

Ammonia

Recap on Ammonia

Chemical Formula: NH_3

Weak Alkalis

- A weak alkali partially dissociates in water to form hydroxide ions. $\text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$

Conductivity of Ammonia

- Ammonia **cannot conduct electricity in solid, liquid, and gaseous states** due to **absence of mobile ions and mobile electrons** to carry charges.
- It is able to conduct electricity in **aqueous state** due to **the formation of ammonium and hydroxide ions**.

Testing for Ammonia

- Place a **piece of moist/damp red litmus paper** at the mouth of the test paper
- Colorless pungent gas **turns moist/damp red litmus paper blue**.

Uses of Ammonia

Ammonia is a very important chemical, used in the manufacture of:

- Fertilisers
- Nitric acid
- Household cleaning products

Nitrogen is an essential element required for the survival of plants. Even with an abundance of 78% nitrogen in the air, there is a lack of nitrogen for crop growth. Why is this so?

- Though N_2 is present in a large percentage of air, plants are unable to absorb N_2 from the air directly. N_2 has to be dissolved in water before plants can absorb them through the roots.
- (Nitrogen is dissolved naturally when lightning occurs and by certain types of bacteria in soil but these processes do not occur fast enough to support current crop growth.)

Common Artificial Fertilisers

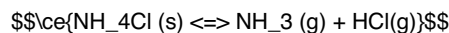
- Ammonium Nitrate, NH_4NO_3
- Ammonium Sulfate, $(\text{NH}_4)_2\text{SO}_4$

Reversible Reactions

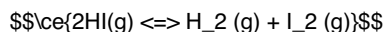
Reversible reactions are chemical reactions that can proceed in both the forward and backward directions.

Examples:

Thermal decomposition of ammonium chloride



Formation and decomposition of hydrogen iodide



In reversible reactions, the reactants can change into products and the products can change back into reactants.

Note

Note the type of arrows to denote reversible chemical reactions.

Production of Ammonia

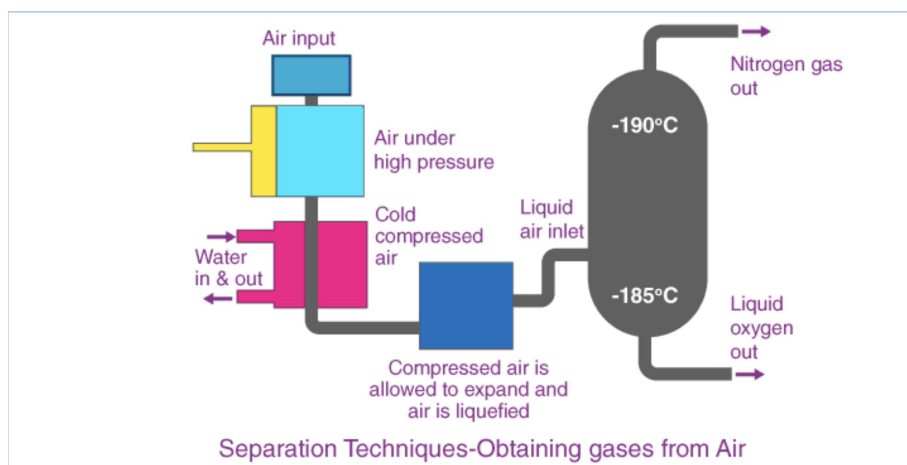
General Word Equation for Reaction Between Ammonium Salt and Base

Alkali + ammonium salt → salt + water + ammonia

Raw materials for Haber Process

- The raw materials in the manufacture of ammonia are **nitrogen** and **hydrogen**.
- The nitrogen is obtained by the **fractional distillation of liquefied air**.
- The hydrogen is obtained from a variety of sources:
 - Reacting together methane and steam
 - methane + steam → carbon monoxide + hydrogen gas
 - $\text{CH}_4 \text{ (g)} + \text{H}_2\text{O (g)} \rightarrow \text{CO (g)} + 3\text{H}_2 \text{ (g)}$

Fractional Distillation of Liquefied Air



- Cracking hydrocarbons found in crude oil:
 - butane → ethene + hydrogen
 - $\text{C}_4\text{H}_{10}(\text{g}) \rightarrow 2\text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g})$

Conditions Suitable for Reversible Reactions

Conditions such as temperature and pressure need to be adjusted for reversible reactions.

Function of the Iron Catalyst

- The iron catalyst is used to increase the rate of reaction
- It increases the speed of reaction by providing an **alternative reaction pathway** with a **lower activation energy**
- The finely divided iron catalyst provides a **larger surface area to volume ratio** for the reaction to take place, further increasing the rate of reaction.

Why is ammonia gas condensed into a liquid and not transported in gaseous state?

- Compressing the gas to liquid state allows more ammonia to be stored per volume
- It also allows for easier storage and transportation of ammonia gas.