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Dependence Of The Synthesis Of Calcium Cyanamide And The Composition Of Exhaust Gases On Temperature

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Annotation

Technical solutions have been developed to create a technology forthe production of calcium cyanamide from lime, carbonate anhydride and industrialammonia. A technological scheme for obtaining nitrogen fertilizer and an effective defoliant, calcium cyanamide, has been developed and the optimaltechnological parameters of the process have been determined. An experimental batch of calcium cyanamide has been produced at the experimental facility.

Keywords. Carbon dioxide, ammonia, expansion gas, calcium cyanamide, waste gases.

Introduction

In the chemical industry of our country, certain results have been achieved in the production of new types of materials, including large-scale measures have been taken in the field of providing the domestic market with import-substituting chemical reagents. It should be noted that special attention is paid in the Republic to the implementation of measures for a scientifically sound system of functioning of industrial facilities and environmental protection through the introduction of innovative technologies. The strategy of actions for the further development of the Republic of Uzbekistan identifies important tasks aimed at "the development of high-tech manufacturing industries, primarily for the production of finished products with high added value based on deep processing of local raw materials". Of great importance in this direction is the production of nitrogen mineral fertilizers based on local raw materials, the expansion of their range, the development of technology for obtaining local resources, including limestone, ammonium nitrate and calcium cyanamide, to reduce their cost.

When obtaining calcium cyanamide, temperature is a key parameter, because itdetermines the energy costs of the process.

The preparation of calcium cyanamide in a wide temperature range was carried out under the following conditions:

1. The initial charge was prepared on the basis of lime obtained by firing limestone of the Jamansai deposit.
2. The charge is prepared on the basis of CaO.
3. The size of the charge granules is 2-3mm.
4. Chargevolume – 10ml.
5. The mass of the initial charge - averaged 4.82g.
6. The drying temperature of the initial charge is 600 ° C.
7. The duration of the passage of the initial gas mixture is 90 minutes.
8. Synthesis temperature from 700 to 900 ° C.
9. The ratio of CO2 to NH3 is 1:9.
10. 10. The volume velocity of the initial gas mixture was 6000 h^{-1}.

For the purpose of absorption and subsequent analysis of the exhaust gases formed as a result of experiments on the experimental setup shown in (Fig.1), the following preparatory work was done:

