G., California
Ludzack, F. J., Central States
Lueck, Bernard F., Central States
Luff, R. M., Pennsylvania
Luippold, G. T., California
Lumb, C., England (I.S.P.)
Luquire, Joseph W., Jr., Georgia
Luske, Wm. E., Central States
Lustig, Joseph, Central States
Luthin, John C., Arizona (Dual-Federal)

Lux, Kathleen F., Central States
Lyman, C. S., Ohio
Lynch, Daniel E., Jr., New York
Lynch, James T., New York
Lynchburg Foundry Co., Associate, Att'n: W. Roy Odor
Lyons, William, New York

McAdoo & Allen Welting Co., (Corporate), Pennsylvania
McAfee, H. D., Texas
McAnlis, Chauncey R., Central States
McArthur, Franklin, Canada
McCabe, Joseph, New York
McCabe, Michael, Pennsylvania
McCall, R. G., Central States
McCallum, G. E., Federal
McCan, Wm. Warren, Texas
McCannel, D. A. R., Canada
McCarthy, Joseph A., New England
McCartney, C. L., Pennsylvania
McCaslin, Walter R., Central States
McClain, E. C., Pacific Northwest
McClave, S. Wood, Jr., New Jersey
McClenahan, W. J., Central States
McClintock, H. C., Rocky Mountain
McClure, Ernest, Central States
McCoombs, John A., Canada
McDaniel, C. C., Central States
McDill, Bruce M., Ohio
McDonald, G. S., England (I.S.E.)
McDonald, N. G., Canada
McDonnell, Geo. H., New York
McFarlane, Walter D., Michigan
McFaul, W. L., Canada
McGeorge, W. L., California
McGrath, C. P., Michigan
McGuire, C. D., Ohio
McGuire, M. H., Pacific Northwest
McHugh, C. J., Canada
McIlvaine, Wm. D., Jr., Central States
McInerney, Gerald J., New York
McIntosh, Pierce B., California
McIntyre, F. J., Ohio
McKay, R. Donald, Canada
McKay, W. G., Canada
McKee, Frank J., Central States
McKee, Jack E., New England
McKee, S. C., Ohio
McKeeman, Edwin C., New York
McKeen, W. H., California
McKeever, R. L., Ohio
McKenna, Harold K., Michigan
McKinlay, Daniel, California
McLaren, Alfred M., California
McLaughlin, C. P., Central States
McLaughlin, Carroll W., New York
McLaughlin, H. L., Rocky Mountain
McLaughlin, John, New Jersey
McLean, D. L., Canada
McLean, R. F., Pacific Northwest
McMahon, Walter A., New England
McManamna, T. L., Canada
McMenamin, C. B., New Jersey
McMillan, Donald C., California
McMorrow, B. J., California
McMorrow, Thos. M., California
McMullen, W. B., Canada
McMullen, William, Central States
McNamara, W. P., Pacific Northwest
McNamee, Paul D., Federal
McNicholas, J., England (I.S.P.)
McNiece, L. G., Canada
McNiven, R., Canada
McNulty Engineering Co., Associate, Att'n: A. Donald McCulloch
McWilliams, D. B., Canada
Mabbs, John W., Central States
Macabee, Lloyd C., California
Macauley, J. W., New York
MacCallum, C., New York
MacCallum, Percy C., New York
MacCrea, J. M., New York
MacDonald, J. C., Central States
MacDowell, R. F., Ohio
MacKenzie, Vernon G., Federal
Mackin, J. C., Central States
MacKinnon, Ronald M., Canada
MacLaren, J. F., Canada
MacLean, J. D., Canada
MacLean, William D., Canada
MacNicol, N., Canada
Maga, John A., California
Magnuson, Francis J., Central States
Maguire, Chas. A., New England
Magwood, W. H., Canada
Mahlle, W. S., Texas
Maier, F. J., Federal
Maier, Paul P., Federal
Main, Ralph A., Michigan
Makepeace, W. H., England (I.S.P.)
Malcolm, Wm. L., New York
Mallalieu, W. C., New Jersey
Mallmann, W. L., Michigan
Mallory, Edward B., Pennsylvania, (Dual-Central States & Michigan)
Malone, J. R., North Carolina
Malony, W. L., Pacific Northwest
Mangones, Robt. J., New York
Mann, Alfred H., New York
Mann, Karl M., New York
Mann, Uhl T., New York
Mannes, C. O., Pacific Northwest
Mannheim, Robert, New England
Manning, Paul, Canada
Manock, W. R., Canada
Mansfield, M. G., Pennsylvania
Manteufel, Lawrence A., Central States
Marchon, Seigmund S., New York
Marcott, D. G., Montana
Mariner, W. S., New England
Mark, Richard S., Federal
Marshall, E. A., New York
Marshall, Herbert, Rocky Mountain
Marshall, J. C., Michigan
Marshall, Leslie S., New York
Marshall, W. B., New York
Marshall, W. W., Canada
Marston, Frank A., New England
Martens, Myron M., Central States
Martin, A. E., New York
Martin, Alexander G., New York
Martin, Benn, California
Martin, Charles P., California
Martin, Edw. J., Jr., New York
Martin, Geo. W., Central States
Martin, George W., Pennsylvania
Martin, Phil J., Jr., Arizona
Martin, S. C., Central States
Martin, Stanley F., California
Marx, Frank, New York
Marx, Geo. W., Arizona
Maryland State Dept. of Health, Maryland-Delaware
Mason, E. R., Canada
Mather, Edw. K., Dakota
Mather, L. A., Rocky Mountain
Mathers, Geo., New York
Mathews, E. R., Dakota
Mathews, Frank E., Pacific Northwest
Mathews, W. W., Central States
Mathieson Alkali Works, Inc., Associate, Att'n: J. O. Logan
Matter, L. D., Pennsylvania
Mattox, Leon, Central States
May, D. C., Michigan
May, Harold L., California
Meaney, W. J., Texas
Mebus, Geo. B., Pennsylvania
Mechanik, Joseph, New York
Medbery, H. Christopher, California
Medland, C. R., Canada
Meeker, Herbert J., New York
Melander, William E., New York
Mendelsohn, I. W., New York
Menzies, D. B., Canada
Menzies, J. Ross, Canada
Mercer, H. S., England (I.S.P.)
Merkel, Paul P., Pennsylvania
Merlo, Louis A., Jr., Canada
Merrick, Ray, Central States
Merrill, Joseph, Canada
Merrill, Walter E., New England
Merryfield, Fred, Pacific Northwest
Merz, H. Spencer, Central States
Merz, R. C., Central States (Dual-Michigan)
Metcalf, H. B., Central States
Metzger, Ambrose B., Pennsylvania
Metzger, Jesse, Central States
Meyer, Carle, New England
Meyer, H. L., Michigan
Meyer, Louis P. H., California
Michael, Fred C., New York
Mick, K. L., Central States
Mickel, John E., Central States
Mickle, Chas. T., Central States
Middleton, Francis M., Federal
Middleton, Walter, New Jersey
Miick, Fred E., California
Miles, Henry J., California
Millensifer, R. W., Montana
Miller, A. S., England (I.S.P.)
Miller, Alden W., Arizona
Miller, Charles W., New York
Miller, David R., Central States
Miller, Fred M., New York
Miller, H. E., Michigan
Miller, J. John, Pennsylvania
Miller, John B., Florida
Miller, John E., Michigan
Miller, L. A., Central States
Miller, Lewis B., Pennsylvania
Miller, Maurice L., Central States
Miller, Noble, Central States
Miller, Norman A., Michigan
Miller, Olly G., Canada
Miller, W. C., Canada
Milligan, Francis B., Pennsylvania
Milling, M. A., Central States
Mills, J. Ralph, California
Mills, W., Stuart, Canada
Mine Safety Appliances Co., Associate
Minneapolis-St. Paul San. Dist., (Corporate), Central States
Mirgain, F. C., New Jersey
Mitchell, Ansel N., Kansas
Mitchell, Burton F., New England
Mitchell, Louis, New York
Mitzel, Robert W., Pennsylvania
Modak, N. V., England (I.S.P.)
Moehr, Louis, Michigan
Moeller, Bernard B., Pennsylvania
Moeller, Carl, Central States
Moeller, William H., New York
Mogelnicki, Stanley J., Michigan
Moggio, Wm. A., North Carolina
Mohlman, F. W., (Honorary) Central States
Moir, Robert W., New England
Molitor, Edward P., New Jersey
Monk, H. E., England (I.S.P.)
Monroe, City of, (North Carolina), North Carolina
Monroe, S. G., Ohio
Monsell, Harry M., New York
Montgomery, Homer M., Oklahoma
Montreal, City of (Quebec), Canada
Moon, James N., Pennsylvania
Moor, Alex, New York
Moor, W. C., Texas
Moore, Charles A., Pennsylvania
Moore, Edward W., New England
Moore, F. Owen, England (I.S.E.)
Moore, Geo. S., North Carolina
Moore, George W., New York
Moore, Lee S., Central States
Moore, R. B., Central States
Moore, R. L., England (I.S.P.)
Moore, W. A., Federal
Moorhead, Truman Orren, Florida
Morehouse, W. W., Ohio
Morgan, Edward F., Jr., New England
Morgan, George, Canada
Morgan, Philip F., Central States
Morgenroth, Fritz, New England
Morin, A., Canada
Morkert, Kenneth, Central States
Morrill, Arthur B., Michigan
Morris, Arval, California
Morris, D. B., Central States
Morris, Lee, Dakota
Morris, Paul J., Pennsylvania
Morris, Rael F., Federal
Morrisey, Richard A., Pennsylvania
Morrison, James E., Pacific Northwest
Morrow, Ben S., Pacific Northwest
Mortensen, Ernest D., New England
Mortenson, E. N., Central States
Moses, H. E., (Honorary) Pennsylvania
Moses, James E., North Carolina
Mosier, J. F., Michigan
Moss, F. J., Federal
Mott, C. A., Canada
Moudy, R. B., Rocky Mountain
Mountfort, L. F., England (I.S.P.)
Mowbray, Geo. A., New York
Mowrey, J. Hase, Pennsylvania
Mowry, R. B., New Jersey (Dual-Pennsylvania)
Moya, Ing. Victor Jose, Pennsylvania
Moyar, Jesse, Ohio

