Synthetic Nitrogen with Special Reference to the Calcium Cyanamide Process.

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IT is perhaps not generally recognised to what extent agriculture at the present time is dependent on the air for its supplies of combined Nitrogen. There are at present 59 factories operating in various parts of the world producing some form of combined Nitrogen. Of these 59 factories, 25 are producing Calcium Cyanamide, 26 Ammonia, 6 Nitric Acid and Nitrates while the remaining two produce Cyanide.

It is unlikely that any further factories will be built to produce Nitrates as the process on which they work (The Berkland Eyde process) is expensive in current per unit of Nitrogen fixed.

The modern processes for the production of Ammonia are now highly efficient and the price of Nitrogen in this form depends to some extent on whether it is marketed as Sulphate, Chloride or Nitrate of Ammonia. The common form is, of course, Sulphate, which is the most easily handled but which depends, of course, on the cheap supply of Sulphuric Acid.

The manufacture of Calcium Cyanamide (Caro and Franck process) is the most economical in current, more Nitrogen being combined for a given amount of current than by any other method. The raw materials required are, however, bulky and great deal depends on the nearness of these raw materials, to suitable conditions of electric supply.

In view of the fairly wide-spread use of Calcium Cyanamide at the present time, the following account of the manufacture of this substance as seen at a typical factory may be of interest:—

The first step in the manufacture is the production of Calcium Carbide, for which pure freshly burnt lime and good coke which is light and porous are necessary. The combination of these two materials to form Calcium Carbide is, of course, brought about by electricity and, on a tour of the factory, it is by far the most spectacular of the processes to be seen. The lime and coke are fed into the open top of an electric furnace

from shoots and fall on to what appears to be an open fire, from the top of which protrude the electrodes, 3 in number. These are large blocks of carbon, measuring about 6 ft. by 6 ft. by 1 ft. 9 inches and as they wear away they are lowered further into the furnace, so that the same amount of electrode is always in contact with the lime and coke mixture. The whole of the top of the furnace is covered with leaping yellow flames, resulting from the burning of the carbon monoxide—the typical bluish flame of this gas in combustion being masked by the yellow tinge produced by the Calcium. The reaction taking place in the furnace being as follows:—

$$2\ CaO + 3\ C_2 = 2\ CaC_2 + 2\ CO.$$

Though the equation above shows a complete reaction, in actual manufacture it is found necessary to carry on the process in the presence of excess of lime.

The next operation to be seen is the drawing off from the furnace of the Calcium Carbide and on a lower floor, the breaking of the slag crust over the drawing opening of the furnace can be watched. This is done with long iron pokers, the man using them being protected by an iron screen through apertures in which the pokers are used. The flow of the molten carbide, at a temperature of about 3,000°C, which follows the breaking of the crust is a brilliant sight and the light and heat are so great that the stream must be watched through blue glasses to avoid damage to the eyes.

The molten carbide falls from the furnace through the floor on which the men who are responsible for the drawing actually stand and a visit to a still lower floor shows the stream falling into trucks which are moved away by a watching attendant by electric power as each truck is filled.

The full trucks are then allowed to stand some time in a large cooling shed after which they are emptied into crushers from which the carbide emerges in about the form of road material. It then passes through a steel ball mill and is then a fine powder ready for the next step in the manufacture of Cyanamide.

The powdered carbide is now packed into a steel container 8 ft. high 2 ft. 6 inches in diameter which has a detachable bottom and is open at the top. Down the centre is a two inch tube. This load is then picked up by a crane and lowered into a second furnace. As the crane is withdrawn the steel container is lifted out and the carbide is retained in its shape by a piece of packing paper which is wrapped round the outside of the container. This paper prevents the carbide from falling into the crevices of the furnace wall. The tube in the centre is lifted out and a carbon electrode (this is about the thickness of a walking stick)

put down the centre of the furnace. The lid of the furnace is secured and the nitrogen is then passed through from the bottom of the furnace and the current turned on. The current and nitrogen are passed through the furnace steadily for about 30 hours during which time the temperature remains at about 1,000-1,200°C and the following reaction takes place:—$2\ CaC_2 + 2\ N_2 = 2\ CaCN_2 + C_2$. The nitrogen used is obtained by the liquifaction of air and subsequent fractional distillation of the liquid. At the end of this time the Cyanamide is lifted out by the crane in a solid glowing red mass approximately the size and shape of the container. These again have to be cooled before they are reduced to powder by the steel ball mill.

The powdered Calcium Cyanamide has then to be moistened to destroy any carbide which may be unchanged, the product is oiled to prevent dustiness, and is ready for packing for the market The cooling at various stages represents an unavoidable loss of heat though the hot water for washing, etc., is heated by the use of blocks of Cyanamide in a special heater.

The actual product marketed contains in addition to the Calcium Cyanamide, a percentage of pure carbon as thrown out according to the second equation shown above, a percentage of pure quick lime used in excess in the manufacture of carbide in the first place and a small amount of slaked lime produced by an action of the water on the calcium carbide and possibly on a small amount of the quick lime.

The carbon contained in Cyanamide or Nitrolim, as it is commonly known, has no value but its removal is not economically possible and it is in no way harmful. The lime, however, has a value in that it renders the action of the manure alkaline and makes it a suitable change from fertilizers with an acid reaction.