
# Analysing Process of Ammonia Production

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**ABSTRACT**

Nitrogen is a colorless, tasteless and odorless gas that plays an important role in human and living life. It is one of the most abundant elements and makes up 1.10-2.0% of the mass of the earth's crust. The main part is in the atmosphere (75.6% by mass, 78.09% by volume) and is equal to $4 \cdot 10^8$ $m^3$. Found in the air, in rivers, seas and oceans. In the Earth's crust, it forms three basic units: free, minerals, and ions. It is recorded in the form of industrial sodium nitrate and potassium nitrate, in the gas clouds of comets, in the solar atmosphere. Nitrogen is present in all living things and contains up to 17% of the protein nitrogen, which is 3% of the total in the human body. Nitrogen is involved in the metabolism of nature, and its amount in the soil is formed due to the activity of nitrogen-fixing bacteria or microorganisms. Plants and microorganisms that absorb atmospheric nitrogen and convert it into nitrogen-fixing compounds together provide 200-500 kg of nitrogen per hectare per year.

**Keywords:** Gas cleaning, cyclones, liquid cleaning of gases, compressor, nitrogen and hydrogen technology, medium temperature catalysts.

**1. Introduction.** Only this mixture of nitrogen and oxygen is the most breathable for most people on the planet. The relative inertness of this gas is extremely beneficial to humanity. If it were more prone to chemical reactions, the Earth's atmosphere would not exist in its current form. Oxygen, a strong oxidant, reacted with nitrogen to form toxic nitrogen oxides. However, if nitrogen was a truly inert gas likes helium, neither chemical production nor strong microorganisms would be able to bind atmospheric nitrogen, and all living organisms would not be bound to bound nitrogen. There would be no ammonia, nitric acid, the most important mineral fertilizers needed for the production of most substances. Liquid nitrogen is used in refrigeration equipment, and the low chemical activity of nitrogen depends primarily on the structure of its molecule. Atomic nitrogen is more active and at normal temperatures it reacts with sulfur, phosphorus, arsenic and some metals, such as mercury. However, obtaining nitrogen as individual atoms is a complex task. The air contains 78.03% by volume of nitrogen, 20.95% by volume of oxygen, and 0.94% by volume of argon and other inert gases [1]

The physical properties of the constituent elements of air are given in the following table:

**Table 1**

| Gas | $T_{liquid}$ ° C | $T_{boiling}$ ° C |
|---|---|---|
| **Oxygen** | **- 218,4** | **- 182,95** |
| **Argon** | **- 189,2** | **- 185,7** |
| **Nitrogen** | **- 209,9** | **- 195,8** |

**2. Methods.** Purified and dried atmospheric air is compressed from $R_1$ to $R_2$ using a compressor. As compression causes the air to heat up, its temperature rises from $T_1$ to $T_2$. When passing through the water cooler, the compressed air is cooled to a temperature $T_1$ and flows in the opposite direction to the throttle through the heat exchanger. With the opening of this nozzle, the compressed air expands and becomes thinner. Expansion is a mechanical work that requires energy. If energy is not consumed, the amount of energy required for this work is due to a decrease in internal energy, which leads to a decrease in the temperature of the gas. The flow of cooled air as it exits through the heat exchanger cools the incoming air considerably before throttling, which in turn lowers the temperature as it expands. As a result of continuous operation of the device for a certain period of time, the air flow to the throttle tap becomes so cold that its expansion leads to partial liquefaction of air. Liquid air ($T_{liquid}$= -194, 2 ° C) is separated in the separator, and the gaseous air escapes from the heat exchanger. The liquid air obtained in this way is often separated into components by setting the liquid-air balance in the rectification towers, and if the pure nitrogen is in the gaseous state, it is poured into black cylinders with the letters "nitrogen" in yellow letters. The main method of nitrogen binding in industrial conditions remains the synthesis of ammonia. Ammonia is one of the largest products in the chemical industry, producing 70 million tons of ammonia a year worldwide. tons. Ammonia itself is used in limited quantities and usually in the form of aqueous solutions. But ammonia, unlike atmospheric nitrogen, is much more easily involved in accumulation and exchange reactions. It is also more easily oxidized than nitrogen. Therefore, ammonia is used as a starting material in the production of most nitrogenous substances [2].