Mudgett, C. T., Michigan
Muegge, O. J., Central States
Mueller Company, Associate
Muldoon, Joseph A., New England
Mulholland, R. A., Texas
Mulvihill, Francis J., Pennsylvania
Munding, Germaine G., New York
Munroe, E. H., Canada
Munroe, Henry F., New England
Munroe, James A. & Sons, Associate
Munroe, Walter C., Maryland-Delaware
Munson, Laura A., California
Murdock, Wm. J., Pennsylvania
Murphree, Verbon L., California
Murphy, John A., Central States
Murphy, Reginald A., New York
Murray, A. E. Scott, England (I.S.E.)
Murschel, Jacob, Dakota
Musgrave, A. S. G., Canada
Muss, Joshua, New Jersey
Mutzberg, F. A., North Carolina
Myatt, H., England (I.S.P.)
Myles, George, Michigan

Naehr, Harry F., Georgia
Nance, E. L., North Carolina
Nangle, B. A., Dakota
Nasi, Kaarlo W., California (Dual-Federal)
Nason, Edward Mck., Canada
National Council for Stream Improvement, (Corporate), Att'n: Harry W. Gehm, New York
National Water Main Cleaning Co., Associate, Att'n: Clinton Inglee
Nauer, Louis A., Jr., Central States
Naylor, William, New England
Neale, William F., Maryland-Delaware
Necker, C. E., Canada
Neffendorf, Alfred, Texas
Neiman, W. T., Central States
Nelle, Richard S., Central States
Nelson, Ben O., Pacific Northwest
Nelson, Casper I., Dakota
Nelson, D. H., Central States
Nelson, Frederick G., California
Nelson, H. G., Michigan
Nelson, H. Lloyd, Pennsylvania
Nemmers, W. P., Iowa
Nesheim, Arnold, Federal
Ness, Ole J., Central States
Neumann, George B., Central States
Neves, Lourenco Baeta, New York
Nevitt, I. H., New York
Newell, M. A., Rocky Mountain
Newell, Town of, (Iowa), Iowa
Newland, Stewart H., Texas
Newlands, James A., New England
Newman, Alfred C., Florida
Newsom, Reeves, New York
Newton, City of, (Iowa), Iowa
Newton, Donald, Central States
Nicholas, Forrest A., Central States
Nichols, Arthur E., New York
Nichols Engineering & Research Corp., Associate, Att'n: R. W. Rowen
Nichols, F. E., Ohio
Nichols, M. Starr, Central States
Nicholson, C. P., New York
Nickel, Jack B., Georgia
Nickle, A. J., Canada
Nicklin, H. S., Canada
Niebergall, Herbert J., New York
Nielsen, N. P., Rocky Mountain
Niles, A. H., Ohio
Niles, Chas. A., New York
Niles, Thomas M., Central States
Nixon, J., England (I.S.P.)
Nixon, M. B., Georgia
Nixon, Ray, Kansas
Noel, Carl F., California
Nold, Vern, Central States
Nollett, Frank, New York
Noltenius, V. Julio, Florida
Nordell, Carl H., Central States
Norfleet, Clark T., California
Norgaard, John, Michigan
Norman, G. A., Central States
Norris, Francis I., Federal
Northrop, L. E., Arizona
Nugent, Harold F., New York
Nugent, Lee M., California
Nussbaumer, Newell L., New York
Nussberger, Fred, New York
Nutter, Frank H., Central States

Obma, Chester A., Central States
O'Brien, Earl F., New York
Ocean City Sewer Service Co., New Jersey
Ockershausen, Richard W., New York
O'Connell, Wm. J., Jr., California
O'Connor, Wm. F., Jr., New York
Odbert, Eugene, Jr., Central States
Odell, Lester, Central States
O'Dell, W. H., New York
O'Donnell, Charles F., New York
O'Donnell, R., Pennsylvania
Oeffler, W. A., Central States
Oeming, L. F., Michigan
O'Flaherty, Fred, Ohio
Ogden, Henry N., New York
Ogden, Willis L., Federal
O'Hara, Franklin, New York
O'Hara, John, Pennsylvania
Ohr, Milo F., Michigan
Oke, Ernest E. W., Canada
Okun, Abraham H., New York
Okun, Daniel A., Central States
Old, H. N., Federal
Olding, A. E., Dakota
O'Leary, W. A., New York
Olewiler, Grant M., Pennsylvania
Oliver, Warren J., Rocky Mountain
Olsen, W. C., North Carolina
Olson, Frank W., Central States
Olson, Jack, Rocky Mountain
Omega Machine Co., Associate
O'Neill, Ralph W., California
Ongerth, Henry J., California
Onions, Robert, Canada
Oplinger, Lester, Pennsylvania
Orchard, W. J., New York
Ordway, E. S., New Jersey
Orr, Wm. S., Canada
Orton, J. W., Michigan
Osborn, L. C., Rocky Mountain
Osenbaugh, R. J., Rocky Mountain
Osterhoudt, William C., New York
Osthoff, Richard H. L., Jr., New Jersey
Otts, Louis E., Jr., Texas
Ousterhout, Alfred, New York
Outlow, J. M., Texas
Overall, W. G., Central States
Owen, Mark B., Canada
Ozelsel, A. M., Central State

