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THE PRODUCTION OF CALCIUM NITRATE BY THE AIR HIGH-VOLTAGE AC PLASMA TORCH

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At present, the main methods for obtaining nitrogen fertilizers are synthesis from nitric acid and ammonia [1]. Both of these substances are produced using hydrogen in a catalytic chemical process. Due to the instability of hydrocarbon prices, the cost of producing nitrogen fertilizers can vary significantly over time. At the same time, political tension significantly complicates the functioning of the nitrogen fertilizer market.

In most cases, the production of nitrogen fertilizers is highly localized due to high capital costs and high productivity of existing chemical facilities [2]. Obviously, it is necessary to create local industries, taking into account regional factors: the need for fertilizers, the availability of chemical and electrical resources, seasonality in the use of fertilizers, etc.

At the beginning of the 20th century, facilities were created for the production of nitrogen oxides from the air by the electric arc method. The Haber method replaced the previous method due to its high performance and relatively low cost. At present, with the development of alternative energy, it is possible to create installations for electric arc synthesis, taking into account the functioning of alternative energy power plants, which makes it possible to use it in the local production of nitrogen fertilizers [3].

The proposed solution is based on a high-voltage AC plasma torch operating in air and a mixture of nitrogen and oxygen (1:1 mol.). This plasma torch has a high thermal efficiency of up to 95% and an operating life of the electrode unit up to 2000 h [4].

It has been experimentally established that a plasma-chemical installation with a high-voltage plasma torch makes it possible to obtain product gas with a nitrogen oxide concentration of up to 3.5 wt%. (predominantly nitrogen monoxide). The application of this method for the synthesis of nitrogen oxides for the production of calcium nitrate ($Ca(NO_3)_3$) was evaluated. The sequence of stages is as follows: 1. synthesis of nitrogen monoxide from air; 2. production of nitrogen dioxide by catalytic oxidation; 3. absorption of nitrogen dioxide by calcium hydroxide and further oxidation to nitrates. The enthalpy of the air plasma generated by the plasma torch is 6.12 MJ/kg.

Table - Energy consumption for obtaining synthesis products

Substance	Yield, kg/kg of air	Energy costs	
		MJ/kg	kW·h/kg
Nitrogen monoxide (NO)	0,035	174,86	48,57
Nitrogen dioxide (NO_2)	0,051	114,04	31,68
Nitric acid (HNO_3)	0,074	83,24	23,12
Calcium nitrate ($Ca(NO_3)_3$)	0,191	31,98	8,88

The table shows that the energy costs for obtaining calcium nitrate are quite large and approach the cost of its production by traditional methods. Thus, the further use of electric arc synthesis of nitrogen oxides for the production of nitrogen fertilizers is advisable for local use in relatively large farms with complex fertilizer logistics.

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