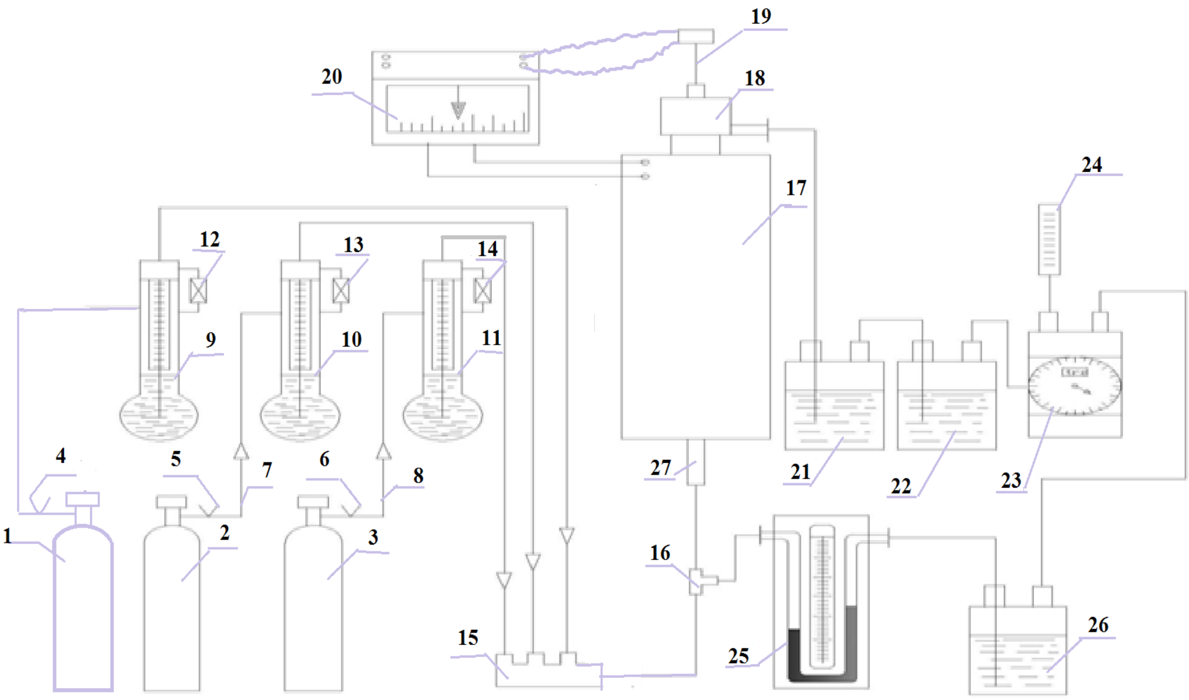

Fig.1. Experimentalsetupdiagram

1. A 7 N solution of sulfuric acid was poured into the absorber (pos.21) in an amount calculated by passing the gas mixture for 15 minutes with a margin of 10%;
2. A 40% NaOH solution was poured into the absorber (pos. 22) in an amount calculated by passing the gas mixture for 15 minutes with a margin of 10%.
3. Absorbers (pos.21 and pos.22) with the contents changed every 15 minutes.

4. The gases that were not absorbed in the absorbers were passed through a gas meter (item 23) to measure their total volume and collected in a gas collector.

The procedure for conducting experiments at a facility for the synthesis of calcium cyanamide from calcium oxide, ammonia and carbon dioxide is described in Chapter 2 of this dissertation.

As a result of the experiments carried out, a granular white product was obtained, the volume of which decreased in comparison with the volume of the initial charge, and its strength was higher than that of the initial charge. The white color of the resulting product indicates the absence of free carbon in it, which is a prerequisite for its processing into other derivatives.

The resulting calcium cyanamide was subjected to qualitative analysis for the content of CO_2 and CN^{-1-}ions according to the methods.The results of these qualitative analyses showed a clear absence of CO_2 and C N^{-1}-ions. The nitrogen content in the synthesized calcium cyanamide, depending on the temperature of the process, is shown in Table 1 and in Fig. 2.

Table1. The nitrogen content in the product depends on the synthesis temperature of calcium cyanamide

Synthesistemperature,ºC.	700	750	800	850	900
Content Nitrogen,%	15,60	25,10	31,40	27,90	22,30

It follows from the data obtained that the nitrogen content in the resulting product initially increases with an increase in temperature, reaching a maximum of 31.40% at 800 ° C, and with its further increase it begins to decrease. The relatively low nitrogen content at temperatures below 800 ° C is explained by the incomplete course of the chemical reaction of the synthesis of calcium cyanamide, and the decrease in its content with an increase in temperature above 800 ° C is associated with the thermal decomposition of ammonia – one of the main starting components.