Pacheco, Leo, California
Pacific Flush Tank Co., (Corporate), Central States (Dual-Ohio)
Padgett, J. W., Arizona
Page, Ronald C., California
Painter, Carl E., California
Palange, R. C., Federal
Pallo, Peter E., New York
Palmer, Benjamin M., New England
Palmer, C. L., Michigan
Palmer, F. F., Montana
Palmer, Harold K., California
Palmer, John R., Central States
Palocsay, Frank S., Ohio
Panian, August J., Central States
Pappmeier, Louis S., Central States
Pardew, W. Holmes, Pennsylvania
Parker, H. C., California
Parker, L. K., New England
Parkes, G. A., California
Parks, C. A., Pacific Northwest
Parks, Ed., Montana
Parrish, Clifford M., Texas
Parish, Miles A., California
Parrish, Rial T., Ohio
Parsons, R. H., Canada
Partin, John L., California
Patterson, Dewey O., Texas
Patterson, J. R., Missouri
Patterson, Orville W., Central States
Patterson, Roy K., New York
Paul, Lewis C., New York
Pawlak, John S., New York
Payrow, Harry G., Pennsylvania
Peak, M. C., Texas
Peake, J. B., New York
Pealer, Thomas, Pennsylvania
Pearce, Fletcher, Montana
Pearce, H. B., Arizona
Pearl, Emanuel H., Texas
Pearse, Langdon, (Honorary) Central States
Pease, Maxfield, Ohio
Peaslee, Geo. A., Central States
Peck, Lawrence J., New York
Pecker, Joseph S., New York (Dual-Pennsylvania)
Pederson, Jean J., California
Pelz, Wm. J., Canada
Pense, Irel V., Central States
Pennington, Marvin, Central States
Pennsylvania Salt Mfg. Co., Associate, Att'n: L. L. Hedgepeth
Pepin, E. J., Montana
Pequegnat, Robt. K., Canada
Perkins, C. K., New York
Perrine, J. Franklin, New York
Perry, A. H., Canada
Perry, Earl R., New England
Peterson, Earl L., New York
Peterson, Edward T., Central States
Peterson, Ivan C., Central States
Peterson, J. H., California
Peterson, Myhren C., Central States
Peterson, Ralph W., Central States
Petrie, Wm. P., New England
Pett, K. M., Central States
Pfeifer, John C., Pacific Northwest
Phelps, B. D., California
Phelps, Boyd E., Central States
Phelps, Earle B., New York
Phelps, Ellis K., Florida
Phelps, Geo., Canada
Philips, H. S., Canada
Phillips, Elmer, California
Phillips, H. N., New York
Phillips, R. S., North Carolina
Phillips, Roy L., Pennsylvania
Phoenix, Edward A., New York
Piatt, Wm. M., North Carolina
Pickett, Arthur G., California
Pierce, C. L., California
Pierce, D. O., California
Pierce, George O., Central States
Pierce, H. M., Dakota
Pierce, W. E., Michigan
Pierron, L. L., Ohio
Pierron, Wm., Sr., Pacific Northwest
Pierson, Nat D., North Carolina
Pincus, Sol, New York
Pine, E. T., Central States
Pinkney, Glenn E., New York
Pinney, F. W., Dakota
Piper, K., Dakota
Pitkin, Ward H., New York
Pittsburgh-Des Moines Co., Associate, Att'n: J. E. O'Leary
Pittsburgh Equitable Meter Co., Associate
Pizie, Stuart G., Florida
Placek, O. R., Federal
Pledger, A., England (I.S.P.)
Plummer, M. W., Montana
Plummer, Raymond B., Central States
Pohl, C. A., New York
Pollex, Elmer, Ohio
Pollock, John M., New York
Pomeroy, Clarence, Michigan
Pomeroy, Richard, California
Poole, B. A., Central States
Poole, S. B., England (I.S.P.)
Poole, Wm. A., California
Pope, Lester, New Jersey
Porges, Ralph, Federal
Porteous, W. K., England (I.S.E.)
Porter, H., California
Porter, J. W., Montana
Porter, Sam D., Michigan
Porter, Thomas H., Canada
Porter, William, New York
Posey, James, Maryland-Delaware
Post, Fred W., California
Post, H. H., Michigan
Poston, R. F., Rocky Mountain (Dual-Federal)
Potter, Dave., Central States
Potter, H. M., Maryland-Delaware
Potts, Clyde, New York
Potts, Harry G., Michigan
Powell, A. R., New York
Powell, Frances, Texas
Powell, G. G., Canada
Powell, J. G., Canada
Powell, Otto, Central States
Powell, Reuben R., Florida

Powell, S. T., Maryland-Delaware
Powell, W. L., Texas
Powers, E. C., Ohio
Powers, R. W., California
Powers, Thomas J., Michigan
Pratt, Gilbert H., New England
Preston, A. M., Texas
Price, C. P., Dakota
Price, D. H. A., England (I.S.P.)
Priess, LeRoy, Kansas
Pringle, H. L., Canada
Probasco, S. R., New Jersey
Prodanovich, Danilo, Georgia
Proportioneers, Inc., Associate, Att'n: H. E. Hollberg,
Proudman, Chester F., New England
Provost, Andrew J., Jr., New York
Pruitt, A. C., Texas
Public Works Magazine, Associate
Puckhaber, Fred H., Texas
Puffer, Stephen P., New England
Purdie, David J., New York
Purser, John R., Jr., North Carolina

Quaely, Martin F., New York
Quartly, Eric V., California
Quigley Company, Inc., Associate, Att'n: R. A. Trefethen
Quinn, Joseph L., Jr., Central States
Quivey, Raymond V., New York

Racek, L., Jr., Central States
Racely, Wilbur A., California
Radcliffe, Jack C., New Jersey
Radel, Andrew, New Jersey
Raisch, Wm., New York (Dual-New England)
Ralston, Wilmer R., Pennsylvania
Ramseier, Roy E., Sr., California
Randall, W. T., Canada
Raneri, Ray, Federal
Rankin, R. S., Central States
Ransiear, Wm. A., New York
Ratcliffe, Robert C., Rocky Mountain
Rath, Henry M., New York
Rawding, Roy, Kansas
Rawley, Leo, Central States
Rawlins, George S., North Carolina
Rawn, A. M., California
Rawson, E. Otto, Canada
Raymond, Nelson I., Michigan
Raymond, R. P., New Jersey
Read, Homer V., Central States
Read, Jack E., Canada
Reames, H. S., Michigan
Reardon, Wm. R., Central States
Reaves, S. H., Georgia
Rector, K. E., Kansas
Redding, Harry P., North Carolina
Redfern, W. B., Canada
Redman, Geo. W., Pennsylvania
Reed, Chas. A., California
Reed, Leon H., New England
Reed, Paul W., Central States
Reedy, Timothy D., Michigan
Reese, Marshall, Pennsylvania
Reeve, Lester G., Pennsylvania
Reeve, S. P., Kansas
Reeves, C. F., California
Rehler, Joseph E., New York
Reid, G. Graham, Canada
Reid, Geo. W., Florida
Reidell, A. G., California
Reiman, F. J., Michigan
Rein, L. E., Central States
Reiners, A. H., New Jersey
Reinhardt, Arthur W., California
Reinke, E. A., California
Reisert, Michael J., New York
Remsburg, W. N., Kansas
Remsen, John, New York
Rendell, Theodore, England (I.S.P.)
Rennels, Willard T., Central States
Renoud, Gleason L., California
Requardt, G. J., New York
Reuning, Howard T., Pennsylvania
Reuschel, Earl R., Missouri
Rew, Myron E., California
Reynolds, Leon B., California
Reynolds, M. W., Michigan
Reynoldson, C. G., Central States
Renoldson, T. B., England (I.S.P.)
Rhoads, Edward J., Pennsylvania
Rhodes, T. W., Georgia
Ribal, Raymond Robt., California

