ammonia and organic nitrogen, as indicated by the large amount of nitrate in the effluent and high nitrogen content of the activated sludge.

In short, analyses of this material when dry show that activated sludge contains from 4 to 4½% of nitrogen, and sludge from certain industrial plants, such as packing houses, may carry even more.

When it comes to recovering this nitrogen, however, we meet with a serious difficulty, because as the sludge gathers in the settling tanks it contains from 98 to 99% of moisture and the bulk of this water must be removed before the dry material can be sold for fertilizer.

The best information now available points to a combination of settling and decantation as a preliminary dewatering process. By this means the water will be cut down from about 99 to 96%. On passing the concentrated residue through a pressure filter the moisture can be cut down to 75%. The press cake can be dewatered in a drier to 10% of moisture or less. More than 30 samples of activated sludge have been dewatered by sedimentation, decantation and pressing at Milwaukee.

It is an interesting and notable fact that two different types of press can handle the settled sludge without requiring the addition of lime. The sludge is not as gummy as was expected, and it presses fairly easily down to 75% of moisture.

In order to try out the feasibility of further dewatering the sludge four samples of the press cake were sent to fertilizer plants and dried there on a commercial scale. Three of these tests were made in a steam-jacketed (indirect-heat) drier and one in a semi-direct-heat drier. In each case the tests proved to be successful from three standpoints: (1) The sludge dried readily to a satisfactory mechanical condition; (2) the processes did not require much power; (3) little nitrogen, if any, was driven off or lost by drying. From the mechanical standpoint, therefore, the recovery of nitrogen in sewage sludge is practicable.

With regard to the question of cost, however, the situation at the time of writing is not so clear. The pieces of apparatus used for settling the raw sludge and drying the press cake were not designed to handle activated sludge in the most economical manner, but were requisitioned as being the best commercial apparatus available at the time.

By comparing the behavior of activated sludge with such matters as packing-house tankage I estimate that this sludge can be dewatered so that the recovery of the nitrogen in it will probably cost, upon present evidence, about $8 to $12 per ton of material containing 10% of moisture, depending upon a variety of local factors. These figures are intended to cover interest charges, depreciation, repairs and renewals, and a liberal provision for labor and fuel, as well as the cost of resettling and decanting of the water of the original sludge, and expenses for handling, freighting and marketing the finished product. Obviously, the total cost per ton will be somewhat more in the case of a small plant than for a large one. For a very large plant, where fuel and labor are relatively cheap, it is possible that further experience will reduce the cost below the lower limit in the range here given.

Analyses of dried samples of sludge are given in Table 4. They indicate that dry activated sludge (basis of 10% moisture) will contain 4.6 to 5% of nitrogen figured as ammonia and 0.6 to 0.7% of available phosphoric acid. In addition to this our data show that the dry product contains about ¼ to ½% of potash and from 3 to 4% of fatty material. At present prices the nitrogen is worth $2.50 per unit (or per cent.). In normal times this nitrogen would be worth about $2 per unit. The phosphoric acid is worth about 50c.; and the potash may

Table 4.—Analyses of Commercially Dried Activated Sludge, Milwaukee.

Sample No.	Character of Drier	Basis of 10% Moisture* % of Nitrogen as Ammonia	% of Available Phosphoric Acid
1	Semi-direct heat	4.36	0.70
2	Indirect heat	4.76	0.81
3	Indirect heat	4.56	0 47
4	Indirect heat	5.06	0.39
	Average of four samples	4.68	0.57

*Additional analyses for percentage of nitrogen as ammonia on the 10% moisture basis showed the following results, the dates being dates samples were collected: May 3, 1916, 5.74; June 20, 1916, 4.65; June 13, 1916, 4.88; June 14, 1916, 4.92; June 16, 1916, 5.01.

be worth something in the future, although the best that can be said of it at present is that it will assure for the fertilizer a more ready sale.

The fat present in the Milwaukee sludge is negligible. It would not pay to recover the fat, nor will the fat injure the selling qualities of the dried sludge.

Summary.—Summing up the whole situation, then, we see that the dried sludge has a market value upon present figures of $9 to $15 per ton of material containing 10% moisture. The total cost of getting this product and placing it on the market will probably run from $8 to $12 commercially per dry ton, depending upon local conditions. For large plants this cost may possibly be reduced as a result of further experience.

The activated sludge containing 4% or more of nitrogen is much nearer a commercial possibility than the sludges obtained by the older methods of treatment, such as chemical precipitation, septic tanks, or the Imhoff process, which the data given in Table 1 indicate to contain only 1½ to 3% of nitrogen.

In case the question arises as to the possibility of finding a market for the dried activated sludge it should be added that raw materials containing nitrogen, phosphoric acid and potash are capable of being worked up readily as a base for making high-grade fertilizers; and as they are not very plentiful, they are in good demand.

Presumably, however, large cities, such as New York, Chicago and others, by installing this activated-sludge process, would produce so much raw material of this character that the product would have to be parceled out among a number of manufacturers. It is even possible that the production might be sufficient to reduce the price. However, the dried sludge is a good fertilizer just as it stands and contains enough value to pay for sale and distribution in quite a large local market.

COBALT ORE SHIPMENTS.

The following are the shipments of ore, in pounds, from Cobalt Station for the week ended October 13th:—

Alladin Cobalt Mine, 41,000; Nipissing Mining Company, 206,830; La Rose Mines, 166,826; Dominion Reduction Company, 176,000; McKinley-Darragh-Savage Mines, 254,625. Total, 845,281 pounds, or 422.6 tons.

From Elk Lake—

Miller Lake O'Brien Mine, 56,600 pounds.

The total shipments since January 1st, 1916, now amount to 24,723,551 pounds, or 12,361.7 tons.