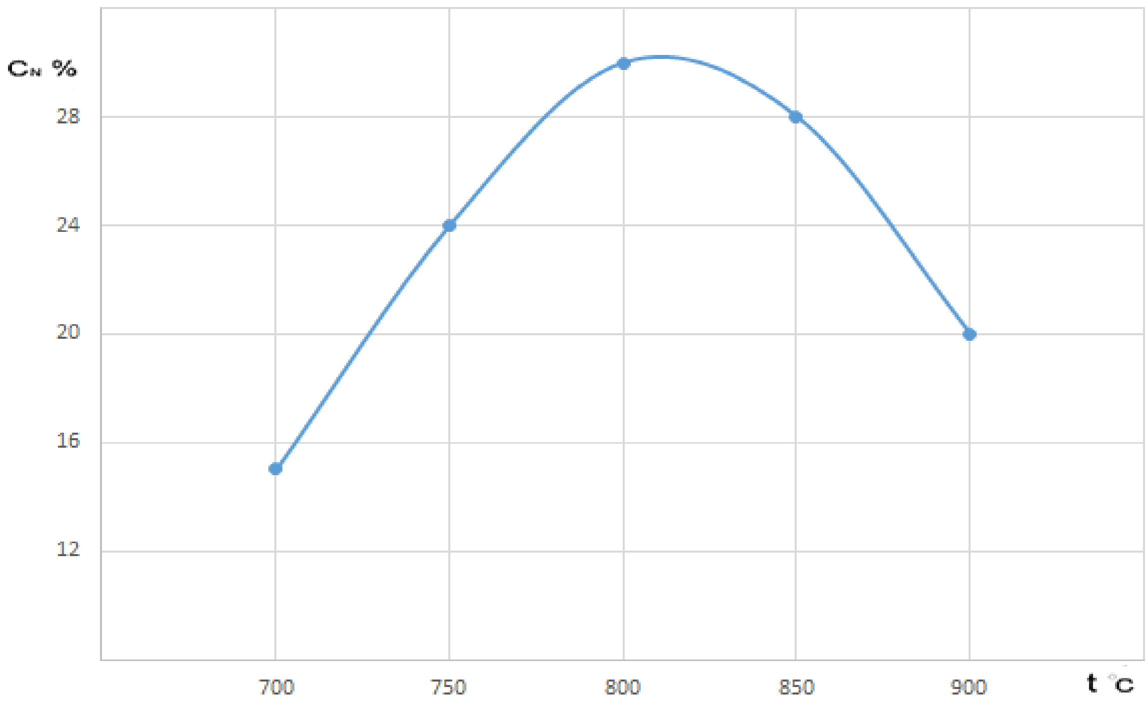

Fig. 2 Dependence of nitrogen content in the product on temperature

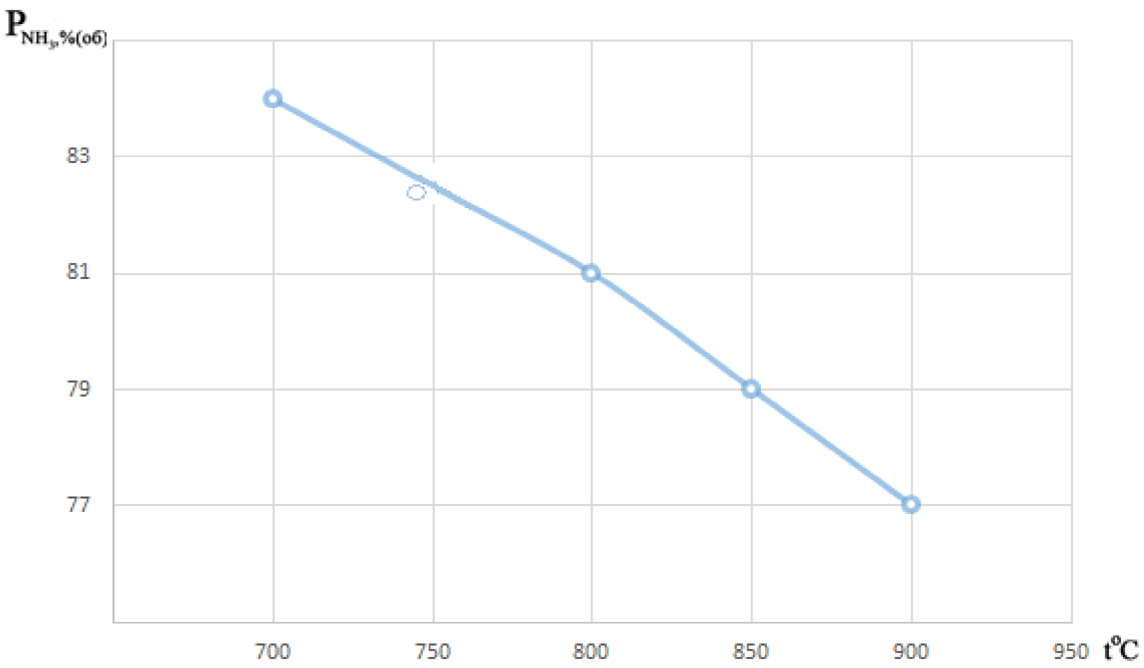

Fig.3 Dependence of ammonia content in exhaust gases on temperature

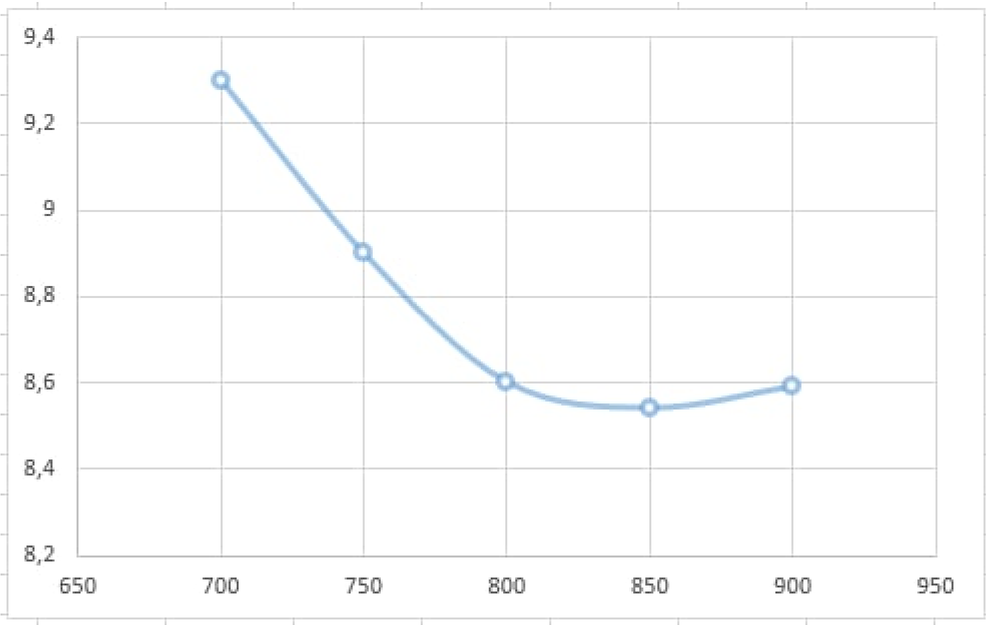

Figure 4 Dependence of carbon dioxide content in exhaust gases on temperature

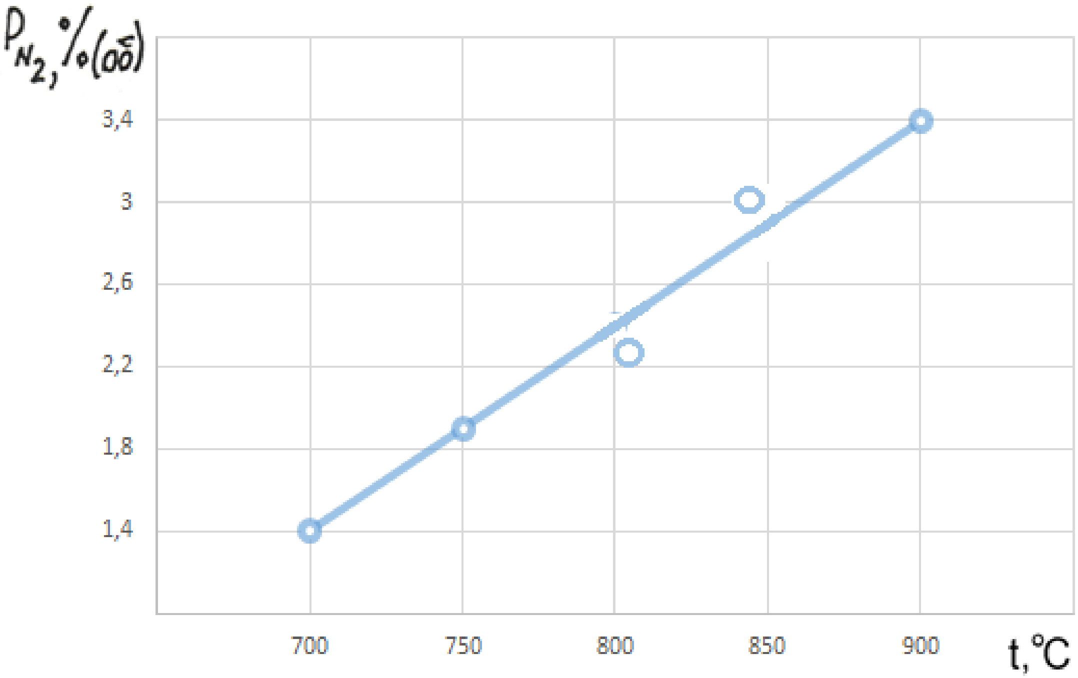

Fig 5 Dependence of nitrogen content in exhaust gases on temperature

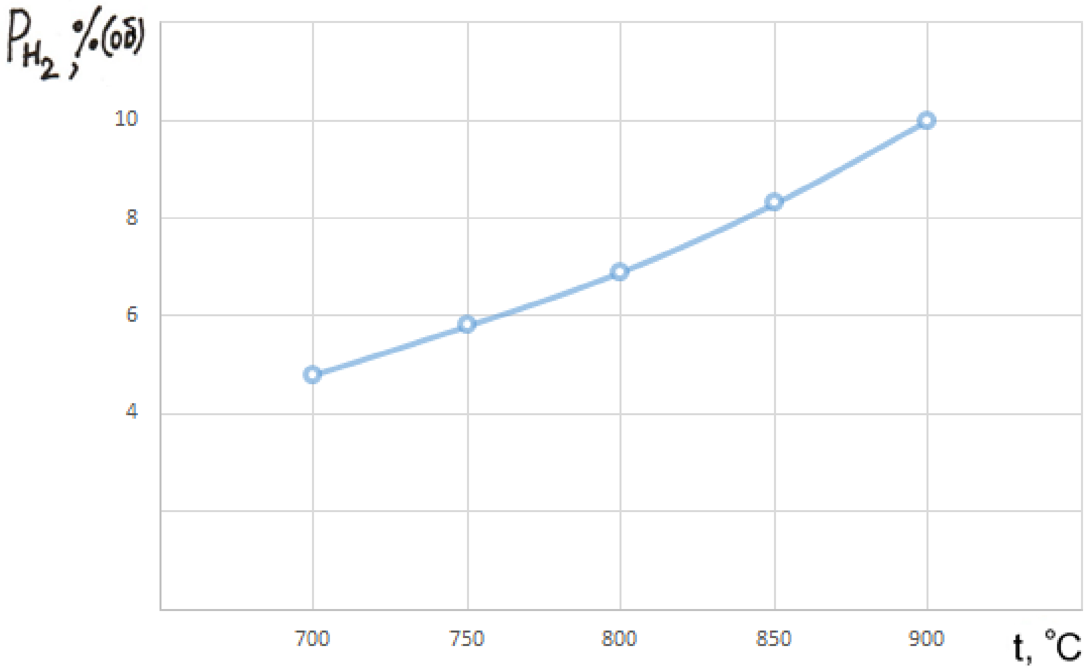

Fig. 6 Dependence of the hydrogen content in the exhaust gases on temperature

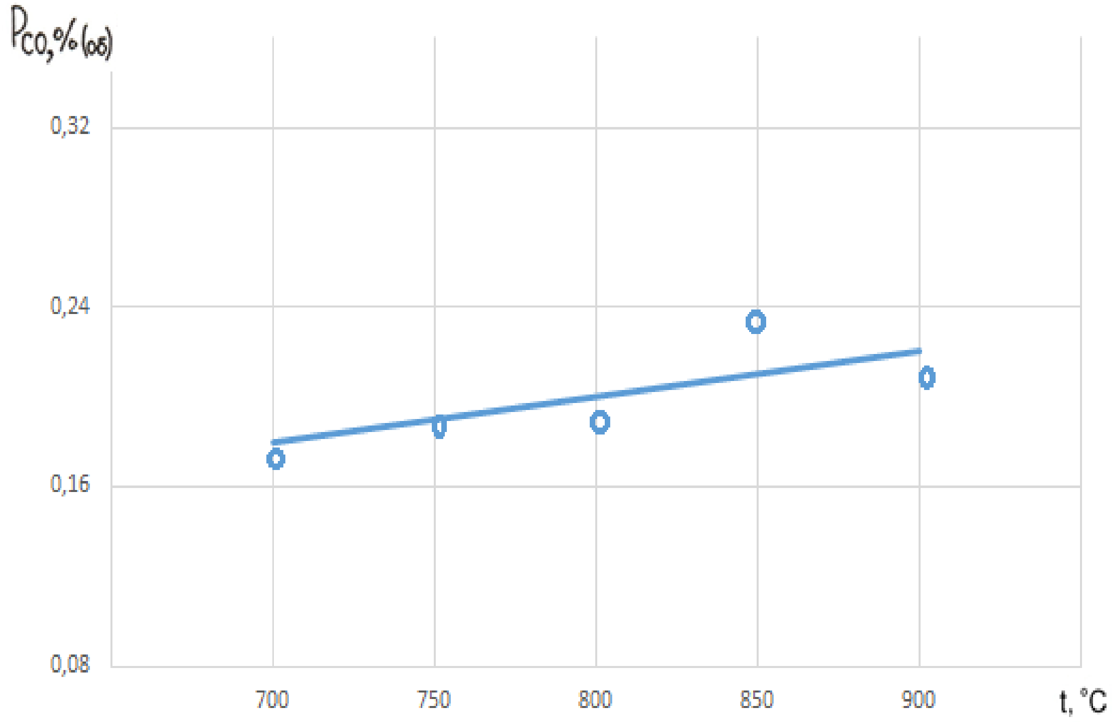

Fig. 7 Dependence of carbon monoxide content in exhaust gases on temperature

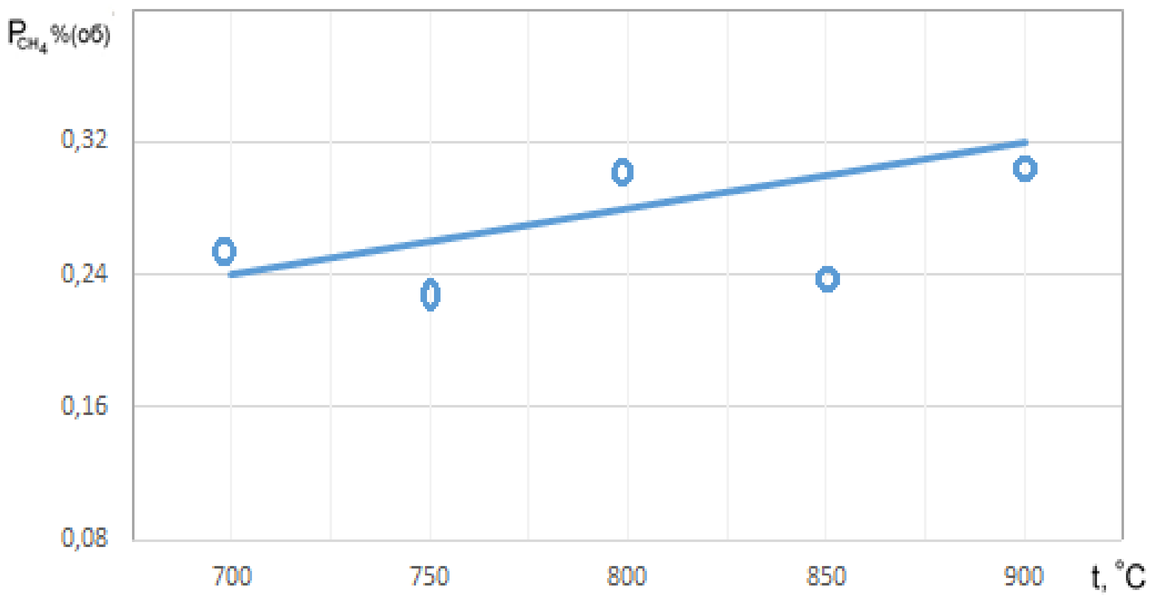

Fig. 8 Dependence of methane content in exhaust gases on temperature