Ribner, M., New York
Ribreau, Gilbert E., New York
Rice, Archie H., Pacific Northwest
Rice, Clifton L., Florida
Rice, John E., Federal
Rice, John M., Pennsylvania
Rice, Lawrence G., New York
Richard, Joseph, Michigan
Richards, G. H., Canada
Richardson, C. G., Associate (Dual-New England). Also see Builders-Providence, Inc.
Richgruber, Martin, Central States
Richheimer, Chas. E., Florida
Richman, W. F., Central States
Richter, James B., Central States
Richter, Paul O., Central States
Rickard, Grover E., New York
Rickenbach, Howard F., Pennsylvania
Rickey, Clifford E., New England
Riddick, Thomas M., New York
Ridenour, G. M., Michigan
Riedel, John C., New York
Riedesel, G. A., Pacific Northwest
Riedesel, Henry A., Central States
Riedesel, P. W., Central States
Riehl, W. H., Canada
Riffe, Norman T., California
Riis-Cartensen, Erik, New York
Riker, I. R., New Jersey
Rinehart, Clidus, Central States
Ritter, Bruce, Michigan
Ritter, Rollin, Georgia
Ritter, Roy H., Maryland-Delaware
Roach, Vincent, Iowa
Roach, W. H., Dakota
Roahrig, Henry L., Central States
Robbins, George T., Florida
Roberton, L. T., Canada
Roberts, A. L., Arizona
Roberts, C. R., New York
Roberts, E. F., Canada
Roberts, F. C., Jr., California (Dual-Federal)
Roberts, Jack, New York
Roberts, W. C., California
Robertson, John, California
Robins, Maurice L., Central States
Robinson, B., Canada
Robinson, Fred M., Central States
Robinson, G. G., Canada
Robinson, I. F., Canada
Robinson, Philip L., Georgia
Robinson, W. S., California
Rocco, John, New York
Rockstraw, F. W., Pennsylvania
Rodwell, Robert D., Central States
Roe, Frank C., Central States
Roe, Joseph P., New York
Roeller, R. S., Pennsylvania
Roetman, Edmond T., Pennsylvania
Rogers, Allan H., New York
Rogers, D. Paul, Pennsylvania
Rogers, Harvey G., Central States
Rogers, Jack C., Federal
Rogers, John A., New England
Rogers, M. W., Canada
Rogers, Milford E., Kansas
Rogers, W. H., Central States
Rogus, Casimir A., New York
Rohlich, Gerard A., Central States
Rolfson, Orville, Canada
Roll, A. H., Central States
Romaine, Burr, Central States
Romeiser, C. H., Central States
Roney, L. R., Dakota
Ronhovde, I. N., Texas
Roob, F. H., Central States
Rosemeyer, Alfred, Central States
Rosen, Milton, Central States
Rosengarten, W. E., Pennsylvania
Ross, Hermann M., Central States
Ross, W. E., Central States
Rosser, A. W., Georgia
Roth, R. F., Ohio
Rothrock, R. K., Texas
Rozar, W. C., Georgia
Rowe, James Albert, Central States
Rowen, R. W., Central States
Royer Foundry & Machine Co., Associate, Att'n: S. B. Davies
Rubincam, James L., Pennsylvania
Ruchhoft, C. C., Central States (Dual-Federal)
Ruck, Franklin, Ohio

Ruckel, Paul J., Sr., Rocky Mountain
Rudgal, H. T., Central States
Rudolfs, Willem (Honorary) New Jersey
Rudolph, R. L., California
Rue, Robert, Ohio
Ruge, J. Herman, Florida
Ruhmann, Ovid G., Central States
Rumble, G. B., Canada
Rumsey, James R., Michigan
Ruppert, E. L., Pacific Northwest
Ruscica, Samuel, Canada
Russell, George, Missouri
Russell, George S., Missouri
Russell, J. P., Canada
Ryan, Alfred J., Rocky Mountain
Ryan, J. Samuel, New York
Ryan, Wm. A., New York
Rybolt, Howard R., Florida
Rymer, Mary E., Rocky Mountain

Saetre, Leif, New York
Sage, Howard D., New York
Sager, John C., Central States
St. John, Conrad H., Florida
St. Louis County Hospital, Missouri
St. Louis Public Library, Missouri
Sala, David W., Central States
Salle, Anthony, New York
Salvato, J. A., Jr., New York
Sammis, L. A., New York
Sampson, George A., New England
Samson, Channel, New York
Samson, R. A., Rocky Mountain
Sanborn, J. F., New York
Sanchis, Joseph M., California
Sander, Irwin P., New York
Sanderson, W. W., New England (Dual-New York)
Sandler, Theodore T., Florida
Sandquist, E., Montana
Sanitary District of Elgin, (Corporate), Central States
Santilli, Frank, New York
Sargent, Edward C., Ohio
Sargent, H. H., Central States
Sauer, Victor W., California
Savage, Edward, New York
Saville, Thorndike, New York
Sawyer, Clair N., Central States
Sawyer, Robt. W., Jr., New England
Sayer, Leslie, Rocky Mountain
Scales, E. P., Georgia
Schaefer, Edw. J., New York
Schaetzle, T. C., Ohio
Schatz, Robert J., Pennsylvania
Schaut, Geo. G., Pennsylvania
Scheak, H. M., Canada
Scheffer, Louis K., Pennsylvania
Scheidt, Burton A., Central States
Schenk, E. F., Iowa
Scherf, Albert W., Central States
Schick, V. R., Ohio
Schier, Lester C., Central States
Schirk, J. M., Rocky Mountain
Schlechty, Eugene W., Ohio
Schlenz, Harry E., Central States
Schliekelman, R. J., Iowa
Schloss, Chas. M., Rocky Mountain
Schmit, J. M., Montana
Schneider, Warren A., California
Schneller, M. P., Central States
Schoepfle, O. F., Ohio
Schott, Edgar C., California
Schouten, Ernest W., Oklahoma
Schrader, Elmer C., Montana
Schreiner, W. R., New York
Schriner, P. J., Central States
Schroeder, Arthur W., Central States
Schroeder, C. A., Central States
Schroeder, G. W., Canada
Schroeder, Harry, Pennsylvania
Schroepfer, George J., Central States
Schuck, H. W., California
Schulhoff, Henry B., New York
Schultz, Ray W., Central States
Schureman, A. L., California
Schwartz, Charles F., New York
Schwartz, H. L., Pennsylvania
Schwob, Carl E., Federal
Sciver, A., England (I.S.E.)
Scott, Cliffton A., Central States
Scott, G. R., Federal
Scott, Homer B., Florida
Scott, L. H., Georgia
Scott, Ralph H., Central States

