10.3 Importance of Ammonia – To make nitrogenous fertilisers (Optional)

(i) Uses of nitrogen in plants

- **Nitrogen is necessary for healthy plant growth**, make proteins, for wear and tear (replacement of plant tissues).
- Nitrogen, **N_2, is found in the air, but is insoluble in water, hence it cannot be taken in by the plant.**
- **For plants to take in the nitrogen, nitrogen found in the fertilisers must be in a soluble in water (recall solubility rules of salts – chap 12), i.e. in the form of ammonium, NH_4^+ or nitrate, NO_3^- ions. Once the fertiliser is added, with water, onto the soil, the ammonium and nitrate become soluble in water and are taken in together with the water by the roots/root hairs**.
- Nutrients for the plants, a.k.a. fertilisers, are necessary for plant growth so that crop yield can be increased to meet the demands of the growing population. Plants tend to grow faster and taller/bigger in size/better fruit etc.
- **Fertilisers can be organic/natural or inorganic/man-made/artificial**
  (1) Organic - farm manure i.e. wastes from animals/plants.
  (2) Inorganic - e.g. liquid ammonia, ammonium sulfate, ammonium nitrate and urea.
- **Other elements needed for healthy plant growth include magnesium, potassium and phosphorus. Thus a lot of fertilisers are classified as NPK fertilisers as they are mixtures of compounds which contain nitrogen (N), phosphorus (P) and potassium (K). There are different brands of NPK fertilisers and they differ in terms of percentage composition by mass of nitrogen, phosphorus and potassium which can be calculated.**

  Example: % of nitrogen in a given fertiliser or see TYS for other examples.

  Apply concept of percentage composition by mass from Chap 9 – The Mole.

  Molar mass of NH_4NO_3 = (14 x 2) + (1 x 4) + (16 x 3)
  = 80 g/mol

  % of nitrogen in NH_4NO_3 = $\frac{14x2}{80}$ x 100 [Given that the]
  = 35.0%

(ii) Problems caused by use of nitrogenous fertilisers

(1) Loss of nitrogen from the fertilisers when quicklime and slaked lime are also added concurrently to alter soil pH.

- Calcium hydroxide (slaked lime) (or sometimes calcium oxide, which is quicklime) is added onto the soil to reduce the acidity by neutralising the excess acid in soil.
- When nitrogenous fertiliser containing ammonium salts e.g. ammonium sulfate is added to soil together with slaked lime/quicklime which is an alkali, they will react with each other to form gaseous ammonia according to following equation:

$$Ca(OH)_2 + (NH_4)_2SO_4 \rightarrow CaSO_4 + 2\mathbf{NH_3\,(g)} + 2H_2O$$

- Ammonia gas escapes into the atmosphere, resulting in the loss of nitrogen from the fertilisers already added to the soil. Thus, plants might not have sufficient amount of nitrogen required for healthy growth.

(2) Environmental problems caused by excessive use of nitrogenous fertilisers – Additional Information

- Recall that nitrates and ammonium ions are very soluble in water. When excessive amount of fertiliser is added and not absorbed by the plants, the nitrates will leach into the water systems.
- Two major problems will occur (eutrophication and water pollution)
    (1) Nitrates in the water provide nutrients for water plants/ algae, causing them to multiply very rapidly, covering the entire water surface, cutting off sunlight from entering the water. Underwater plants do not capture sufficient sunlight, reducing the rate of photosynthesis, meaning less oxygen is produced underwater.
    (2) Algae dies (due to overcrowding/natural death) and starts to decompose, using up more of remaining dissolved oxygen in the water.
- Oxygen is slowly used up causing the death of fish and aquatic organisms, making the water incapable of supporting any life form.
- This change that occurs in the water is known as eutrophication.
- Nitrates dissolved in water is dangerous, esp. for babies. They prevent haemoglobin in the blood from transporting oxygen around the body. Nitrates can also from nitrosoamines which can cause cancer.