The Nitrogen Problem: By-products.[1]

IT is surely high time that we, as a nation, were more fully alive to the necessity of a complete investigation of the recovery of by-products, and that not merely in connection with nitrogen products. There is still too much of the feeling—one comes across it quite frequently—that so-called waste products form a recognised loss in any process. The investigation of the treatment of any waste product is not looked upon as the work of the person engaged in the specific manufacture from which that waste product is obtained. Competition becomes keener as the years pass, and if our position is to be retained by-products must be recovered in all cases where such recovery can be economically effected. A waste product may even become the starting point of a new industry. The detailed investigation of the position as regards nitrogen by-products manufacture comes as a very welcome record and as a much-needed indicator of the forward path.

The world's ammonia production, in terms of sulphate, advanced between the years 1903 and 1913 from 540,200 long tons to 1,389,790, an increase of more than 150 per cent. The chief producers were Germany, the United Kingdom, and the United States, who were respectively responsible in 1913 for 39, 31, and 12½ per cent. of the total production. The essential sources are gas-works, coke-ovens, gas-producers, shale-works, iron-works, and bone, etc., carbonising works.

In the years 1911 and 1913 the coke-oven industry was responsible for 84 and 86 per cent. respectively of the German production, in 1913 for 78 per cent. of the United States production, and in 1911 and 1913 for 27 and 30 per cent. of the United Kingdom production. The United Kingdom production rose from 233,664 long tons in 1903 to 432,618 in 1913, of which, in 1903, gas-works provided 149,489 long tons, or 64 per cent. of the total, which steadily increased to 182,180, or 42 per cent. of the total. Coke-ovens in the United Kingdom provided in 1903 only 17,438 tons, or barely 7½ per cent., but continual increase brought up the amount by 1913 to 133,816 tons, practically 31 per cent. of the production of the country. Iron-works during this period retained a steady output of 19,000 to 20,000 tons, shale-works production increased gradually from 37,353 to 63,061 tons, and that of producer-gas, bone, etc., carbonising works from 10,265 to 33,605 tons.

These are illuminating figures which deserve consideration and show plainly the development of the by-product industry up to the commencement of the war period.

In addition to supplying home demands for ammonia nitrogen, there was an average yearly export of ammonia, ammonia salts, and products made therefrom during the years 1911 to 1913 equivalent to 82 per cent. of the total home production. This would have been more than sufficient to provide the nitrate and nitric nitrogen required for all purposes had the means of conversion been available, which they were not, so that we were dependent on imported nitrates for various purposes, including agriculture, the manufacture of sulphuric acid, nitric acid, explosives, and other products.

Passing on to the war period, estimates for the year 1917 indicate a by-product ammonia increase of 130 per cent. in the United States, 27 per cent. in Germany, and only 6 per cent. in the United Kingdom; but Japan has in the meantime taken a considerable step forward and increased her output more than sixfold—from 8000 tons in 1913 to 50,000 tons in 1917. The production of sulphate from coke-ovens in the United States had increased by 1916 to 83 per cent. of the total output, and in the United Kingdom to more than 36 per cent. of the total. Even during 1915 and 1916 considerably more than half our production of ammonia nitrogen was exported, and we were using large quantities of imported nitrate, all of which might be produced economically by ammonia oxidation or by synthetic processes, details of which are fully discussed in the report. We have now arrived at the stage where synthetic manufacture begins to complicate the ammonia problem and the economics of the various processes require the closest attention.

With regard to post-war conditions, it is certain that agricultural demands will be much greater than formerly: many lessons were learnt during the war, not the least being that of the need for increased food production at home. The consumption of combined nitrogen practically doubled during the ten years preceding the war, and there is little doubt that the increase will continue, nitrogenous fertilisers being more and more in demand, especially now that much more land is under cultivation than in pre-war days; in fact, our own agricultural demand for fixed nitrogen in the form of sulphate of ammonia and nitrates was more than doubled during the war period only. Moreover, nitric nitrogen will be needed in increased quantities owing to the extension of chemical manufactures, such as dyes and drugs, which hitherto have been too much neglected; and with this will be involved the oxidation of by-product ammonia.

It would appear likely that the world's productive capacity should now be able to provide some 30 to 40 per cent. more combined nitrogen than in 1914, and this does not appear to be greater than would have been the case under normal conditions had the ordinary rate of growth in consumption in the pre-war period been maintained during the four years under consideration.

