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THE DRYING OF SEWAGE SLUDGE UNDER PRESSURE

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These Studies deal with current activities in the department of Civil Engineering. They serve as progress reports of major investigations, and in general as a means for disseminating information not readily adaptable for presentation in formal technical papers or bulletins.

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1. Development of the Process.--The successful drying of sewage sludge by alternately freezing and thawing is reported in Bulletin 198 of the Engineering Experiment Station, University of Illinois, entitled "Results of Tests on Sewage Treatment." The successful drying of sewage sludge by freezing is explained by the supposition that particles of water held within particles of sludge freeze and expand as they change from liquid water to solid ice. The formation of the ice crystals may rearrange the water molecules or disrupt the sludge particles, or both, in such a manner as to release some of the water upon thawing. This water easily and quickly drains away leaving a light, fluffy sludge with a relatively low moisture content.

The possibility was suggested of creating a similar condition by heating the sludge under pressure and suddenly releasing the pressure. It was hoped that the sudden conversion from a liquid to a gaseous state would result in a release of retained molecules of water, and might serve as an effective method of drying sludge.

2. Procedure and Equipment.--The procedure followed at first was to place a charge of wet sludge in a pressure vessel, called a "gun," to heat to a predetermined pressure and to release this pressure suddenly by the opening of a quick-opening gate valve. Sludge, violently discharged, was caught in a "target" receptacle and was placed on a sand drying-bed. Observations were made upon the rates of drying of the sludges, and rates of drying were compared among various types of sludges and of various

pressures.

A sketch of the "gun" and receptacle used in the tests is shown in Figure 1. Heat was applied to the gun by an insulated electric resistance coil wound around it.

In the first series of runs the gun was loaded by inserting a charge of sludge weighing approximately 5 kilograms through the breech end. The breech block was closed and the temperature was raised until the pressure on the gage registered the desired intensity. At first the pressure used was 100 p.s.i. The quick-opening valve was then opened and the sludge exploded into the receptacle.

Samples of sludge were immediately transferred to a sand bath at 103°C. temperature. The samples were weighed at regular intervals of time to permit the calculation of the degree of drying against time. A control sample of "unexploded" sludge was dried on the sand bath in a similar manner.

In view of the fact that the heating of the sludge to a temperature of 212°F. or greater would be effective in drying the sludge without exploding it, tests were conducted also on various sludges heated only to 212°F. and dried on the sand bath without explosion.

A third method of heating the sludge was studied in order to demonstrate the degree of efficacy of "exploding" the sludge. In this method the sludge was heated under pressure in the gun to a predetermined pressure, usually 100 p.s.i. The heat was then turned off, without opening the quick-opening valve, and the pressure was allowed to drop to atmospheric pressure before the gun was opened and a sample of sludge was taken and placed on the drying-bed. Sludge treated in this manner was called "hot compressed" sludge.

A fourth method of heating was devised primarily to overcome

a difficulty encountered in the drying of activated sludge. The equipment used is shown in Figure 2. In making a run with this equipment a sample of sludge was placed on a sand filter which was then placed in the steam jacket C. A similar sample was placed, as a control, on a sand filter which was left in the open air at room temperature. Valves A and B were closed and the pressure in the boiler built up to about 180 p.s.i. Valves A and B were then opened slowly and steam entered the steam jacket surrounding the sample, air being bled from the jacket through pet-cock D. The pet-cock was closed when air had escaped. The steam pressure dropped to about 60 p.s.i. and was held at this figure for about 15 minutes. Valves A and B were closed, and D opened to release the steam pressure in the jacket. The moisture content was determined in samples of sludge taken from the drying bed in the steam jacket and from the control drying bed.

During the course of the tests it became evident that the drying of sludge on the warm sand bath was indicative only of a laboratory test, and that conclusions drawn from such tests might not be applicable to field conditions. Consequently it was decided to place the sludges under test on a sand filter of the type shown in Figure 3, designed to simulate conditions on a sand drying-bed. The moisture content of the sludge on the drying bed was computed from the data obtained by periodically measuring the filtrate draining from the bed and by weighing the original sample of sludge placed on the drying-bed.

Sludges tested were: (1) fresh sludge removed by plain sedimentation from sewage taken from the outfall sewer of the Urbana-Champaign sanitary district. This is primarily a fresh, weak, domestic sewage. (2) Digested sludge from the digestion compartment of the Imhoff Tanks of the Sewage treatment plant of the Urbana-Champaign Sanitary District,

and (3) Activated sludge produced in the Sanitary Engineering Laboratory at the University of Illinois.

Discussion of Results.--Some results of tests on fresh sludges are shown graphically in Figures 4, 5, and 6. Inconsistency is shown by these results in that in some cases exploded sludge dries most quickly and in other cases hot-compressed sludge dries most quickly. In one test sludge heated to 212°F. dried in half an hour faster than exploded sludge, and as fast as hot-compressed sludge. In every case the heated sludges dried more rapidly than unheated sludge.

Results of heating and of exploding Imhoff sludges were as inconsistent as were the results of heating primary sedimentation sludge.

