Aerobic Heavy Sludge Digestion

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In recent years there has been an increasing amount of research on the operation of sewage and refuse disposal methods. One of the most recent fields of study has been that of heavy sewage sludge and garbage digestion by aerobic means. Heavy sludge is the non-suspended residue material which is collected from the bottom of the settling tanks of a sewage treatment plant. This sludge should not be disposed of in its raw state and further treatment is necessary before the heavy sludge can be safely disposed of or utilized.

The disposal of heavy sludge is the greatest problem in a sewage treatment works because of the difficulty of handling and the great amount of time required to stabilize the material under conditions available. At the present time many sewage digestion plants handle the heavy sludge by an anaerobic digestion method. The sludge is placed into a closed tank which is similar to a floating-top gas storage tank. Controlled temperatures are applied to the sludge and it is allowed to be digested by microorganisms under anaerobic conditions. Methane is collected as a by-product and is sometimes utilized as fuel to heat the sludge and as fuel for other purposes. However the anaerobic process of heavy sludge digestion involves expensive equipment and, on the average, requires about 30 days for stabilization.

It would be desirable to have a more efficient and less expensive system to handle the same task. A system would be desirable making use of the highly efficient principles of aerobic metabolism, such as that used in the digestion of the light suspended solids found in the liquid portion of the sewage.

Aerobic digestion has been partially investigated at Michigan State University. A digester was designed to digest garbage under aerobic conditions. The device was built on a rotating drum principle which would be costly to maintain and construct on a large scale (Figure 1).

The Fairfield Engineering Company, Marion, Ohio, has been investigating aerobic digestion of garbage on a commercial basis in an experimental plant, but digestion of the material was slow and undesirable odors developed.

In an effort to solve some of the problems encountered by the company, a small pilot plant was built in our laboratories following basically the design of the Fairfield Engineering Company. From the information available, it appeared that the limiting factor to the success of the project might lie in the method and amount of air supply to the sludge digestion system. In the small pilot plant, careful consideration was taken to incorporate a variable air supply.

The pilot model (Figure 1) was constructed from a 25 gallon steel drum, 22 inches in diameter, with a diffusion plate installed on the bottom of the tank. The purpose of the plate was to diffuse compressed air up through the heavy sludge in the tank. The diffusion plate was made of

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Figure 1. Pilot model of aerobic digester.

sheet metal in which many fine holes were drilled to allow the maximum amount of air contact with the sludge. A converted refrigerator compressor with appropriate control valves was used to supply air.

The most unusual part of the digester was the mixing mechanism. It is primarily a rotating bridge with independently rotating impellers. The bridge was constructed of an aluminum "C" channel and supported on nylon rollers which rested on the edge of the tank. Attached to the bridge were seven motors necessary to propel the mechanism. Each of six motors turned a shaft, each of which had four nylon impellers attached for stirring the sludge. The seventh motor rotated the entire bridge 360 degrees by means of a gear reduction mechanism. This device provided for complete mixing of the sludge. Non-corrosive parts were used wherever practicable.

The entire digester was placed inside of an isolette constructed of three mm plastic sheeting (polyethylene) 3x3x4 feet. The isolette was sealed to prevent the escape of any un-wanted odors in the event the digestion did not proceed as planned. The chamber was kept at a positive pressure and was vented through a water trap into a sewer drainage system.

Five gallons of fresh sludge was obtained from the bottom of the primary settling tanks of the Greencastle Municipal Sewage Treatment Plant. The sludge was diluted to ten gallons (12% by weight solids). Air pressure was supplied to the diffusion plate and the speed control was set to give the bridge a rotation speed of $\frac{34}{4}$ rpm. The impellers had a rotation speed of 6 rpm. The initial experiment gave a more desirable rate of digestion than had been obtained before and a stable

product resulted after six days. A slight odor was produced during the digestion which indicated the possibility of some anaerobic digestion in "dead" spots at the bottom of the digestion chamber. The air supply was redesigned to increase air input and the rotation speeds increased which resulted in more rapid digestion with very little odor.

For following runs, the sludge was not diluted, but run at 25% by weight solids, pH 5.4 and temperature of 24 degrees centigrade. It was found that these conditions held steady for the duration of each run.

These primary experiments were repeated and the variables increased to the maximum limitations of the pilot machinery. The product showed that digestion was taking place as planned, but the optimum conditions had not yet been established. It was evident that three basic improvements would have to be made, namely, improved air circulation, better agitation, and the amount of water present would have to be reduced.

The above conditions were incorporated by the Fairfield Engineering Company, e.g. reduced water content and the introduction of large volumes of air into the pulverized garbage mixture through a diffusion system. At present in the large experimental plant, stabilized material is being produced from pulverized garbage in about five days at an operating temperature of 160-170 degrees F.

Further experiments are planned with an improved model of the original unit which should allow for the optimum conditions to be found. Also work is being done to find practical uses for the final product, possibly as a soil conditioner.

The perfection of an aerobic heavy sludge and garbage digestor will allow for a great increase in the efficiency of most sewage treatment plants at a minimal cost. The present anaerobic digestion tanks of most sewage plants could be easily converted to the above aerobic system with a great reduction in time for stabilization of raw product. Such a unit could handle the sewage and garbage disposal problems of a community simultaneously.

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