Now, if food production in this country is to

[1] "Ministry of Munitions of War. Munitions Inventions Department. Nitrogen Products Committee. Final Report." Pp. vi+357. (London: H.M Stationery Office, 1919.) Cmd. 482. Price 4s. net. See also NATURE, January 22 and 29.

be rendered independent of imported nitrogenous fertilisers, as is surely desirable—and recent conditions have shown that it may at any time become even absolutely necessary—and if this is to be coupled with a continued large export trade in nitrogen products, we must have a considerably increased production of ammonia nitrogen.

So far, practically all the by-product nitrogen has come from the manufacture of coal-gas, producer-gas, coke, and shale-oil; two possible sources have been practically untouched, viz. peat and sewage, though from the latter, owing to our position, perhaps little may be expected—certainly so unless some simple method should be discovered for recovering the soluble nitrogen from very dilute material. At the same time, it may be pointed out that the estimated annual amount of nitrogen in the sewage of the United Kingdom is 234,900 metric tons, 86 per cent. of which is in urine.

Power cost is, of course, the great factor in the question of by-product recovery *versus* synthetic manufacture, and this is affected by coal cost: the problem is fully discussed in the report. But questions of the first importance to the by-products industries, which must strive to increase production, are such questions as the efficiency of work on existing processes, the modification and further development of such processes, and the introduction of new methods.

Reviewing the gas industry, it is seen that, with existing methods, an increase in the amount of sulphate of ammonia recovered should certainly be expected. Many small gas-works run to waste the ammonia liquor, chiefly owing to their isolated position; a proposal is made in the report to work up liquors at small works in travelling sulphate plants, but this has been attempted in several instances and afterwards abandoned. One would remark, however, that some small works might well adopt the direct system of recovery, which has in some cases served very well, and a local demand for the sulphate produced would obviate cost of transport. A general consideration of the direct method of recovery demands more attention than has been given to it; much has been done and published in recent years by the Chief Alkali Inspector. Storage of ammoniacal liquor still needs attention; there are in use inefficient methods of running ammoniacal liquor into imperfectly covered wells and tanks: this point is strongly indicated in the report. In dealing with concentrated ammonia liquor, the losses are apt to be particularly heavy. It is considered that several thousand tons of sulphate might be added yearly to the gas industry ammonia recovery by attention to such matters as these. Moreover, it will be necessary to produce a somewhat higher grade and at the same time a neutral sulphate. But a question that demands perhaps even more attention is the introduction of new methods whereby the sulphur content of the gas itself would be made available, and so transport and use of sulphuric acid avoided. The Burkheiser and Feld processes still require to be worked out satisfactorily, and quite recently comes the proposal of Cobb to use sulphate of zinc as a starting material. These methods are perhaps all the more worthy of careful investigation owing to modern developments in the manufacture of coal-gas; the increase in the vertical retort method of carbonisation, coupled with steaming, has given rise to increased quantities of liquor of decreased strength.

In the metallurgical coke industry many of the bee-hive plants have disappeared in recent years, and this has, of course, had its effect on the ammonia production. There is now no longer any question as to the relative merits of bee-hive and by-product oven coke, and proper treatment might lead to an increase of 10 per cent. or more on the present total production of ammonia from all sources.

In the producer-gas industry, again, there is scope for investigation; scarcely sufficient stress appears to be laid on producer-gas practice as regards steaming and liming. Hydrated lime certainly has a quite appreciable effect on ammonia production, and it would seem, moreover, to admit of greater latitude in the choice of the coal used.

It is unfortunate that peat has not received more attention in this country; apart from nitrogenous by-products, some of the by-products from peat gasification appear to have quite a special value, judging from results obtained in Scotland and Ireland. Moisture and transport are, however, difficulties, yet schemes for the utilisation of peat on the spot might well be considered from a power point of view, even though the addition to the by-product nitrogen production would not be by any means of the first order.

A Survey of National Physique.[1]

ONE of the more valuable after-results of the great wars in the last century was the increased interest aroused in regard to national physique, leading to various measures directed towards its improvement. After the Napoleonic wars there arose the great gymnastic clubs of Central Europe and Scandinavia, which laid the foundations of physical education on a wide scale. The Civil War in America led to the first great demographic survey, the data of which were rendered public in the report of the Surgeon-General of the Federal armies on the statistics of the recruiting bureaux. The War of 1870 was followed by surveys of the population in Germany, and on a smaller scale in France, which to a large extent

[1] Ministry of National Service 1917-19. Report, vol. i., upon the Physical Examination of Men of Military Age by National Service Medical Boards from November 1, 1917-October 31, 1918. Pp. iv+159+charts. (London: H.M. Stationery Office, 1920.) Price 6s. net.