Methods of Sewage Disposal; Dilution, and Sedimentation.—I shall not attempt to discuss here the question of sewage disposal by dilution, other than to point out that such a method is entirely legitimate within the oxidation capacity of the body of water into which the sewage is discharged. I will, therefore, turn to a consideration of the methods of preliminary treatment which may be covered by simple sedimentation, decomposition, either aerobic or anaerobic, and chemical precipitation. In the operation of a sedimentation tank, sludge is removed frequently in the early stages of decomposition. The resultant improvement of the sewage from the standpoint of dilution will, of course, vary with the composition of the sewage and the amount of suspended matter present. We have recently demonstrated the fact that the simple removal of settling suspended matter improves the physical character of the sewage and its relative stability to some extent, but not to as great an extent as might be assumed from the actual physical improvement. In other words, the removal of 50 to 60% of the suspended matter will improve the character of the sewage from the standpoint of dilution from 25 to 30%. This means that the additional removal of the pseudo-colloidal matter will improve the liquid far out of proportion to the quantity of suspended matter thus removed. A device which would remove this fine suspended matter, without resorting to biologic treatment, would undoubtedly furnish an effluent which on a large scale would be intermediate between the preliminary or partial purification effected by settlement, and the more complete purification made by a sprinkling filter. In some cases it might suffice where preliminary purification alone would not.

Septic Tank.—The anaerobic decomposition of sewage finds its widest application at present in the septic tank. This process may also be called a hydrolytic or liquefying process, and is substantially the same as that in the ordinary cesspool. The cellulose decomposes, forming hydrogen and marsh gas. Carbon dioxide and fatty acids are produced as by-products. Nitrogen is formed, probably due to nitrate reduction. Thirty-two degrees Cent. is the optimum temperature for the decomposition of cellulose; therefore a septic tank shows more violent ebullition of gas during the hot season, and frequently unloads large amounts of suspended matter. In our climate not enough gas is produced for any practical purpose, but at Matunga, in India, the gas from a septic tank has been utilized for driving an engine to pump sewage and for lighting and cooking purposes.

The ammoniacal fermentation taking place in sewage is due to the presence of urea. It starts readily and is frequently completed in the sewer itself. In septic-tank treatment the protein substances are the ones responsible for the foul odors, since hydrogen sulphide, mercaptan, indol, skatol, and various amines result from their decomposition. Fats when present in appreciable quantities may give rise to an objectionable rancid odor.

It is still a question whether the decomposition taking place in sewage under anaerobic conditions, as in a septic tank, is an advantage in the further purification. Current practice favors the treatment of a freshly settled sewage. However, treatment of what may be called a "semi-digested" liquid has, apparently, some points in its favor, since compounds which are ultimately formed by these putrefactive processes yield more readily to oxidation than do the higher complex bodies originally present. On the other hand, the anaerobic decomposition products are probably inimical to the aerobic organisms present in the body of the filter.

Biolytic Tank.—In our biolytic tank, a remarkable reduction of the organic nitrogen has taken place, accompanied by the excessive formation of hydrogen sulphide. The pseudo colloidal matter has been completely eliminated, leaving nothing save a slight amount of black sediment and the hydrogen sulphide odor. All this occurs in less than four hours. Without further oxidation the effluent from this tank would be a nuisance, and a detriment from the dilution standpoint.

The chief objection to-day to the use of septic tanks is that they may produce a nuisance, and may discharge sludge in hot weather when the ebullition is a maximum. For these reasons the separate digestion of the settled suspended matter is recommended, particularly in double-deck tanks of the Emscher type.

The septicity of the sewage is a point worthy of comment. If we assume that hydrogen sulphide is the proper index of the increase in septicity, the formation of insoluble ferrous sulphide might be accepted as a measure, provided enough iron were present in solution to combine with all of the hydrogen sulphide. The key to the question probably lies in the bacterial control of the septic tank process, but a far deeper knowledge of the species involved is required than we possess at present.

Sludge.—Whether sludge be fresh or old, its ultimate disposal has been and still is a problem for sewage experts. In order to fully appreciate the difficulties encountered in the commercial utilization of the product, it is necessary to consider its physical as well as its chemical composition. Fresh sludge is a black semi-liquid substance with an odor varying from that of burnt rubber to an acrid putrid stink. The specific gravity varies 0.01 to 1.06. In our case the grit chamber sludge frequently contains considerable quantities of heavier material, and its specific gravity may be as high as 1.35. The average quantity of moisture is from 85 to 95%, the percentage of organic matter 60, and of fixed matter 40 when calculated on a dry basis, in fresh sludge. The nitrogen on a dry basis amounts approximately to 2%, the fat varying from 1% to 5%.

Many schemes have been suggested for the utilization of sludge as fuel, as filling for fertilizer and as material for gas, or even the manufacture of alcohol. Only in isolated cases under peculiar conditions has any process for the recovery of any by-products been successful. For instance in Bradford, England, where the sewage contains a deal of wash water from wool pulleries, fat has been successfully extracted from the sludge. The difficulty of the quick removal of the moisture from the sludge makes its use as a fuel doubtful. For the same reason drying the sludge for fertilizer purposes is uneconomical. Old sludge thoroughly digested contains much less volatile matter than the fresh sludge, the amount decreasing frequently from 60% to 40% of the total dry matter. In Germany and England, sewage sludge has been sold or given away to neighboring farmers, but the general experience has hitherto demonstrated the difficulty of disposing of sludge continuously in any such manner.

Partial purification of sewage can be accomplished under semi-aerobic conditions, as in a Dibdin slate-bed, which is akin to a contact bed. In this device nematode worms, infusoria, and bacteria accumulate and work over the sludge. Experience in this country with the slate beds has not been favorable.

Chemical Precipitation.—The colloidal matter in crude sewage may be eliminated by the use of chemicals as a precipitant. Ferric sulphate, aluminum sulphate, lime and ferrous sulphate have been frequently used in various combinations. The chemical to be employed and its quantity is largely governed by the composition of the sewage, and the cost of obtaining the chemicals. The quantity of sludge resulting is larger than from any other method of clarification. The effluent is low in suspended matter and is susceptible of treatment on filter beds at a high rate. Beyond a certain point, however, the application of chemicals does not reduce the amount of suspended matter appreciably. A concentrated sewage is better adapted to chemical clarification than a weak sewage.