Scott, Roger J., Central States
Scott, Rossiter S., New York
Scott, W., England (I.S.P.)
Scott, W. M., Canada
Scott, W. R., Georgia
Scott, Walter M., New York
Scott, Warren J., New England
Scovill, John R., New York
Scudder, A. P., New York
Searight, Geo. P., Pennsylvania
Searls, Glenn, New York
Seaver, Wirt D., Missouri
Segel, A., California
Seid, Sol., New Jersey
Seifert, Wm. P., New York
Seitel, G. C., California
Seligmann, Irving S., Texas
Sellers, A. E., England (I.S.P.)
Seltzer, J. M., Pennsylvania
Semino, Carlos A., Argentina
Sencey, Joe, Central States
Setter, Lloyd R., New York
Senseman, Wm. B., California
Sewage Works Engineering, Associate, Att'n: Karl M. Mann
Shank, John J., Pennsylvania
Shannon, R. C., Michigan
Shapiro, Robert, New York
Shapley, William H., Iowa
Shard, R. H., England (I.S.P.)
Sharp, G. W., Canada
Sharp, Perry C., Federal
Shaw, Frank R., Federal
Shaw, Morton, Central States
Shaw, Paul A., California
Shaw, Robert S., New Jersey
Shea, Walter J., New England
Shearer, A. B., California
Sheen, Robt. T., Pennsylvania
Sheets, W. D., Ohio
Shephard, W. F., Michigan
Shepperd, Frederick, New York (Dual-New England)
Shera, Brian L., Pacific Northwest
Sherman, Leslie K., New England
Sherratt, Gayle F., Pennsylvania
Shertzer, J. H., Pennsylvania
Sherwood, William H., Arizona
Shields, James L., Pennsylvania
Shiffer, Russell R., Pennsylvania
Shillinger, William D., Central States
Shipman, H. R., Central States
Shivers, Clifford H., Pennsylvania
Shockley, C. A., Missouri
Shockley, Homer G., New York
Shoebotham, T. B., Central States
Shook, H. E., California
Shook, Howard R., Canada
Showalter, Charles M., Pennsylvania
Shupe, S., Canada
Sickler, Archie H., New York
Sidle, R. S., England (I.S.P.)
Sieber, John D., Pennsylvania
Siebert, Christian L., Pennsylvania
Siegel, John A., California
Signor, C. V., Pacific Northwest
Sigworth, E. A., New York
Silberbauer, Walter R., California
Simmerman, John S., New Jersey
Simmonds, I. G., Canada
Simon, Samuel S., New York
Simplex Valve & Meter Co., Associate, Att'n: Everett M. Jones
Simpson, Maynard, Central States
Simpson, Rolland W., New York
Sims, Chas. H., New York
Singer, Oscar C., Ohio
Singleton, M. T., Georgia
Simmons, M. F., Georgia
Simonton, Lewis R., Georgia
Sisler, H. H., Pacific Northwest
Siverts, Samuel A., California
Skinner, J. F., California (Dual-New York)
Sklarevsky, Rimma, Maryland-Delaware
Slagle, Elmer C., Central States
Sleath, Aubrey B., New England
Sleeger, Warren H., Central States
Sloan, Garrett, Federal
Slocum, Adelbert I., New York
Slough, John, New York
Smallwood, Charles, Michigan
Smith, A. H., Ohio
Smith, Benjamin L., New York
Smith, C. A., California
Smith, E. A., Cappelen, New York
Smith, E. E., Canada
Smith, Earl T., Michigan
Smith, Edward J., New York
Smith, F. L., Canada
Smith, Frank J., New York
Smith, G. C., England (I.S.P.)
Smith, Gilbert M., Central States
Smith, H. G., California
Smith, Harold, New York
Smith, Harold L., Michigan
Smith, Harvey J., Pacific Northwest
Smith, J. F., California
Smith, J. Irwin, Central States
Smith, L. R., New York
Smith, Mansel W., Texas
Smith Manufacturing Co., A. P., Associate, Att'n: W. P. Baerenrodt
Smith, Marvin L., Pennsylvania
Smith, Neal D., California
Smith, Paul L., Maryland-Delaware
Smith, R. C., New Jersey
Smith, R. L., Central States
Smith, R. Trumbull, Pacific Northwest
Smith, Ralph A., Central States
Smith, Robt. J., Michigan
Smith, Russell S., Federal
Smith, S. H., Michigan
Smith, Stanley F., Texas
Smith, W., Austin, Georgia
Smith, W. T. E., Canada
Smith, Walter E., Michigan
Smith, Willard R., New York
Smithson, Thomas, Pacific Northwest
Smithwick, S. Carl, Pacific Northwest
Sneath, Roy G., Canada
Snedeker, L. LaVerne, Michigan
Snell, J. R., New England
Snelsire, Wm., Pennsylvania
Snider, L. N., Central States
Snook, W. F. A., England (I.S.P.)
Snow, Donald L., Central States (Dual-Federal)
Snow, Willis J., New England
Snyder, John A., Jr., California
Snyder, M. K., Pacific Northwest
Snyder, N. S., New York
Snyder, R. F., Ohio
Sohler, George W., California
Solander, Arvo A., Federal
Solboe, Richard, Central States
Somers, Verne, Central States
Sommerfeldt, Everett L., New York
Sowden, Howard J., Central States
Sowdon, Wm. K., New York
Spaeder, Harold J., Central States (Dual-Ohio)
Spaeth, Julius, Kansas
Sparks, George H., Georgia
Sparr, A. E., New York
Spaulding, L. H., Pacific Northwest
Spear, James J., California
Spear, Wm. B., Pennsylvania
Speiden, H. W., Pennsylvania
Speirs, George W., New York
Spencer, Albert W., New York
Spencer, City of, (Iowa), Iowa
Spencer, C. C., Federal
Sperling, Elmer J., Florida
Sperry, John R., Central States
Sperry, Walter A., Central States
Spiegel, Milton, Central States
Spieker, Roy G., Dakota
Spier, Daniel R., New York
Spies, Kenneth H., Pacific Northwest
Sporseen, Stanley E., Pacific Northwest
Spragg, H. J., Iowa
Spriggs, W. R., England (I.S.P.)
Spry, Fred J., New York
Spurgeon, Ralph, Central States
Stack, John P., Central States
Staley, H. H., Kansas
Stalker, W. D., Canada
Stanbridge, H. H., England (I.S.P.)
Stanford, W. J., Texas
Stanhope, Clifford T., New York
Stanley, C. M., Iowa
Stanley, J. B., Texas
Stanley, Wm. E., New York
Stapf, R. J., Dakota
Stapley, Edward R., Oklahoma
Stark, Louis, Michigan
Starks, Lee W., Rocky Mountain
Stauff, Paul V., Central States
Staven, Julian, Dakota
Staynes, E. H., England (I.S.P.)
Steeg, Henry B., Central States
Steffen, A. J., Central States
Steffensen, S. W., New York
Steffes, Arnold M., Central States
Stegeman, Paul, Michigan
Steigman, Harry, Federal
Steindorf, R. T., Central States
Steiner, Joseph, Central States
Steiner, S. K., New York
Stepanek, Charles H. B., New York
Stepleton, Harold A., Ohio
Sterbcow, Edith, Texas
Sterns, Edward A., New York
Stevens, Donald B., Federal
Stevens, Harry, Maryland-Delaware
Stevenson, Albert H., New York (Dual-Federal)
Stevenson, Ralph A., California
Stewart, Clyde L., Oklahoma
Stewart, Dueray L., California
Stewart, Earl, Canada
Stewart, F. C., Canada
Stewart, F. D., Ohio
Stewart, H. M., Pennsylvania
Stewart, Jesse A., California
Stewart, L. O., Iowa
Stewart, Morgan E., California
Stewart, R. E., California
Stewart, W. H., New York
Stiemke, Robt. E., North Carolina (Dual-Federal)
Stigall, J. C., Texas
Stilson, Alden E., New York
Stipe, George J., Rocky Mountain
Stock, Mitchell B., New England
Stockman, L. R., Pacific Northwest
Stoker, E. C., England (I.S.P.)
Stolp, R. C., Central States
Stone, A. R., England (I.S.P.)
Stone, Ralph, Florida
Storey, Benjamin M., Central States
Storm, Wm. H., Central States
Storrie, Wm., Canada
Stotter, Meyer, New Jersey
Straker, M. L., Ohio
Strand, Philip E., Central States
Strandburg, Charles J., New York
Strang, J. A., Kansas
Strangard, Edward L., California
Stratton, Charles H., New York
Straub, Conrad P., New York (Dual-Federal)
Street, Haskell R., Texas
Streeter, H. W., Federal
Streeter, Robert L., Rocky Mountain
Streeter, S. H., England (I.S.E.)
Strelow, J. L., Iowa
Strickland, G. H., Canada
Strickland, Raymond, Central States
Stringer, R. M., Georgia
Strockbine, Walter, Pennsylvania
Stroessenreuther, G. A., Central States
Strohmier, Charles W., Pennsylvania
Strong, A. L., Montana
Strong, Bruce F., New York
Strowbridge, John C., New York
Stuart-Brumley Corp., Associate, Att'n: Fred E. Stuart
Studebaker, Leo, New York
Studinski, C. R., Rocky Mountain
Sturgeon, R. G., Canada
Stutz, C. N., Central States
Sulentic, S. A., Kansas
Sullivan, Fred O., Central States
Summers, M. W., England (I.S.E.)
Sund, Gutorm, Central States
Susa, Stephen A., Pennsylvania
Sutcliffe, H. W., Canada
Suter, Max, Central States
Sutherland, Henry M., New York
Sutter, Oliver, Ohio
Suttie, R. H., New England
Sutton, R. W., England (I.S.P.)
Svenson, Sven, Kansas
Svore, Jerome H., Dakota
Swab, Bernal H., North Carolina
Swartz, Martin, North Carolina
Swearingen, W. H., Montana
Sweeney, J. Stanley, Florida
Sweeney, R. C., New York
Swender, Harvey P., Iowa
Swenholt, John, New York

