Combined vapors of solvent and water vapor pass out through vapor line to surface condensers of suitable capacity, and in these the mixture of solvent and water vapor is condensed to liquid, which, leaving the tail pipe of the condenser, passes to separating tank, where by virtue of the lighter gravity of the solvent, separation of solvent and water is effected. The solvent flows to storage for re-use. Owing to rapid evaporation, the solvent level is lowered in the tank and a further quantity is pumped in.

Four to five hours are required for the evaporation of all of the water, and at this time, through the sight glasses, the dried fibre, etc., can be observed floating on the top of the solvent. At this point the agitator is stopped, the steam turned off, the drain valves opened, and the grease-laden solvent pumped out through a solvent out-pump line. Several washes with fresh solvent complete the degreasing of the mass, which is then heated, agitated and (with the help of live steam) freed from the absorbed solvent left in the mass after draining.

Preliminary Treatment

Solvent carrying with it the extracted grease, soaps, etc., must receive preliminary treatment before passing to the solvent-recovery and grease-finishing stills. This treatment is carried out in a lead-lined tank provided with an agitator. To the solvent is added a sufficient quantity of sulphuric or muriatic acid and water to completely decompose the metallic soaps present. The acid water is well churned up with the solvent, allowed to settle and drained off; fresh water is added and mixed, allowed to settle and the clear grease-solvent solution run to the recovery stills.

By this treatment, foaming and other difficulties are avoided in the distillation, and the grease recovered does not form the difficultly separated emulsions it is disposed to do. Such grease can be cleaned up and settled free from mechanical impurities and moisture without undue trouble.

The entire cycle of operations takes place in a closed circuit, and the only vent for non-condensable gases for the whole system of tanks (or reducers), condensers, separating tanks, washers, stills and storage tanks, is on the final solvent storage tank or tanks. This vent in turn exhausts through an oil scrubber to recover traces of naphtha carried over by carburetting. During no period of the operation is the sludge exposed to the air or manhandled in any way, until it is finally discharged from the side-door of the tank in a dried, degreased condition. The only places where odors or noxious effluent is exposed to the air and liable to cause an unsanitary and nuisance condition, are at the gas vents on the storage tanks and at the effluent overflow on the separating tank.

This effluent is, of course, distilled water from the sludge, and carries with it the odor of the sludge, which in the case of fresh sludge and that preferably handled, is very offensive. The quantity of this water is of course equal to that contained in the sludge prior to desiccation and the condensed steam from the steaming out of the solvent from the drained sludge prior to dumping from machine. This approximates a ton of effluent for every ton of sludge handled.

Deodorizing Effluent by Chlorination

The only way found by the writer to effect deodorization of this effluent and to render it harmless is by the addition of chlorinated lime or chlorine water. The greatest amount necessary for deodorizing very foul water is one part of 35% available chlorine bleaching powder to 3,000 parts effluent. The non-condensable gases leaving the storage tank vents must be scrubbed with chlorinated lime solution before being allowed to pass to atmosphere.

With these precautions, it is safe to say that the entire operation of desiccation and degreasing, or the whole recovery operation, can be carried out with no offense to public welfare and sanitation.

In handling sewage sludge by this method, no difficulties have arisen, other than those usually met with in handling wet organic materials of other sorts, and since in sludge the moisture is present in free condition, mechanically combined, the period required for desiccation is much shorter than that met with in the treatment of garbage and animal refuse, in which the majority of the water is more or less chemically combined. For this reason only four or five hours are required in drying a given amount of sludge, compared with at least twice that for same amount of garbage.

Capacity and Cost

Experiments and trial runs indicate the capacity of each tank as 8 tons in 24 hrs., and in a plant handling the sludge from a town of 200,000 inhabitants (approximately 40 tons daily, 75% moisture basis) the cost for handling, including overhead and fixed charges, will approach $6 to $6.50 per ton on green sludge.

This cost will not be greatly changed in handling sludge containing 65% or 50% moisture, but since the gross tonnage to be handled would be greatly reduced, the plant investment would be greatly reduced, and the by-product returns per green ton much greater. If by any method of dewatering on beds or other inexpensive method, the moisture can be reduced below 75%, by just so much will the success of a recovery plant pass from just self-maintenance to a possible profit.

After carrying out such an operation, what possible yield of by-products may be expected, and what is their character and what their value? This depends entirely on the nature of the sewage handled. It has been presupposed that any sludge running less than 3% of ammonia on a dry tankage basis is not worth handling, unless indeed the grease content is very high, in which case it is possible that the grease alone might pay for recovery.

From an average of a number of analyses, however, it would seem as if a sludge low in ammonia is also low in grease, so that a 3% ammonia tankage would indicate a 15 to 25% grease content on a dry basis. For these reasons, in handling a 75% moisture sludge, a yield of 420 lbs. of tankage and 75 lbs. of grease may be expected.

Market "Value" of Grease

What is the nature of this grease and tankage? Have they any market value? What use is it to rescue this material if it cannot be sold or used? This is not a matter to be dismissed offhand. At the present time, if either or both of these products were thrown on the market, emphatically they would not find a purchaser, or certainly the price would be absurdly low. Consider the nature of these by-products as indicated by their analyses:—

ANALYSES OF GREASES FROM DIFFERENT TYPES OF SLUDGE

	Free fatty acid.	Unsaponifiable.	Neutral.	Dirt and moisture.
Baltimore (acidulated),	77.48%	11.78%	......	10.74%
Chicago (activated), ..	48.80%	24.40%	19.10%	7.70%
Syracuse (sedimentation),	51.50%	19.30%	18.70%	10.50%
Pleasantville, N.Y. (sedimentation), ...	75.70%	19.80%	4.50%	......
Boston, Moon island (sedimentation):—				
Free fatty acid (as oleic), ...				48.40%
Free fatty acid (by weight), ...				40.19%
Rosin acids (in fatty acid), ...				14.36%
Fatty acids (by difference), ...				25.83%
Unsaponifiable, ...				21.09%
Neutral grease (by weight), (molecular weight of neutral fatty acids, 272), ...				20.00%
Metallic soaps and solid impurities, ...				3.30%

The first four analyses are of grease recovered in the process outlined, and it will be noticed that in the first three, large quantities of solid impurities and moisture are recorded. All grease of sewage sludge origin on leaving stills contains large amounts of such impurities, since due to the emulsifying action of the waxes present in the so-called unsaponifiable, it is very difficult to obtain clean greases without subsequent washing with acid and settling. The fourth analysis is of a grease after such treatment.

These analyses are of several different types of sludge and sewage treatment, yet all present the following general characteristics:—