Ammonia synthesis is carried out by the following reaction without waste products: N2 + 3H2 → 2NH3 + Q.

The raw materials for this process are the products of two-stage steam conversion of natural gas: CH4 + O2→ 2CO +2H2 + Q

Air nitrogen is also mixed with the atmospheric oxygen used at this stage. The resulting carbon (II) oxide reacts with water vapor. CO + H2O→ CO2 + H2 + Q

Unlike nitrogen, hydrogen, and oxygen, ammonia has a pungent odor. Its odor is so strong that in the presence of insignificant amounts of gaseous ammonia, a person has a runny nose, tears, and signs of respiratory suffocation. As far as we know, the amount of ammonia in ammonia water used by farmers and in ammonia water is very low (less than 10%) and therefore it is considered relatively safe. Unlike nitrogen, hydrogen, and oxygen, gaseous ammonia is very easy to convert to liquid ammonia. It is enough to cool it to -33 ºC. Under pressure, gaseous ammonia can be diluted even at room temperature [3].

This level of easily liquefied gas is very useful. As the liquid evaporates, it removes heat from its surroundings. This is because the liquid molecules have more energy to move to the gaseous state faster. After soaking your skin in water or alcohol, you may have noticed that this area of skin feels cold during the construction process. However, ammonia should be handled with extreme caution, even with pure water, and should not be handled without special protective equipment. When working in a room where ammonia is present, it is necessary to have ventilation in the state of the air, which constantly renews the air. Otherwise, a person who inhales ammonia will be severely poisoned as a result of shortness of breath and ingestion of ammonia into the mucous membranes of the eyes and mouth.

Liquid ammonia on the skin or eyes can cause severe chemical burns [4].

Catalysts are used to extract ammonia from the nitrogen-hydrogen mixture, so the purity of the gas must be very high. For example, the natural gas supplied to the catalyst (methane conversion process) must contain less than 2 mg / m³ of sulfur. The release of ammonia depends on many factors: temperature, pressure, contact time of the gas with the catalyst, the composition of the mixture, the activity of the catalyst, the structure of the device. In industry, the pressure is maintained at 10-100 MPa. Depending on the pressure, low pressure (10-15 MPa), medium pressure (25-60 MPa) and high pressure (60-100 MPa) processes are recorded, and the medium pressure process is more common. Only part of the nitrogen-hydrogen mixture is converted to ammonia after passing through the catalyst (ammonia is 14-20%). Ammonia is condensed from the gas mixture leaving the contact device, and the unreacted nitrogen-hydrogen mixture is sent back to the contact device by means of a compressor. A new nitrogen-hydrogen mixture is added to the amount of ammonia formed in this mixture [5].

The most important device of the ammonia synthesis technological process is the synthesis tower. It must be strong, safe and last a long time. The body of the tower is made of chrome and vanadium steel. Internal structure - needle contact device is equipped with double heat exchange tubes. The tower is cylindrical; the wall thickness is 176-200 mm, height 12-20 m, inner diameter 1.0-2.8 m. The tower will be installed vertically. There are steel covers on the top and bottom. The tower is covered with a layer of thermal insulation. If ammonia is liquefied under pressure and then released from this pressure, ammonia will quickly take away the heat of all the surrounding objects in the process of returning to the gaseous state.