Activated sludge gave markedly different results. These results are not shown graphically because the activated sludge was so liquefied by heating and by explosion that after heating or explosion the fluid sludge quickly drained through the bed leaving only a thin film of dried solids on the sand. This difficulty was overcome by the use of the apparatus shown in Figure 2. Some results of heating activated sludge under pressure by this process are shown in Table 1.

Table 1
Results of Heating Activated Sludge Under Pressure in the Apparatus Shown in Fig. 2

Sample	Activated Sludge per cent Moisture			Solids in Filtrate per cent	
	Before Heating or Filtering	After Filtering without Heating	After Heating and Filtering	Without Heating	Heated
A	99.0	95.5	71.7	0.08	0.15
B	99.5	92.8	89.4	0.05	0.10
C	99.4	96.0	60.8	0.10	0.20

It became evident from the results of heating and exploding activated

sludge, and from the results shown in Figure 1, that the rate of drying of sludges cannot be based or compared on the volume of filtrate alone, but that the solids in the filtrate must also be observed and taken into account.

However, for the purposes of studying the effect of drying sludges by explosion results such as those shown in Figure 4, 5, and 6 are significant. These results show clearly that exploded sludges dry no more easily than sludges that are heated without explosion, and that even hot compression is inadequately effective in expediting draining. It is evident that the nature of water molecules is not rearranged by sudden transformation from a liquid to a gaseous state in such a manner as to permit the release of "bound" water in sewage sludge.

It is concluded, therefore, that the drying of sludge by "explosion" is not a practical or economical procedure.

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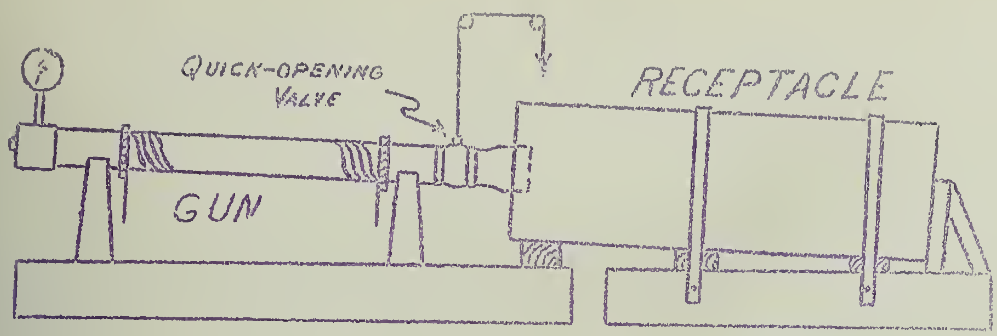

FIG. 1 SLUDGE EXPLOSION AND CATCHING EQUIPMENT

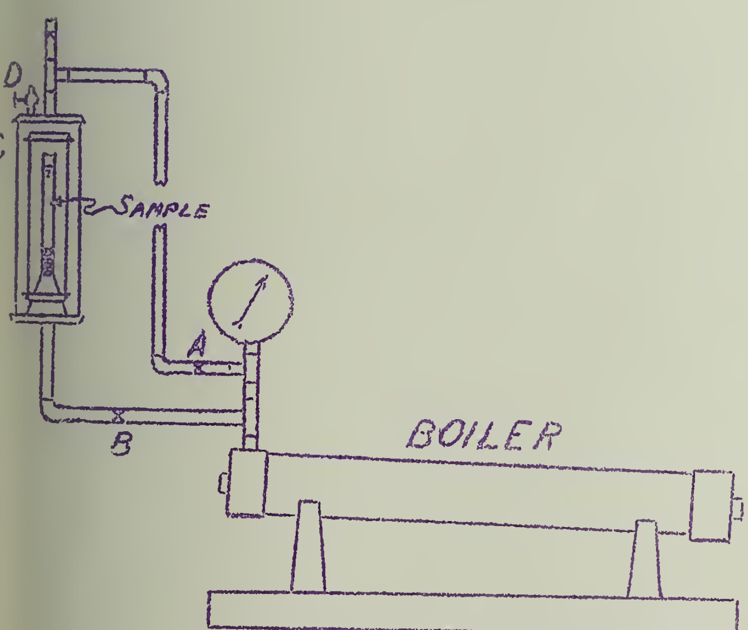

FIG. 2 SLUDGE HEATING EQUIPMENT

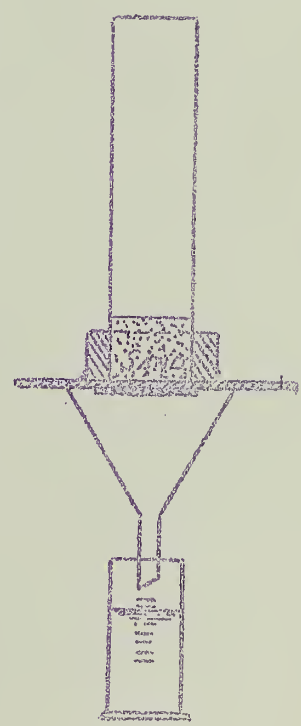

FIG. 3 SECTION THROUGH SAND FILTER