## NITROGEN FROM SEWAGE.*

**By Dr. S. Rideal, F.I.C., F.C.S.**

Much progress has been made in recent years, and many of us remember the explosions which took place in some of the closed septic tanks in the early days when they were of no military importance.

These gases are derived from the anaerobic decomposition of the organic matter in the sludge, and have hitherto hardly been utilized. They consist largely of methane, and may be 2 or 3 per cent. of the volume of the sewage from which they are derived. When septic change does not take place, the equivalent organic matter remains in the sludge, and thus increases its calorific value; when formed in Imhoff or Travis tanks they are also combustible. Analyses of the gases from the Atlanta Imhoff tanks have shown 8 per cent. of hydrogen and over 80 per cent. of methane. When sludge is activated with air these gases are not formed or are lost.

Cavel, in 1912, in Paris, studied the formation of gas from the sludge. He mixed the dried sludge with 20 per cent. of coke and obtained 81.7 cubic metres of producer gas having 3,500 calories per cubic metre. In his experiments he used the gas so formed for drying fresh portions of the sludge, and calculated that from Paris and the Seine Department 300 tons of dry sludge could be obtained per day, giving 24,500 cubic metres of gas, worth 447,000 francs per annum.

To utilize these gases for war material, the Hensler engine seems best adapted for further study. In it the explosion takes place in excess of air, and the oxides of nitrogen formed, as in an arc lamp, are rapidly removed to a cooling chamber to prevent their decomposition.

When absorbed in a water tower weak nitrogen acids are produced without the employment of sulphuric acid, and thus a direct fixation of atmospheric nitrogen to nitric acid could be effected by the waste gases from our sewage works. I will not venture, from the data I have given you, to make a calculation, as in the case of glycerine, of the metric tons of nitrate that could be obtained in this way, as, fortunately, in this country at any rate, fuel for gas producers will outlast this war, but in beleaguered Bucharest, after a prolonged siege, such a device might be turned to advantage.

**Utilization of Sewage Nitrogen.**—I must now turn to the most important part of my subject, viz., the conversion of sewage nitrogen into available nitric acid.

The utilization of sewage nitrogen is no new problem. Sir William Crookes, many years ago, said: "We have the startling fact that in the United Kingdom we are content to hurry down our drains fixed nitrogen to the amount of no less than £16,000,000 per annum. This unspeakable waste continues, and no effective and universal method is yet contrived of converting sewage into coin." At the time of this calculation nitrate of soda was worth £7 10s. per ton, so that nitrogen even then was over £50 per ton. Mr. Ashton referred to this waste in his interesting paper on sugar from sewage in 1910 before the Manchester branch of your association. It would take me too far afield to discuss whether in war-time we ought to import nitrogen as wheat or as nitre, as the taxation of land values and the problems of transport and freights must be foreign to the business of this meeting.

I can give you some figures which show the enormity of the problem which you can better appreciate.

One hundred thousand persons produce on the average 90 grms. per person per day of fæces and 1,170 grms. of urine, equivalent to 3,300 tons per annum of solids and 43,000 tons of urine. The nitrogen in fæces is 1 per cent., in the urine .60 per cent. We have, therefore, 33 tons of organic nitrogen in the solid fæces and 258 tons in the urine.

Our military camps could furnish 11,640 tons per annum and the civil population 116,400 tons if all the nitrogen could be converted.

We may get a total nitrogen figure direct from sewage analyses. A fair figure to take is 5 parts per 100,000, or 5 lbs. per 10,000 gallons at 40 gallons per head, or 250 persons, so that a military camp of 4,000,000 could furnish 80,000 lbs., or 40 tons a day, or 14,600 tons per annum.

It is, of course, a war secret how much nitric nitrogen is required by the belligerents per annum, but we know that the Chili exports have now all been diverted from Germany, and that in the past we have relied on this source, while the Central Powers have had to improvise their raw material.

The Badische Anilin and Soda Fabrik have published their output of sulphate of ammonia by their Haber process of synthetic production from atmospheric nitrogen as equal to 300,000 tons, which is equivalent to 62,000 tons of nitrogen per annum.

This synthetic sulphate of ammonia in Germany is now being converted into nitric acid by the Ostwald process to replace the Chili nitre, which the Allies have commandeered. My figures show that in sewage we have twice as much nitrogen available, but not yet utilized, already in combination, either as ammonia or in organic form.

**Recovery of Ammonia.**—How can this ammonia be removed from our sewage? It is not like extracting gold from sea-water, as we have all of us smelt it at our works, and many of us have determined the amount in our laboratories.

I suggest the recovery of the free ammonia by one of two simple methods: (1) Its removal by heat; (2) its removal by air.

(1) The Removal of Ammonia from Sewage by Heat.—It is common knowledge that heat exchangers can be now designed to work with a very small loss of energy, and that the removal of the free ammonia from a tank effluent is, therefore, not an impossible task. The addition of lime to ensure the freeing of any ammonium salt may be necessary, and the effluent, after being "de-ammoniated," could be further purified by filtration or land treatment.

(2) The Removal by Air.—Sewage treatment by aeration and activation is now one of the recognized methods, and has been tried in many places in this country and America. The colloidal and suspended matters form a sludge which is especially rich in nitrogen, and the effluent contains nitrates before filtration. It would seem that the air treatment thus brings about a rapid evolution of carbonic acid and nitrification, so that the escaping gases will not, under ordinary conditions, contain any ammonia.

When, however, air is aspirated through an ordinary sewage, the ammonia is removed by the air, and I suggest that if the "activation" be carried out in presence of lime, nitrification will not be so complete and some of the ammonia will be present in the escaping gases.

*Abstract of paper read before the Association of Managers of Sewage Disposal Works.