Swenson, John P., Georgia
Swinehart, Eugene B., Pennsylvania
Swink, Earl M., Missouri
Swope, Gladys, Central States (Dual-Pennsylvania)
Sylliassen, M. O., Pacific Northwest
Sylvester, Wm. L., New York
Symons, G. E., New York
Szymanski, John R., New England
Szymanski, Walter C., California

Tabor, James Vernon, Pennsylvania
Taggart, R. S., New York
Tallamy, Bertram Dalley, New York
Tallent, Lee H., Rocky Mountain
Tamer, Paul, New York
Tapleshay, John A., Central States
Tapping, C. H., Central States
Tarbell, W. P., Dakota
Tarbett, R. E., Federal
Tark, M. B., Pennsylvania
Tralton, Ellis A., New England
Tarman, John E., Pennsylvania
Taylor, Arthur, California
Taylor, D. R., Florida
Taylor, F. W., Georgia
Taylor, Frank S., Oklahoma
Taylor, Godfrey M. C., England (I.S.E.)
Taylor, H., England (I.S.P.)
Taylor, Henry W., New York (Dual-Pennsylvania)
Taylor, J., England (I.S.P.)
Taylor, Spencer R., California
Taylor, Warren G., New York
Teisinger, Fred, Iowa
Tempest, W. F., Central States
Temple, N. E., Pennsylvania
Tennant, H. V., Central States
Terhoeven, G. E., Federal
Ternent, Andrew, Canada
Terrill, James G., Jr., California (Dual-Federal)
Terry, Frank, New York
Tetzlaff, Frank, New York (Dual-Federal)
Thalheimer, Marce, Central States
Thamasett, Otto E., New York
Thatcher, E. F., Missouri
Thatcher, Fred A., New York
Thatcher, H. D., England (I.S.P.)
Thayer, Paul M., Central States
Thayer, Reginald H., New York
Theriault, E. J., Federal
Theroux, Frank R., Michigan
Thews, Vernon W., California
Thoits, Edw. D., California
Tholin, A. L., Central States
Thomas, A., England (I.S.P.)
Thomas, A. H. R., Canada
Thomas, Ariel A., Central States
Thomas, E. C., Canada
Thomas, E. R., North Carolina
Thomas, Vernon B., Ohio
Thompson, H. Loren, Central States
Thompson, N. J., Rocky Mountain
Thompson, Robert B., New England
Thompson, S. E., Central States
Thompson, Thomas C., New York
Thompson, Walter E., New England
Thomson, F. N., New York
Thomson, J. B. F., New York
Thorn, William J., Pennsylvania
Tier, J. V., Florida
Tierney, Lawrence J. J., New England
Tigrak, Mehmet Fuat, Central States
Timanus, C. S., Kansas
Timmons, Cyrus L., Florida
Tippy, Kenneth Clem, New England
Todd, Lee O., Texas
Todd, Leon J., Central States
Todd, Stanley B., New York
Tolles, Frank C., Ohio
Tolman, S. L., New York
Tomek, Arthur O., Central States
Tomm, LaVern M., New York
Tompkins, Lloyd, Michigan
Towne, John W., Central States
Towne, W. W., Dakota
Townend, C. B., England (I.S.P.)
Townsend, Darwin W., Central States
Tracy, Edward L., New England
Trautman, Robert J., Maryland-Delaware
Travaini, Dario, Arizona
Travers, V. P., Florida
Trebler, H. A., Pennsylvania
Troemper, Paul A., Central States
Trostle, N. E., Texas
Trotter, Roy M., California
Troutman, LeRoy, Federal
Trulander, Wm. M., Central States
Tuhus, Kenneth, Central States
Turley, Comer, Georgia
Turner, J. R., Ohio
Turner, Wm. S., Pacific Northwest
Turpin, U. F., Central States
Turner, Homer G., Pennsylvania
Tuttle, Leon E., New England
Twin City Testing & Engr. Lab. (Corporate), Central States
Tygert, C. B., Pennsylvania
Tykosky, Frank, Michigan
Tyler, H. G., Canada
Tyler, Jacob W., New York
Tyler, R. G., Pacific Northwest

Uhlmann, Paul A., Ohio
Umbenhauer, E. J., Pennsylvania
Underwood, J. E., Canada
United States Pipe & Foundry Co., Associate
University of Calif. Library, California
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Upton, Frank W., New York
Upton, Glenn, Central States
Urban, Robert C., New York
Ure, Douglas G., Canada
Urick, R. H., Iowa
Urquhart, M. B., Rocky Mountain
Uyanik, Mehmet E., Central States

Vaaler, Adrian W., Pacific Northwest
Van Atta, J. W., New York (Dual-New England & Pennsylvania)
Van Blarcum, B. H., Kansas
Vandenberg, Alfred John, California
Van Denburg, J. W., New York
Vanderlip, Arthur N., New York
Van Der Vliet, Henry, New Jersey
Van Derwerker, Ralph J., Federal
Van Deusen, Claude R., New York
Van Deusen, E. J., New York
Van Deventer, M. S., Missouri
Van Horn, R. B., Pacific Northwest
Van Kleeck, LeRoy W., New England
Van Ness, Joseph A., Rocky Mountain
Van Norman, Jas. H., California
Van Pelt, Richard, California
Van Praag, Alex, Jr., Central States
Vapor Recovery Systems Co., Associate, Att'n: C. T. Stanhope
Varner, Frank S., Pennsylvania
Vaseen, V. A., Rocky Mountain
Vaughan, E. A., California
Veale, J. C., England (I.S.P.)
Veatch, F. M., Rocky Mountain
Veitch, Wm. M., Canada
Velz, C. J., New York
Velzy, C. R., New York
Venables, W. M., Canada
Venn, Frank, Michigan
Vensano, H. C., California
Ver Dow, William H., New York
Verhoek, J. B., Central States
Vest, W. E., North Carolina
Victoria, John, New York
Vincent, G. G., Canada
Vinson, A. T., Florida
Vivier, Harvey, New England
Voden, Stewart, Montana
Vogelbein, Charles J., Missouri
Vognild, R. O., Pacific Northwest
Voigt, Richard C., New York
Volonte, August F., Maryland-Delaware (Dual-Federal)
Volpp, A. G., Pacific Northwest
Vosicky, Frank E., Pennsylvania
Vredenburg, Edward L., New York
Vrooman, Morrell, New York

