F4 FERTILISERS

BUILDING FERTILISERS FROM MOLECULES 1

CHEMICAL INDUSTRIES
RESOURCE PACK

Did you know?

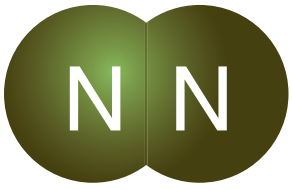
The nitrogen supply for ammonia synthesis is truly inexhaustible since the atmosphere contains 3,8 quadrillion tonnes of the element.

Nitrogen

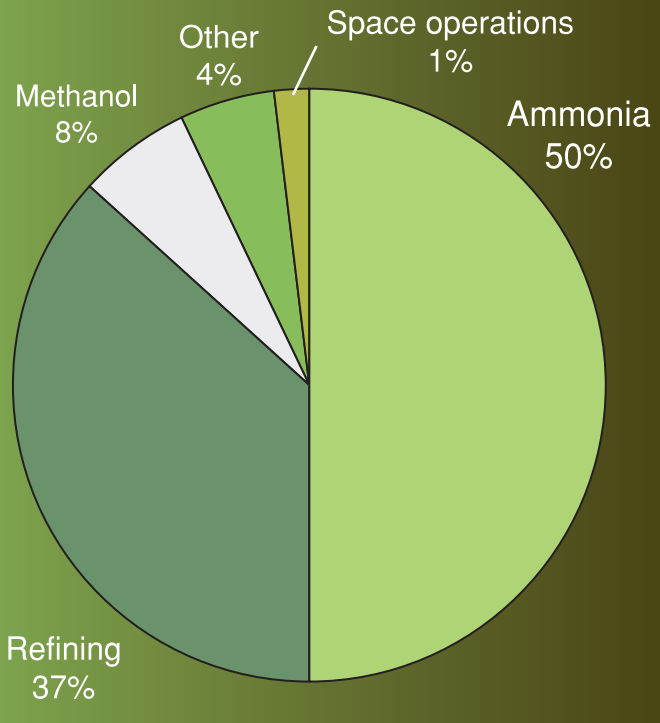
Nitrogen comes from the air. 78% of the air that we breathe is nitrogen. Air can be liquefied and nitrogen obtained by fractional distillation of air. The strong chemical bond between the two nitrogen atoms in a nitrogen molecule leads to the molecule being unreactive and most plants can't use nitrogen directly. We therefore need a process to convert this abundant resource into a usable form for plants.

Other sources of nitrogen include: nitrogen fixing bacteria; decomposing bacteria and fungi; nitrifying bacteria; lightning.

A representation of the nitrogen molecule



The largest consumers of hydrogen today



Source: Bellona Foundation

Hydrogen

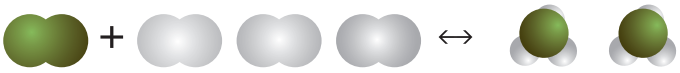
Hydrogen has been produced and used for industrial purposes for over one hundred years. Of the world's total hydrogen production of approximately 45 million tons, over 90% comes from fossil raw materials. The largest producers of hydrogen are the fertiliser and petroleum industries.

A representation of the hydrogen molecule

The Haber-Bosch synthesis of ammonia

Fritz Haber discovered that at a temperature of 600°C and a pressure of 200 atm, nitrogen and hydrogen form an equilibrium mixture in the presence of a suitable catalyst. The equation for the reaction can be seen below:

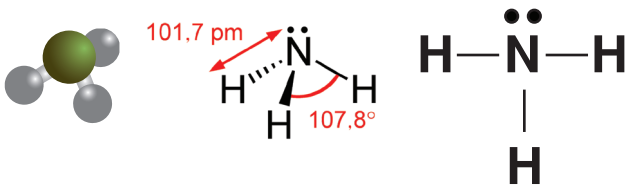
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$; $\Delta H = -92kJ/mol$ of N_2



The conditions giving rise to the maximum yield of ammonia are high pressure and low temperature. In practice the operating temperature is usually about 400 - 450°C because at lower temperatures the reaction is too slow, even in the presence of a catalyst. The operating pressure is normally about 25 MPa (~250 atm), although pressures up to 101 MPa (~1000 atm) have been used. The best catalyst is iron mixed with various promoters such as aluminium and potassium oxides to increase its catalytic activity.

Ammonia (NH_3)

Different representations of the ammonia molecule



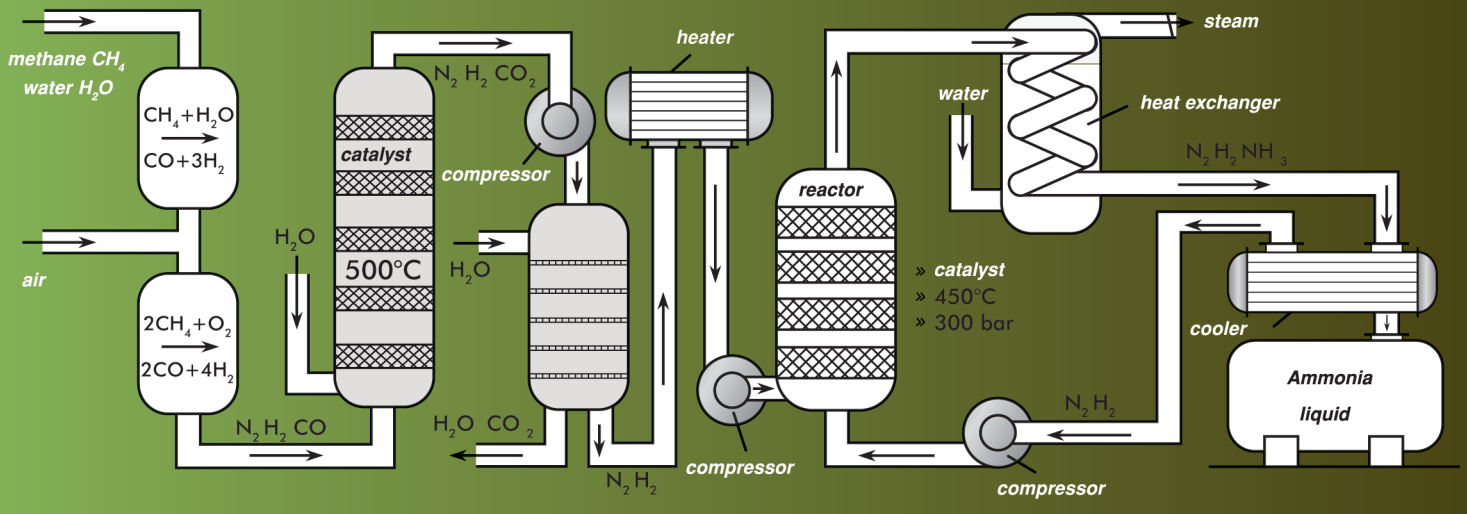
Source: Wikimedia Commons

Properties of ammonia:

- Melting point : -78°C
- Boiling point: -33,5°C
- Extremely soluble in water:
  $NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$
- Reacts with and corrodes copper, zinc, and many alloys
- It is a colourless gas at room temperature with a characteristic pungent odour
- Less dense than air

This material was adapted from Wikipedia. Learners - if you use any part of it you need to write it in your own words and include the following in your reference list: Wikipedia.org. 2010. Ammonia. [Online]. Available: http://en.wikipedia.org/wiki/Ammonia [1 July 2010].

Production of synthesis mixture and production of ammonia



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