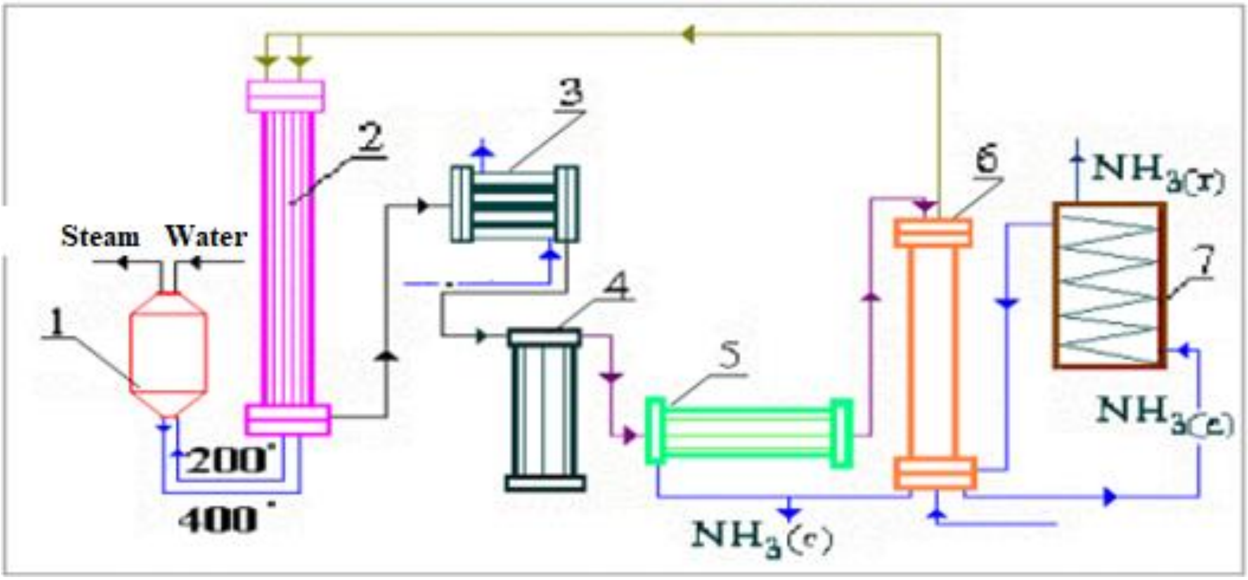

Figure 1. Technological scheme of ammonia production

If this process is started by diluting the ammonia under pressure, then returning it to a gaseous state, allowing heat to escape through it, and then diluting the same gaseous ammonia again and converting it into a gas again , ammonia gas carries with it more and more heat during each cycle. Modern ammonia synthesis towers produce 1,360 tons of ammonia per day. The theory of ammonia synthesis from simple substances is much more complex. Here only the optimal conditions of the process based on the principle of shifting the chemical equilibrium are shown. Since this reaction is exothermic, a drop in temperature shifts the equilibrium towards ammonia formation [6]. But in this case the speed of the reaction is greatly reduced. Therefore, the synthesis of ammonia has to be carried out at 500-550 ° C in the presence of a catalyst. Because the catalyst accelerates both the direct reaction and the reverse reaction to the same extent, the rise in temperature shifts the equilibrium towards the starting material, which is undesirable for ammonia production in industry. The plant will be able to produce nitric acid, urea and ammonium nitrate from ammonia. The gaseous mixture is transferred to the top of the synthesis column with 3-4% ammonia leaving the column (4). There, the ring moves and the catalyst enter the first heat exchanger (5) through the boxes. There, the mixture rises to a temperature of 300-400oC and enters the second heat exchanger through the central tube (8). This means that pressure must be used to counteract the effects of high temperature in accordance with the principles of equilibrium shear. Pressures from 15 to 100 MPa are used to synthesize ammonia. Depending on the pressure used, there are three different methods of producing synthetic ammonia: low pressure (10-15 MPa), medium pressure (25-30 MPa) and high pressure (50-100 MPa). The most common of these is the medium pressure method. However, even under such conditions, only part of the nitrogen-hydrogen mixture is converted to ammonia. For more complete utilization of the starting materials, the ammonia formed is liquefied at low temperatures, and the unreacted portion of the nitrogen-hydrogen mixture is sent back to the reactor. The technological process by which unreacted substances are separated from the reaction products and sent back to the reaction apparatus for reuse is called a circulation process.

**In conclusion. A**fter the synthesis column, 15-20% of the ammonia nitrogen-hydrogen mixture is fed to an aqueous condenser in the Nay in the Nay system. In it, ammonia condenses and separates. And the gas is collected in a separator and sent to the warehouse. The unreacted gaseous mixture is sucked through the injector, mixed with a new portion and sent back to the synthesis column.

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