Waddell, W. H., Canada
Wade, W. J., Central States
Wadhams, S. H., New England
Wagenhals, H. H., New York
Waggoner, E. R., California
Wagner, E. P., New York
Wagner, Edwin B., Pennsylvania
Wagner, Vincent, Pennsylvania
Wahlstrom, Carl A., Central States
Wailes Dove-Hermiston Corp., Associate, Att'n: W. H. T. Thornhill
Waite, Paul W., Pennsylvania
Wakeley, Guy B., Central States
Walbridge, Thornton, Central States
Walker, C. C., Ohio
Walker, Chas. L., New York
Walker, Edward A., Pennsylvania
Walker, J. Donald, Central States
Walker, James G., New York
Walker, W. P., Jr., Texas
Walker, William W., Federal
Wallace & Tiernan Co., Inc., Associate, Att'n: B. M. Lindsay
Wallach, Arthur, Federal
Walters, F. Y., Canada
Walters, Grover L., California
Walton, Graham, Central States
Ward, A. R., England (I.S.P.)
Ward, C. N., Central States
Ward, Oscar, Central States
Warden, Lotus A., Central States
Wardle, J. McClure, New York
Wardwell, T. M., Central States
Ware, Howard, New York
Waring, F. H., Ohio
Warner, E. L., Pacific Northwest
Warner, Richard G., Dakota
Warren, George D., New York
Warrick, L. F., Central States
Washburn, Howard C., New York
Washington State Pollution Commission, Pacific Northwest
Water Dept., (Lenoir, N. C.), North Carolina
Water & Sewage Works (New York, N. Y.), Associate
Waterman, Earle L., Iowa
Waters, Geo. E., Central States
Watkins, F. B., Pennsylvania
Watmough, W. W., Canada
Watson, C. K. F., England (I.S.P.)
Watson, Carl H., New York
Watson, David M., England (I.S.E.)
Watson, H., England (I.S.P.)
Watson, Henry G., Rocky Mountain
Watson, W., England (I.S.P.)
Watters, T. C., Central States
Weachter, Horace, Pennsylvania
Weasner, Leo, Central States
Weatherby, Charles H., New York
Weaver, E. D., Canada
Weaver, W. H., Georgia
Webber, R. H., Canada
Weber, Robert R., Ohio
Webster, Roy W., Pacific Northwest
Webster City, City of (Iowa), Iowa
Wechter, W. H., New York
Weed, Sam A., California
Weeber, Earl R., Michigan
Wedeman, John D., New York
Weibel, S. R., Federal
Weil, Harold M., New York
Weir, E. McG., England (I.S.P.)
Weir, H. McLean, Canada
Weir, Paul, Georgia
Weisel, W. O., Pennsylvania
Weiss, Federico F., Argentina
Weiss, R. H., Texas
Welker, Leland A., New York
Wells, E. Roy, Central States
Wells, H. O., Texas
Wells, S. W., Florida
Welsch, W., Frederick, New York
Wenger, J. H., Ohio
Wenselblat, Nicolas R., Argentina
Wentworth, John P., New England
Wertz, C. F., Pennsylvania
Wertz, Leroy F., Ohio
Wesby, Vernon L., Central States
West, A. W., Central States
West, L. E., New Jersey
Westergaard, Viggo, New York
Westfall, Milton, Central States
Westgate, Thomas A., California
Weston, Arthur D., New England
Weston, H. S., England (I.S.P.)
Weston, Roy F., Pennsylvania
Westwood, H. W. D., England (I.S.E.)
Wheeler, C. E., Jr., Central States
Wheeler, Robert C., New York
Whelchel, H. E., Georgia
Whipple, Frank E., Texas

Whipple, Melville C., New England
Whitby, Stephen S., Pennsylvania
Whitcomb, Leon R., Pennsylvania
White, Clyde, Texas
White, F. L., Pennsylvania
White, Geo. C., California
White, H. H., California
White, Paul R., Central States
White, R. E., California
White, R. H., England (I.S.E.)
White, Roy, Central States
White, W. E., Texas
Whitehead, F. E., New Jersey
Whitlock, Ernest W., New York
Whitlock, Henry C., New England
Whitney, Alfred C., Central States
Whittaker, H. A., Central States
Wiest, Gordon J., Pennsylvania
Wieters, A. H., Iowa
Wightman, J. L., Michigan
Wigley, Chester G., New York
Wild, Harry E., Florida
Wiley, Averill J., Central States
Wiley, John S., Federal
Wilkes, F. Dean, Canada
Wilkins, George F., California
Willett, C. K., Central States
Williams, A. C., Pennsylvania
Williams, Chas. H., Pacific Northwest
Williams, Chas. W., Central States
Williams, Clyde E., Central States
Williams, G. Bransby, England (I.S.E.)
Williams, George W., Central States
Williams, J. T., Canada
Williams, Johnnie E., Texas
Williams, Leon G., Central States
Williams, S. J., Michigan
Williams, W. B., Michigan
Williams, William D., Pennsylvania
Williamson, A. E., Florida
Williamson, Joe, Jr., Florida
Wilson, Alex, Canada
Wilson, C. T., Iowa
Wilson, Donald H., Dakota
Wilson, F. E., Florida
Wilson, Harry L., Central States
Wilson, J. Preston, Rocky Mountain
Wilson, John N., Federal
Wilson, Murray A., Kansas
Wilson, N. Bruce, Canada
Wilson, R. D., Central States
Wilson, R. H., Jr., Ohio
Wilson, Robert A., Central States
Wilson, Walter, Texas
Wilson, William B., Canada
Wilson, W. G., Canada
Winch, Norman M., New England
Windridge, M. E. D., England (I.S.P.)
Winebrenner, K. J., Montana
Winfield, Wilmer M., New York
Wing, Frederick K., New York
Winne, Geo., New York
Winsor, C. E., England (I.S.P.)
Winston, Joe B., Texas
Wintersgill, A. T., California
Wirt, R. M., Pennsylvania
Wirts, John J., Ohio
Wise, Melvin J., California
Wise, William S., New England
Wisely, F. E., Central States
Wisely, W. H., Central States
Wishart, J. M., England (I.S.P.)
Wismer, J. Earl, Pennsylvania
Wisniewski, Theo, Central States
Witcher, C. Preston, Michigan
Wittmer, Earl F., Ohio
Wittwer, N. C., New Jersey
Woese, Carl F., New York
Wojdugo, J. M., Central States
Wolf, Wm. E., Central States
Wolfteich, John, New York
Wolman, Abel, Maryland-Delaware
Wolterink, Paul, Michigan
Woltmann, J. J., Central States
Wontner-Smith, H., England (I.S.P.)
Woo, Francis H., California
Wood, George L., California
Wood, Herbert M., New York
Wood, J. R., Canada
Wood Co., R. D., Associate
Woodburn, James G., Central States
Woodhouse, Herbert M., Canada
Woodring, R. W., Pennsylvania
Woodruff, F. L., Ohio
Woodrum, Logan, Central States
Woods, W. G., Canada
Woodward, John D., Pennsylvania
Woodward, R. L., Federal
Wooley, Chas., New York
Woolidge, H. V., Canada
Wooten, Frank M., Jr., North Carolina
Wormuth, W. H., New York
Worrest, Howard A., Pennsylvania
Worthington, Erastus, New England
Worthington Pump & Machinery Corp., Associate
Wright, Arthur, Rocky Mountain
Wright, Arthur, New Jersey
Wright, Charles T., Federal
Wright, Edw., New England
Wright, Edward C., Missouri
Wright, L. R., California
Wright, Scott, Texas
Wurtenberger, Helen, Central States
Wyant, Clifford, Pennsylvania
Wyatt, Bradley W., California
Wyckoff, Charles R., New York
Wyckoff, H. A., Georgia
Wyllie, Geo. F., Michigan
Wymore, Allan H., Missouri

Yaeck, Arthur W., Canada
Yaffee, C. D., Federal
Yeager, Bert T., Dakota (Dual-Central States)
Yenchko, John, Pennsylvania
Yeomans Brothers Co., Associate, Att'n: Chas. Yeomans (Corporate), Central States
Yerkes, Milton R., Pennsylvania
Yoder, M. Carleton, California
York, Walter H., Georgia
Yost, Harold W., Arizona
Young, Alden W., New York
Young, C. H., Pennsylvania
Young, Norman C., Pennsylvania
Yow, W. E., North Carolina

Zack, Samuel I., New York (Dual-Pennsylvania)
Zander, Karl L., Federal
Zele, Alexander S., New York
Zeller, P. J. A., Texas
Zetterberg, Edw., Central States
Ziegler, C. H., Pennsylvania
Zievers, Robt. J., California
Zimmer, W. E., Michigan
Zoglmann, Martin, Central States
Zorn, Ray H., Ohio
Zydallas, Charles, New Jersey

Original Woodcut by Lynd Ward

2 BIG

CONDUCTED

$2000.00 IN CASH

SPONSORED

PITTSBURGH EQUITABLE METER DIVISION

TO STIMULATE THINKING ABOUT THE COMMUNITY BENEFITS

CONTEST NO. 1

Complete the last line of this jingle

Water works systems should not be neglected,
All other utilities are meter protected.
When water is wasted, costs run high;
The mounting deficit makes taxpayers cry.
100% metering is the only fair way,
- -

This one is easy—anyone can enter and win. Study the principal advantages of 100% metering listed on this page. Then write a clever, informative last line for the jingle. As an example, the last line could read:

"To charge consumers, make water plants pay."

