

always possible to remove any clogging matters by air pressures of 10 lbs. or over.

On May 16, 1919, the plant was first started in a preliminary way with the intention of obtaining activated sludge from the contents of two cesspools which were emptied into one of the aerating tanks. The cesspool material amounted to about 11,000 gals. and represented the accumulation of some months, coming from the water-closets used by the 200 employees. There was some interruption in getting the mechanical equipment in smooth working order and very little was obtained as a result of the first month's operation. The cesspool wastes appeared to have been septicized to a point where it was difficult to activate the suspended matter.

#### Activation of Outside Material

Failure to obtain proper sludge from the cesspools resulted in a systematic effort being made to obtain activated sludge by using organic substances other than the factory wastes. Use was made of peat, humus, sawdust, horse manure and cow manure. Barrel experiments were made with these different substances alone and with the addition of washings from rich garden soil inoculated the organic material with nitrifying bacteria.

It was found that the use of peat presented difficulties caused by mineral matter which clogged the openings of the distributing pipes. In a measure the same was true of the straw mixed with the horse manure. Humus was tried but the expense was greater than for other materials and it was of such a texture that it was impossible to suspend in the liquid treated more than about 5 per cent. as measured by the volume of the sludge after 10 minutes' sedimentation.

Inoculation with washings from garden soil allowed a satisfactory sludge to be obtained in from 3 to 5 days with either peat or humus, and in not to exceed 12 days with cow manure or horse manure. Apparently these latter two materials require a longer period for activation on account of their anaerobic condition initially as compared with the aerobic condition of the peat and humus; without inoculation the sludge was ripened in 18 to 24 days, thus showing that inoculation with nitrifying bacteria materially hastened the activation process.

#### Combustion of Organic Matter

One of the interesting results obtained was the extent to which organic matter disappeared through wet combustion resulting from the oxidizing and nitrifying nature of the process. Studies were carefully made of available sources of organic matter which could be obtained cheaply and readily and which would be satisfactory as regards grit and fibrous products which would tend to clog the air distributing lines. It was finally decided that everything considered, the best material to use is cow manure obtained from neighboring dairies. The volume required is about 8 cu. ft. per 24 hours for a flow of about 150,000 gals. of wastes. The water content of this material varies somewhat but probably averages about 70 per cent. This indicates a needed addition of dry organic matter of about 130 parts per million. The material is mixed with water in a wheel-barrow until in a liquid condition and then applied to the inlet section of the aerating tank. This is done about four times during eight hours of the day or at the rate of about 1 cu. ft. of cow manure per hour during that period. No cow manure is added during the remaining 16 hours when no creamery wastes reach the plant.

#### Operating Program

Under normal conditions the flow is directed to one aerating tank to the amount of about 100,000 gals. daily; quantities in excess of this flow to the second tank. Acid discharges occurring from one to five times per day are bypassed to the re-aerating tank and from there applied with the pumped discharge of limed sludge from the final tank.

The amount of air used is about 0.5 cu. ft. per square foot of tank surface per minute or about 1.5 cu. ft. per gallon of liquid treated. An aeration period of about 3 hours ordinarily seems to suffice and with peat a two-hour period of aeration seems reasonably sufficient for short intervals. The amount

of sludge is kept as nearly as possible to 20 per cent. as a smaller amount does not satisfactorily clarify the wastes and a greater amount requires additional expense for cow manure.

#### Final Sedimentation

After the wastes have been aerated and discharged to the final tank the supernatant liquid is drawn off at the top and the sludge collecting in the hopper bottom is removed continuously by the air lift to the inlet distributing trough as previously explained.

It was found that plain sedimentation for the period available did not produce complete clarification and lime was added at the inlet to the final sedimentation tank at the rate of about 3 grains per gallon. This produces a clear effluent and the lime pumped with the sludge serves a double purpose in that it not only aids in precipitating suspended matters, but it also serves to correct the acidity which appears in the mixed wastes and which are by-passed to the re-aerating tank.

The final effluent is not only well clarified and substantially free of fatty products, but is stable without dilution for a period of more than 14 days in stoppered bottles, subject to the methylene blue test at ordinary temperature.

#### General Considerations

The novelty of this process as applied under local conditions, will be appreciated when it is stated that the problem consists essentially of finding a material with which to build up sludge rather than that of encountering the expense of disposing of sludge as is usually the case; in fact, the sludge beds on an adjoining cinder dump have not been used at all during the first three months of operation of this plant.

The average temperature of the mixed wastes, about 40 degs. C., does not seem to be a handicap to this process, but on the contrary is probably a material factor in intensifying operations as indicated by the relatively short aerating period required as well as by the weight of organic matter which is actually burned out in the aerating tanks. An occasionally influent temperature of about 60 degs. C. for a few minutes is of course not helpful, but the plant seems to recover during the interval between such occasions.

The process is also much less sensitive to acids than one might suppose, although it is a fact that it is somewhat interfered with at times, due apparently to acidity.

The process is greatly dependent on freedom from interruption of the air supply. This was demonstrated when on July 23rd an extraordinarily heavy rain produced local floods which resulted in a suspension of the air supply on two occasions during the same day, one of them being for 8½ hours. This was sufficient for the sludge to lose its activation and become putrescible. It required aeration of about 7 days following this mishap to place the plant on a normal working basis again.

In spite of adverse local conditions this activated sludge plant shows that plants of this type will satisfactorily treat even so difficult a waste as this, and its operation shows that a satisfactory substitute for the suspended matters usually met with and utilized in municipal sewage treatment works of this type may be obtained from various materials outside of those contained in the sewage, the selection of the best material depending on local conditions as to availability and cost.

The plant has not been controlled with the aid of extensive laboratory tests, although at the factory there are reasonably satisfactory laboratory facilities. Working procedures have been developed on the basis of listing one after another the difficulties which arose with a description of remedial steps to be taken in each respective event. During the tuning up operations an experienced operator of sewage disposal plants has been sent to this factory several times each week in order to study its behaviour and the effect on aeration of seeding with garden soil, the correction of acidity and use of lime, as well as the mechanical manipulation of the plant, and steps needed to control the wastes more effectively prior to their entrance into the aerating tank. This tuning up occupied a period of about 10 weeks.