The experimental data obtained show that the nitrogen content in the synthesized calcium cyanamide increases, reaching a maximum of 31.40% at 800oC, and with its further growth it begins to decrease. At temperatures below 800 ° C, the relatively low nitrogen content is explained by the incomplete course of the chemical reaction of the synthesis of calcium cyanamide, and the decrease in its content with an increase in temperature above 800 ° C is associated with the thermal decomposition of ammonia - one of the main starting components.

This nature of the change in the nitrogen content in the synthesized product is practically consistent with the known data.

In the composition of the product obtained at temperatures below 800 ° C, the presence of calcium carbonate was detected. This is due to the fact that under these conditions, the following chemical reaction of the formation of calcium carbonate partially takes place:

$CaO+CO_2=CaCO_3$

At 800 ° C or more and sealed conditions, the equilibrium of this reaction will shift to the left side, which is the reason for the absence of calcium carbonate in the product.

The literature review provides data indicating that the composition of the waste gases of the calcium cyanamide production process may contain gas components, the presence of which primarily depends on the type of raw materials used and a number of processes occurring during the synthesis of calcium cyanamide. These factors may be the reason for the presence of carbon monoxide and carbon dioxide, ammonia, hydrogen cyanide, nitrogen, hydrogen, water vapor, etc. in the exhaust gases.

The composition and amount of waste gases were determined or in accordance with the nitrogen content in the finished product by stoichiometric calculations of reacting substances by chemical reaction:

$CaO+2NH_3+CO_2=CaCN_2+3H_2O$

