Ammonia is an inorganic, colorless gas. It is identified by its strong, suffocating characteristic smell. The molecular configuration of ammonia consists of a Nitrogen atom bonded to three Hydrogen atoms through hydrogen bonds (NH3), while the molecular weight is 17g/mol. Other physical and chemical properties of the gas include: boiling point of -33°C, melting point of -78°C, density of 0.696, vapor pressure of 8.5atm, heat of combustion (382Kj/mol), heat of vaporization (5.581kCal/mol), corrosive to galvanized surfaces, alkaline pH, ionization potential of 10.18eV, pKa of 9.25 at 25°C, refractory index of 1.394, slightly soluble in alcohol, while highly soluble in water, chloroform and ether. When ammonia is heated to a point of decomposition, it emits nitrogen oxides and toxic fumes (Pach).

Ammonia is produced in the body during the decomposition of organic substances during metabolism. This ammonia is produced in its aqueous form, ammonium hydroxide. Ammonia usually occurs naturally, and is produced by human activity. Plants and animals need nitrogen in their growth, development and normal functioning, and ammonia is a great source of this. Bacteria in the intestine of animals can also produce ammonia. The gas was first obtained in 1774 by Joseph Priestly, an English chemist. In 1784, Claude Louis Berthollet decomposed ammonia into its elements, and thus derived the composition of the gas (Noyes).

Process of production

The industrial production of ammonia involves a procedural process known as the Haber process. Here, hydrogen, obtained from methane through a process known as steam reforming, is reacted with nitrogen at a given temperature, pressure and in the presence of a catalyst to form ammonia. The reaction is reversible and exothermic. It is illustrated below.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -92\ kJ\ mol^{-1}$$ (Task)

The process utilizes an iron catalyst. A pressure of 400atm and temperatures of between 400-500°C are also maintained during the process. When the gases are in the reactor, about 15 percent of the gases are converted into ammonia. The rest of the gases are recycled. The ammonia gas is then cooled to liquid. Below is a diagrammatic illustration of the Haber process.

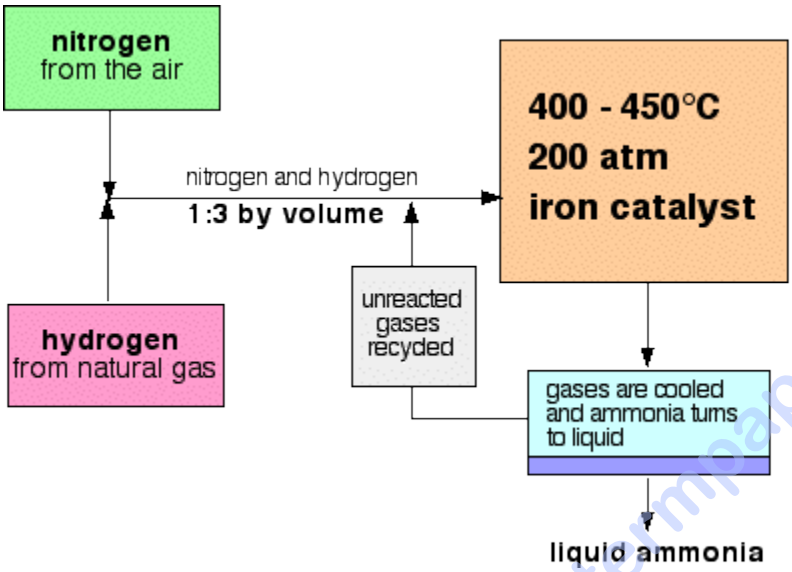

Figure 1: A diagrammatic illustration of the Haber process, (Pach).

Environmental and safety concerns

Ammonia is a flammable gas. Ammonia can also cause severe skin corrosion and irritation. On inhalation of ammonia gas, one may present with acute toxicity, and the gas can also be toxic to aquatic life.

Use of ammonia

Ammonia has been used industrially in the production of the following: Agricultural products such as fertilizers, garden care and lawn products, water treatment products, rubber and plastic

products as well as paper and ink products. It has also been used as absorbents, adsorbents, finishing agents, oxidizing, reducing agents, plasticizers, process regulators and solvents.

Economics

Yields can be increased cost effectively by adding an excess amount of reactants and periodically removing the products. At these current times, the price of ammonia is about 0.25 dollars per pound. Demand for ammonia comes mainly from the fertilizer industry, and over the past decade, global demand for ammonia has been growing at a rate of about 2%. In 2013, about 164 million tonnes of ammonia were produced worldwide, China being the largest producer.

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