Chem. Process & Articles

Chemical - Mechanical Treatment of Sewage

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V—*Sludge Treatment. Factors Governing Choice of Method—Results Obtainable*

Dewatering on Sludge Drying Beds One method of dewatering sludge is by placing it on ordinary underdrained sludge drying beds. In those parts of the country where the climate is warm these beds can be uncovered, but where it is cold and subject to freezing weather the beds should be glass covered. Potter and Killam ran a series of extensive experiments at the Atlanta experimental treatment plant on the dewatering of chemical sludge on open sludge drying beds and found that the sludge drained rapidly. In 14 days the average sludge concentration was increased from 5 per cent to 50 per cent and in 30 days it was increased to 80 per cent. The sludge dried with the characteristic cracking and spalling, was spadeable within 10 days, relatively dry in 14 days and had dried to a hard compact cake within 30 days and assumed a fibrous powder form. During this test the average mean temperature was 71°, the average humidity was 68 per cent and the average monthly rainfall was 3.15 inches. This same method of sludge drying was practiced to some extent in the old order of chemical treatment, but the sludge was not conditioned prior to its application to the beds, and more often than not it was septic before it was placed on the beds. With comparatively fresh sludge, conditioned to improve its drainability, drying on underdrained sand beds is an efficient and inexpensive method of dewatering chemical sludge, particularly for the smaller plants. The dewatered sludge contains a sufficient amount of ferric hydroxide and calcium oxide to materially delay putrefactive action and when reduced to between 30 and 40 per cent concentration repeated wetting by rain has no apparent effect on the sludge.

Vacuum Filter Dewatering In larger plants and in plants where sludge drying beds would have a deleterious effect on the appearance of the plant, chemical sludge can be dewatered by means of vacuum filters. With these the sludge is pumped out of the settling tank, with a minimum disturbance and agitation of the sludge, and discharged into sludge conditioning tanks where chemicals are added, usually ferric chloride, for supplementary coagulation. From here it is piped to the vacuum filters, the dewatered cake being transported by belt or screw conveyors to its ultimate point of disposal and the filtrate returned to and mixed with the raw sewage for subsequent treatment. The capacity of vacuum filters is usually rated in pounds of solids (dry basis) per hour per square foot of filter area. This capacity is influenced somewhat by the characteristics of the raw sludge, but depends largely on the effectiveness of the conditioning of the sludge by means of added coagulants to improve its drainability. In actual installations of vacuum filters, dewatering chemical sludge, capacities as high as 12 to 14 pounds of solids (dry basis) per hour have been secured per square foot of filter area. In experimental work, capacities of 3 to 4 pounds were obtained using unconditioned sludge. For average sewages and conditioning of the sludge prior to dewatering it is probably safe to base the filter area on an average loading of 10 pounds (dry basis) of sewage solids per hour per square foot of filter area and determine the total area by the amount to be dewatered during a predetermined number of hours per day of filter operation.

Centrifuge Dewatering The dewatering of chemical sludge in centrifuges has not been practiced in this country. At the present time experimental work is being conducted on two full size centrifuges. One of these is located at the Collingswood, New Jersey, activated sludge treatment plant and has been operated daily for almost a year on raw sludge, digested sludge and combinations of these with activated sludge. This machine is of the vertical batch type with automatic control of loading and unloading. The other machine is located at the Philadelphia Northeast sewage treatment plant and has been operating on raw and digested sludge. This machine is of the vertical continuous loading and unloading type. Centrifuges have been in successful operation for several years in the dewatering of sludge at Frankfort (Germany) plant. These machines are of the horizontal batch type with automatic loading and unloading of the sludge. They operate at the same speed during both loading and unloading. Centrifuging of chemical sludge should be quite practical as the filtrate from the machine will be relatively low in suspended solids and the characteristics of the sludge are such that accelerated gravitational separation should result in the rapid segregation of the solids from the liquid. This method of sludge separation is not only feasible, but may be preferable in many instances to vacuum filter dewatering. However at the present time there are not sufficient data available on which to base any conclusions covering their use.

Chemical Sludge Digestion Chemical sludge, that is one produced by a ferric or ferrous salt with the addition of lime, is not particularly amenable to digestion on account of its high lime content and hydrogen-ion concentration (pH). While the pH could be reduced to the point under which digestion usually proceeds, the lime itself cannot be removed. Digestion is retarded, foul odors are produced and molds and fungi develop rather than bacteria. Some laboratory experiments were conducted by the authors on the digestion of a lime-iron sludge. These experiments were not carrid out on an elaborate scale, but from observations and tests made, digestion of this kind of sludge is not an effective nor an efficient method of sludge treatment. On the other hand, sludge produced by a ferric salt or chlorinated copperas, without lime, can be digested. Rather extensive experiments have been conducted by Rudolfs in which it was shown that the iron slightly retarded the digestion at the beginning but once having started, digestion then proceeded satisfactorily. This method of sludge treatment is now in use at the Birmingham, Alabama, plant. By proper balancing of the quantity of sludge added per day and with suitable control and operation, digestion once set up proceeded normally to its conclusion. Therefore digestion, as a method of converting the unstable organic matter to inorganic ash, can be used with an

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is doubtful if any chemical treatment plant can be designed without infringing one or more claims. It therefore behooves the engineer to investigate carefully the patent situation, and unless he adopts some one so-called process he should ascertain wherein he may infringe and then take steps to circumvent such claims. While most process patents have a questionable standing in a field as old as chemical treatment they can be extremely embarrassing at times and may in some cases serve to restrict competition, in which instance the project can be indefinitely delayed by taxpayers' suits. Equipment patents on the other hand have a more secure position as in most applications competing equipment is available.