Experimental data (Fig.4) show that with an increase in the temperature of obtaining calcium cyanamide from 700 to 850 ° C, the amount of carbon dioxide in the exhaust gases decreases. An increase in temperature above 850 ° C leads to an increase in the carbon dioxide content.

This pattern can be explained by an increase in the nitrogen content in the product with an increase in temperature, and then decreases. A decrease in the amount of nitrogen in the product leads to the fact that carbon dioxide in a smaller amount enters into the chemical reaction of the synthesis of calcium cyanamide.

Experimental data on the dependence of the process of obtaining calcium cyanamide on temperature show that with an increase in temperature, the nitrogen content in the product increases, reaching a maximum value at a temperature of 800 ° C, and with a further increase in temperature, the nitrogen content decreases.

The firing product turned out to be white, which proves the absence of free carbon in it.

Calcium cyanamide was obtained in the form of strong granules with a content of 31.40% nitrogen at an optimal temperature of 800 ° C. It contains 1.5 times more nitrogen than calcium cyanamide obtained by the carbide method.

The results of the analysis of the composition of the exhaust gases (Fig. 3-8) showed that with an increase in temperature, the content of carbon dioxide and ammonia decreases, and the content of ammonia decreases much more than carbon dioxide, which is explained by a side chemical reaction of decomposition of ammonia.

The amount of methane and carbon monoxide in the exhaust gases was minimal (0.19-0.31), which gives reason not to consider these gases as products of any side reactions.

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