

Pearse's results showed that acid treatment produced a higher recovery of fat, namely 69% of that in the sewage as compared with 47% obtained by plain subsidence for three hours. The sludge, which amounted to 2,275 lbs. per million gallons, contained, on an average, 93% of moisture and 25% of fats. The results also showed a great reduction in oxygen demand,—170% of that obtained by an Emscher tank. They also showed a removal of 71% of the suspended matter.

TABLE 1—COMPARISON OF AVERAGE RESULTS OF TREATING SEWAGE WITH SULPHUROUS ACID, AS SHOWN IN EXPERIMENTS BY E. S. DORR AND M. I. T. SANITARY RESEARCH LABORATORY, 1912-1914 AND 1915, RESPECTIVELY

	Experiments by E. S. Dorr.	Experiments by M. I. T. Sanitary Research Laboratory.
Average daily flow of sewage during experiments, gallons	92,514,647	103,498,049
Average amount of dry sludge, pounds per million gallons of sewage	1,738	1,909
Average percentage of grease in dry sludge	21.7	22.66
Average amount of grease precipitated from sewage, pounds per million gallons	436	430.1
Average amount of sulphur dioxide used, in pounds per million gallons	*2,300	1,963

Much more extensive experiments have been conducted by Prof. C.-E. A. Winslow of the Yale University Medical School, and Dr. F. W. Mohlman, now chemist of the Connecticut State Department of Health. The results of these experiments have been embodied in a paper read in September, 1918, before the American Society for Municipal Improvements at its meeting in Buffalo and abstracted elsewhere.†

The experiments were conducted at New Haven under the auspices of a special committee, and consisted of four long-time runs with the sewage from the East Street sewer, and one run with that from the Boulevard sewer, the former runs varying from twenty-four to seventy days, the latter being twenty-nine days' duration. Alongside the experiments with the Miles acid process, there were conducted experiments with screens, with the activated sludge process, and with Imhoff tanks and with plain subsiding basins, with and without chlorine disinfection.

In the experiments with the Miles process, the sewage was acidified with sulphur-dioxide gas, and a four-hour period of subsidence was provided. The alkalinity of the

TABLE 2—CHARACTER OF MILES ACID SLUDGE AT NEW HAVEN

	East Street Sewer.	24 days	44 days	70 days	29 days
Length of run	25 days	239,400	407,820	602,220	145,600
Total gallons sewage treated.	260,000				
Pounds of wet sludge per mil. gals. sewage	3,750	4,025	3,200	2,600	5,375
Specific gravity	1,067	1,048	1,054	1,061
Per cent. moisture	86.6	88	86.3	85.7	92.5
Pounds dry sludge per mil. gals. sewage	503	483	439	368	403
Ether extract, per cent. dry sludge	23.7	24.0	29	32.6	30.9
Ether extract, pounds per mil. gals.	119	116	127	120	124
Volatile matter, per cent. dry sludge	47.2	51.2	57.3	63.8	78.5
Nitrogen, per cent. dry sludge	1.6	1.6	2.4	2.0	3.0

East Street sewage was very low, so that it was necessary, to secure an excess acidity of 50 p.p.m., to add only 700 lbs. of gas per million gallons of sewage treated. With the Boulevard sewage, 1,130 lbs. of acid per million gallons of

sewage were required to secure the same excess acidity (computed in terms of calcium carbonate).

The treatment removed from 61% to 66% of the total suspended, and 90% of the settleable solids. The removal of bacteria was all that could be desired, the two last experiments, with the East Street and Boulevard sewages respectively, indicating removals of over 99% of the total bacteria, and of the gas-forming organisms.

The use of acid accelerated the precipitation of the suspended solids by about 50%, only 40% being removed from the untreated sewage by plain subsidence as compared with 60% when the Miles process was used. The data regarding the production of sludge are as follows:—

Opposed to these very favorable results is the presence in the grease extracted from the sludge of a large proportion of unsaponifiable material (waxes, mineral oils and similar substances). Substances of this kind are practically worthless, and their removal is attended with a great deal of expense. The sludge from the East Street sewers contained 24% of grease, 46% of tankage and 28% of water. The grease had the following composition:—

	Per Cent.
Moisture and volatile matter	11.0
Unsaponifiable material	21.1
Free fatty acids	40.2
Neutral grease	22.3
Insoluble soaps	3.3
Per cent. of resin in free fatty acids	14.4
The degreased sludge had the following composition:—	
Ammonia	3.91%
Phosphoric acid, P ₂ O ₅	0.96%

Winslow and Mohlman are advised by experienced users of grease that it would be necessary to distill the crude extracted product in order to produce a salable grease. This fact has been recognized, and, on the basis of distillation experiments, they estimate that the grease in the East Street sewage would be worth \$5.00, and the fertilizer \$2.09 per million gallons,—a total of \$7.09 net,—while the grease value of the Boulevard sewage would be \$8.50, and the fertilizer value \$2.88 per million gallons,—a total of \$11.38, net.

Conditions at New Haven are such that the effluent must be clarified and disinfected, but not necessarily nitrified. These conditions are favorable to the Miles process, to Imhoff tanks combined with chlorination, and to fine screening combined with chlorination, respectively. The activated sludge process would not work because of the presence of copper salts in the sewage.

The operation costs of the disposal plant are estimated in the following tables:—

TABLE 3—ESTIMATED COST OF TREATMENT OF EAST STREET SEWAGE—DOLLARS PER MILLION GALLONS

	Miles Acid Process.	Imhoff Tanks and Chlorination.	Fine Screens and Chlorination.
Tanks and Buildings (interest and depreciation) ..	\$ 2.47	\$ 5.28	\$ 4.60
Acid treatment	6.93		
Drying sludge	2.09		
Degreasing sludge	1.78		
Redrying sludge17		
Superintendence	1.06	.46	.46
Labor on tanks and screens ..	1.00	1.20	1.42
Disposal of sludge or screenings		1.00	.50
Chlorination		4.05	4.05
Gross cost	15.50	11.99	11.03
Revenue	6.57		
Net cost	8.93	11.99	11.03

The results of these experiments have warranted the New Haven Committee in recommending the Miles process for adoption by the city of New Haven, and that a plant be built first at the East Street sewer, which discharges 16,000,000 gals. daily, and, if this plant be successful, the sewage from the other outfalls should be treated.

* Approximate.

† Engineering News-Record, 81, 1034-1036. Also 82, 32-36.