Design Procedure Having determined that a chemical treatment best meets the obtaining conditions of plant location, seasonal or constant dilution ratios, etc., the next step is the actual design of the plant. There being no valid basic patents covering chemical treatment of sewage, its use does not present grounds for litigation and the major portion of the plant can readily be designed so as to circumvent existing patents covering proprietary processes and combinations thereof. This covers such parts as bar screens, grit chambers, settling tanks (without integral filter), chemical storage and feeding equipment, sludge handling and dewatering, incineration if required and filtration (separate beds) if a high degree of treatment is required. All of these should be so designed as to allow competitive bidding.

Among the features which may involve patent claims are certain combination methods of applying coagulating chemicals, methods of flocculation, combined settling and filtration tanks, the use of inert materials in a certain order and the removal of nitrogen ammonia from the sewage. The parts of the plant involving patented methods can be readily covered by preparing plans for each method and with alternate bid items for each. The same procedure can be followed for the coagulating methods and flocculation devices. Where filtration of the effluent is to be included as a part of the treatment plant, plans can be prepared covering the unit combined with the settling tank or as separate filter bed units. Alternate bid items can be provided so that bids may be taken on two or more methods or equipment.

While such a procedure requires considerably more work in the preparation of the contract plans and specifications, it will tend to largely eliminate any claims covering restriction of competition and may in the end be less expensive than specifying and showing one type of equipment or any one process. After bids are received it is comparatively easy to evaluate the bids on each process or items of equipment by adding to the cost of the competing items of equipment such construction as is required for its installation and operation. After such additions are made they serve to become the basis of award to the lowest responsible bidder. The consulting or designing engineer should be thoroughly familiar with all new developments not only in chemical treatment as a whole, but in the application of the special equipment required in the plant. In the final analysis, the engineer in charge of the work is the arbiter and the success of any project depends largely on his ability and good judgment in the handling of project.

Results Obtainable

Degree of Treatment Possible Treatment results as instanced by plant operation at Dearborn, Mich., and Birmingham, Ala., and by experimental plant operation at Atlanta, Ga., Chicago, Ill., Philadelphia, Pa., Palo Alto, Calif., New York, N. Y., etc., indicate that chemical treatment effects the removal of practically all of the suspended and colloidal solids in the sewage and that with filtration the effluent is clear and sparkling in appearance. Much stress has been laid on the inability of chemical treatment to effect a reduction in dissolved organic solids, but from a practical standpoint the only difference between chemical flocculation and biological flocculation is the ability of the latter process to oxidize unstable ammonia nitrogen to the stable nitrates. Chemical flocculation causes little or no reduction in the ammonia nitrogen in the sewage. Therefore it might be stated that the optimum chemical treatment of sewage obtainable is that which secures the maximum removal of suspended and colloidal organic solids up to dissolved ammonia nitrogen.

Effect on Ammonia Nitrogen The quality of ammonia nitrogen in sewage is variable and is influenced largely by the age and density of the sewage. While there is no actual relation between the oxidizable matter and ammonia nitrogen, or between this and the suspended solids in the sewage, the average ammonia nitrogen content of raw sewage is roughly 15 per cent of the 5-day B.O.D. and 10 per cent of the suspended solids. It is generally known that the presence of ammonia and nitrogenous organic compounds increases the bactericidal action of chlorine. This has been attributed to the formation of chloramine according to the reaction—

$$Cl_2 + NH_3 = NH_2Cl + HCl$$

The chlorine in the chloramine is an oxidizing and sterilizing agent and when in the alkaline state the chloramines produced are powerful retarders of action (B.O.D.) in the stream into which the effluent is discharged.

Treatment Results The treatment results possible with a properly designed and operated chemical treatment plant, without filtration, will effect a reduction of between 75 and 85 per cent of the biochemical oxygen demand; and with filtration will effect a practically complete removal of the suspended solids in the sewage. With chlorination, the nitrogenous compounds are reduced to chloro-substitution compounds which are more or less useless as bacterial foods and are therefore less putrescible.

Power Plant Installed From Water Profits

Instances are numerous (we have described a number of them) where municipal light and power plants have furnished, from their profits, funds for buying, installing or extending water works plants; but Gainesville, Tex., furnishes news by reversing the procedure and installing a power plant from the profits of its water plant.

Originally the water was lifted from well to standpipe by steam engines, using gas under the boilers. Cost, $30 per million gallons.

Then oil became cheap and was used under the boilers. Cost, $20 per million gallons.

In January of this year a Diesel engine was installed. Present cost $6.00 per million gallons.

The diesel (a Type J T Cooper-Bessemer, 365 hp. at 327 rpm) drives direct an electric generator (312 KVA, 2400 volt, 3 phase, 60 cycle) which, besides pumping the supply, furnishes current for the White Way, City Hall, Fire Department, parks, and some street lights.

Money for buying this diesel was obtained from the surplus revenue of the water plant. With still more profit obtained with the more economical plant the city hopes to be able soon to buy a 750 hp. diesel and have a real municipal power plant.