You can send in as many last lines as you wish.

PRIZE LIST

1st Prize—$500.00
2nd Prize—$250.00
3rd Prize—$100.00
4th Prize—$ 50.00
10 Consolation Prizes of $10.00 each

TIPS ON ADVANTAGES OF 100% METERING

Metered consumers only pay for the water that is used—not for someone else's waste.

Metering discourages water waste—often cuts per capita distribution in half—conserves power, lowers treatment costs.

100% metering, by eliminating extravagant use of water, frequently curtails the need for costly added sources of supply.

By metering all services the burden caused by excessive wasted water on overloaded sewage disposal systems can be relieved.

Meters produce added revenue, usually enough to cover initial investment, maintenance costs and depreciation.

The meter system provides the only fair and equitable basis for apportioning water charges to all consumers.

TEAR OUT THIS COUPON NOW!

CONTESTS!

AT THE SAME TIME

PRIZES

ENTER EITHER OR BOTH!

BY THE

ROCKWELL MANUFACTURING CO.

RESULTING FROM 100 PER CENT METERING

CONTEST NO. 2

Write a paper not exceeding 2,000 words in length on the subject

"How A Community Is Benefited By Metering All Services"

Here is a topic all water works superintendents, municipal officials and engineers can write about. Contestants can either cite actual instances (with supporting data) to show where 100% metering has produced benefits to the communities concerned, or give their own arguments in favor of metering all services. Logic and clear thinking will count equally as well as past metering experience.

Contestants will, at the discretion of the Editor, be offered a $25.00 cash release fee for the use of their papers in the Pittsburgh-Empire Water Journal.

PRIZE LIST

1st Prize — $500.00
2nd Prize — $250.00

3rd Prize — $100.00
4th Prize — $ 50.00

10 Consolation Prizes of $10.00 each

CONTEST RULES and REGULATIONS

Everyone is eligible to participate except employees and members of their families of any DIVISION or SUBSIDIARY of ROCKWELL MANUFACTURING COMPANY and their Agents.

All entries must be accompanied by coupon clipped from any contest announcement. Only one coupon is required to identify a contestant who submits a number of entries at the same time.

Write on one side of paper only. *DO NOT* put name or address on any entry. An executed coupon will serve as contestant's identification.

Contests close August 31, 1946. Entries must be postmarked on or before that date.

Winners names in both contests will be posted in Pittsburgh-Empire Meter exhibit booths at the fall water works conventions. Checks will be mailed to winning contestants immediately upon completion of judging.

All entries will be impartially judged by a panel of informed water works authorities. Names will be announced later.

The decisions by the judges will be final and no entries will be returned. In case of ties, duplicate prizes will be awarded.

USE THIS COUPON

Fill in coupon with name and address. Clip, pin or staple to entry sheet or sheets. Upon receipt a code number will be assigned to each contestant and this number alone will appear when subject matter is being considered by the board of judges. No entries accepted without coupon.

PITTSBURGH EQUITABLE METER DIVISION
ROCKWELL MANUFACTURING CO.
400 N. Lexington Ave., Pittsburgh 8, Pa.

Attached find my entry or entries for

CONTEST NO. 1 ☐ CONTEST NO. 2 ☐

Check in boxes provided. Where entries are submitted in both contests, check both boxes.

Your Name .... Title ....

Business Connection ....

Street ....

Town .... State ....

CONTESTS CLOSE AUGUST 31, 1946

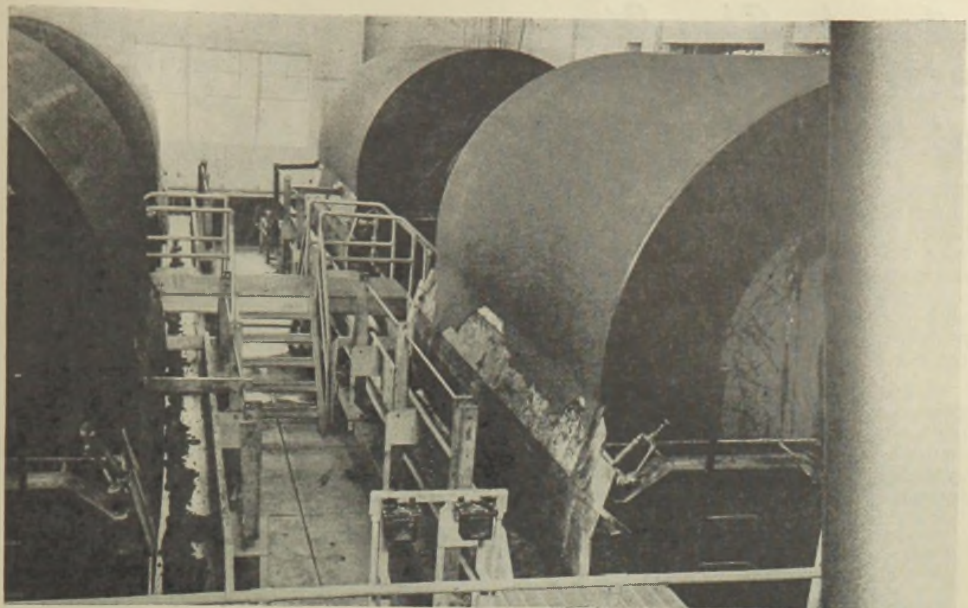
DIRECTORY OF ENGINEERS

(Continued on pages 36 and 37)

DIRECTORY OF ENGINEERS

(Continued from preceding page)

DIRECTORY OF ENGINEERS



Let your HEAD take you

(The average American today has a choice of just going where "his feet take him", or choosing wisely the course to follow. Let's skip ahead 10 years, and take a look at John Jones—and listen to him . . .)

"SOMETIMES I feel so good it almost scares me.

"This house—I wouldn't swap a shingle off its roof for any other house on earth. This little valley, with the pond down in the hollow at the back, is the spot I like best in all the world.

"And they're mine. I own 'em. Nobody can take 'em away from me.

"I've got a little money coming in, regularly. Not much—but enough. And I tell you, when you can go to bed every night with nothing on your mind except the fun you're going to have tomorrow—that's as near Heaven as man gets on this earth!

"It wasn't always so.

"Back in '46—that was right after the war and sometimes the going wasn't too easy—I needed cash. Taxes were tough, and then Ellen got sick. Like almost everybody else, I was buying Bonds through the Payroll Plan—and I figured on cashing some of them in. But sick as she was, it was Ellen who talked me out of it.

" 'Don't do it, John!' she said. '*Please* don't! For the first time in our lives, we're really saving money. It's *wonderful* to know that every single payday we have *more* money put aside! John, if we can only keep up this saving, think what it can mean! Maybe someday you won't have to work. Maybe we can own a home. And oh, how good it would feel to know that we need never worry about money when we're old!'

"Well, even after she got better, I stayed away from the weekly poker game—quit dropping a little cash at the hot spots now and then—gave up some of the things a man feels he has a right to. We didn't have as much fun for a while but we paid our taxes and the doctor and—we didn't touch the Bonds.

"What's more, we kept right on putting our extra cash into U. S. Savings Bonds. And the pay-off is making the world a pretty swell place today!"

The Treasury Department acknowledges with appreciation the publication of this advertisement by

FEDERATION OF SEWAGE WORKS ASSOCIATIONS

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