volatile matter than fixed matter, a septic sludge being higher in mineral constituents. The content of moisture may run from 85% to 95%, depending upon the device.

Since the determination if the settling suspended matter is of importance in the control of a sedimentation plant, the daily variations may be advantageously followed by determining the loss of suspended matter on settling gravimetrically, or else by measuring the number of c.c. of settled matter in a conical-shaped glass holding one liter. Such glasses are used in Germany, and may be of value in dealing with strong sewages containing considerable amounts of settling suspended matter, but in our weak American sewages the control is not as satisfactory, since the 39th Street sewage, for instance, contains, on an average, only 140 p.p.m. of total suspended matter, of which from 40% to 50% is capable of settling. In our case, actual gravimetrical determinations are made of the total volatile and fixed suspended matters by the Gooch crucible method.

Sprinkling filter effluents contain, as a rule, some suspended matter, but of a different character from the original floating or colloidal matter. A sprinkling filter is not built primarily as a means of removing suspended matter, but as a machine to oxidize and mineralize the organic material delivered to it. In the long run, a sprinkling filter should deliver, in its effluent, nearly as much solid as received. At times the effluent may be very clear. Some observers claim that more is delivered. The effluent, however, is greatly improved from the chemical standpoint, and also from the standpoint of putrescibility. The suspended matter, when unloaded, may give rise to putrefaction if stored in considerable quantities, and may become septic, so that shallow secondary settling basins may change a non-putrescible filter effluent into a putrescible final effluent.

Oxygen Consumed.—The time-honored oxygen-consumed test indicates the amount of oxygen absorbed by the oxidizable matter during titration in acid solution with permanganate, and in particular the amount of organic carbonaceous matter present. At present there are so many modifications of the test, that the results from various laboratories cannot be directly compared, without knowledge of the method employed. In our laboratory the 30-minute water bath boiling method is used. For comparative purposes this is a valuable test, although the figures obtained do not represent anything absolute. The result covers only a small percentage of the total carbon. The organic carbonaceous compounds vary in their resistance toward acid permanganate solution. The average of the oxygen consumed in our sewage is about 50 p.p.m.; the average of the effluent of a sedimentation tank is about 40 p.p.m.; and the average in our sprinkling filter is about 25 p.p.m.

It is important to remember that the oxygen-consumed test does not represent the oxygen which the liquid would absorb under natural conditions in a water course. From the practical standpoint, a far superior test is one which indicates quantitatively the rate at which oxygen is absorbed in fresh water. I would style this the biologic oxygen-consumed test in contradistinction to the permanganate oxygen-consumed test. I shall refer to this later.

Nitrogen.—Nitrogen in its various forms represents the never-ending cycle in the conversion of animal into mineral matter, and vice versâ. The organic nitrogen, in decaying, splits off ammonia which, in turn, becomes oxidized to nitrites and then to nitrates not by simple chemical oxidation, but through the activity of various micro-organisms, of which very little is understood. Extensive bacterial research on the problem of nitrification has been made by Winogradsky, Frankland, and others. That the process of nitrification is a bacterial one is not in doubt, since Schlösing and Muntz demonstrated that when solutions containing ammonia were allowed to percolate through the soil, the ammonia was converted mainly into nitrate, but if the living organisms in the soil were paralyzed by chloroform vapor, or other antiseptics, nitrification did not take place. For the activity of these organisms the presence of oxygen is essential, as well as of a base to neutralize the nitrous and nitric acid which is formed. Moderate temperatures are most favorable, but the action may take place even at temperatures as low as 3° or 4° Cent. Species have been isolated which require very little or no organic matter for their subsistence. Such bacteria seed themselves in biological filters, and nitrify or mineralize the material coming to them. In general, the larger the bacterial surface the greater the nitrification will be for a given application of liquid. The size of the material and rates of application have to be varied for the process attained. In an intermittent sand filter, only 100,000 gallons can be applied to an acre in a day, whereas in a coarse grain sprinkling filter from 2,500,000 to 3,000,000 gallons can be applied to an acre in a day. A sand bed 3 ft. deep would give a much higher nitrification than a sprinkling filter bed 5 ft. deep of stone from 1½ to 2 in. in size, at the rates mentioned. Overloading a filter will interfere with nitrification. It is interesting to note how short a period is required to establish nitrification on a large scale. The nitrates represent the last step in the oxidation of the nitrogenous matter, and serve as food for the higher developed living organisms. These organisms, in dying, form the starting point of another nitrogen cycle.

As yet our understanding of the nitrifying organisms, and the processes involved, is very meagre, so that in the future, research will be desirable to learn the exact action taking place. Possibly the nitrification process can be intensified by artificial means.

Denitrification.—It is interesting to note that certain species of bacteria have the power of reducing nitrates to nitrites, free ammonia, and free nitrogen, in contradistinction to the nitrifying group. Grayson and Dupetit made the first observations in 1882, and concluded that denitrification was essentially the result of combustion of organic matter by the oxygen of the nitrates. Frankland and Beyerinck have added to our knowledge. Many organisms have been found which do not bring about denitrification.

Because of the research into the protein molecule, I wish to speak of the nitrogenous intermediate products, which in sewage disposal are frequently productive of disagreeable odors, as for instance indol, with its putrid odor, or ammonia, with its characteristic odor. Free nitrogen, as mentioned, is produced by the denitrifying action.

Significance of Nitrogen Cycle.—The nitrogen cycle offers a good index to the efficiency of a modern sewage filter of any kind. In a settling tank we do not expect much change in the nitrogen, except the elimination of some of the organic nitrogen in the settling suspended matter. In a more extended storage period the free ammonia may increase, and the nitrates and nitrites decrease, provided the sewage originally applied was not septic. In a septic tank the free ammonia ordinarily increases, and the nitrates and nitrites decrease, or become entirely eliminated. The increase in the free ammonia in a septic tank results from the reduction of nitrates and the breaking down of the organic nitrogen. The biologic treatment on sprinkling filters and sand filters is an oxidizing process, and should result in an increase of the nitrates and nitrites. The organic nitrogen is decreased in a filter, on account of the bacterial decomposition and the escape of the volatile nitrogenous products and free nitrogen proper.

Determination of Nitrogen.—The organic nitrogen, as well as the free ammonia, the nitrates and nitrites, are determined as a routine procedure on all our samples from the sewage testing station. The method for the determination of the organic nitrogen is that introduced at the