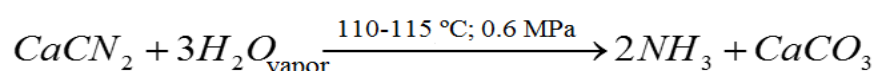


Today, instead of *the electric arc*, the *plasma method* is used, which is less energy-consuming.

The *cyanamide method* was developed in the twentieth century in the production of  $CaCN_2$  fertilizer:



The energy consumption per 1 ton of bound nitrogen by the cyanamide method is 12,000 kW · h.

The *ammonia method* was developed in Germany and Russia in the XIX-XX centuries. The basic reaction equation is:



The energy consumption per 1 ton of bound nitrogen by the ammonia method is 5,000 kW · h with a process capacity of 100,000-300,000 tons/year. The ammonia method is the most energy-efficient process.

A variant of the ammonia method is to obtain  $NH_3$  and  $Al_2O_3$  from bauxite through Al nitride (early 20th century).

### **Methods for producing a nitrogen-hydrogen mixture (NHM)**

*Methods for producing nitrogen:*

- 1) the physical separation of air into nitrogen and oxygen;
- 2) the joint production of nitrogen and hydrogen by binding  $O_2$  to  $CO_2$  and its separation.

**Hydrogen production. The main industrial methods for the synthesis of hydrogen (carbon and carbon monoxide conversion, water electrolysis and coke oven gas processing).**

**The synthesis of ammonia. Physico-chemical basis of the process of ammonia synthesis (composition of the nitrogen-hydrogen mixture, catalysts, pressure, temperature). The choice of optimal synthesis conditions. Technological (circulating) ammonia production scheme**

*Sources of hydrogen:*

- natural gas;
- methane and its homologs;
- water, semi-water, coke oven gases;
- water.

The liquefaction of air is carried out by throttling, followed by distillation.

*Hydrogen production by methane conversion (co-production of nitrogen and hydrogen by binding  $O_2$  to  $CO_2$  and separating it):*

- a) methane conversion by water vapor: