Ch 16 - Some Non-metals and their Compounds (summary notes)

Properties of Hydrogen:

1. The lightest of all the elements
2. It is a colorless gas.
3. No smell
4. Reacts with O_2 in a highly exothermic reaction
5. Can be used as a reducing agent for metals lower than it in the reactivity series

Properties of Nitrogen:

1. It is an unreactive gas, since it is diatomic with a strong triple bond
2. Very little of it dissolves in water
3. Colorless
4. Odorless
5. It reacts with H_2 to for Ammonia
6. Reacts with O_2 to form Nitrogen oxides.

Ammonia and the Haber Process

Properties of Ammonia

1. Colorless gas
2. Pungent smell
3. It is basic. Reacts with Acids to form ammonium salts
4. Less dense than air
5. Produces when an Ammonium salt reacts with a base
6. Solution in water is Alkaline
7. Reacts with HCl to form a white smoke of Ammonium chloride
8. Very soluble in water

Haber process (process used to make Ammonia)

1. First Nitrogen and Hydrogen gasses are obtained
2. They are then scrubbed and mixed to remove impurities
3. Mixture is compressed. Gas is added until pressure in pipes is **200 atm**
4. The mixture moves into converter. Inside this there are beds of iron at 450°C. Iron is a catalyst for this reaction
5. Only 15% of mixtures forms Ammonia. Mixture is cooled and liquid Ammonia forms.
6. The other 85% of mixture is unreacted. It gets recycles. It undergoes step 4 and 5 again.

Why use 200atm and 450°C for Haber process

1. 400 atm and 350°C give a better yield.
2. At 350°C the reaction is too slow, faster rate at 450°C, however at higher temperatures, the reverse reaction is favoured.
3. 400 Atm is a very high pressure. It needs very strong equipment (such as strong pipes) and also powerful pumps are needed. Furthermore, it requires more electricity. With 200Atm costs are saved and also is safer.
4. Catalyst speeds both sides of reaction
5. Final yield is high since liquid Ammonia is removed and the unreacted gasses are recycled.

Fertilizers

- Any substance that is added to the soil to make it more fertile
- Usually, soils are fertile. Roots absorb minerals from soils in their solution. Some get replaced naturally however the soil will eventually get worn out which makes us need fertilizers.
- Synthetic fertilizer – made by humans, Natural fertilizer – made naturally e.g. Manure

Problems with fertilizers

1. Can cause eutrophication
2. If it gets into rivers it may enter out water supply. Nitrate ions are turned into Nitrite ions in our body. These combine with Hemoglobin. Blood carries less O_2. People die form O_2 starvation, causes illness, causes blue tinge in skin.

Mineral	**Why plants need**
Nitrogen	Make proteins, chlorophyll
Potassium	Help Make proteins, resist disease
Phosphorus	Helps roots grow, and crops ripen

Sulfur and the Contact Process:

Properties of Sulfur:

1. Non metal
2. Brittle, yellow solid
3. Has 2 allotropes
4. Low melting point
5. Does not dissolve in water
6. Does not conduct electricity
7. Reacts with O_2 to form SO_2
8. Reacts with metals to form sulfides

Where is it extracted from?

1. Found in large underground beds. Super-Hot water is sent to these beds which causes Sulfur to melt. Liquid Sulphur Is then projected up.
2. Found in Fossil fuels
3. Compound in ores of some metals
4. Found near rims of volcanoes

Uses of Sulphur

1. Makes Rubber tougher (vulcanizing) in car tires for exp
2. Added to cement to make Sulphur concrete. This is not attacked by acids.
3. Shampoo's, cosmetics
4. Drugs
5. Making sulphuric acid

Properties of Sulphur dioxide:

1. Colorless gas
2. Heavier than air
3. Choking smell
4. Dissolves in water forming Sulfurous acid – H_2SO_3 (not sulfuric acid)
5. Acts as a bleach when it is damp or in solution
6. Kills bacteria

Sulfur Dioxide as a Pollutant

1. Causes lung problems
2. Forms acid rain which attacks buildings and statues

Uses of Sulphur dioxide

1. Manufacturing Sulfuric acid
2. Bleach
3. Food preservative

Contact process

Raw materials required: Sulphur or Sulphur dioxide, air, water

1. Burn Sulphur in air to form Sulphur dioxide
    - $S(s) + O_2(g) \rightarrow SO_2(g)$
2. Excess air is added.
3. Mixture is passed over beds of vanadium(V) oxide at **450°C**. SO_3 forms.
    - $SO_2(g) + O_2(g) \rightleftharpoons SO_3(g)$.
    - To increase yield of SO_3, Four separate beds are used to give the reactants more chances to react.
    - SO_3 is removed between the last 2 beds to increase yield.
    - 450°C is used to keep the temperature low to favour the forward reaction while maintaining a temperature which allows catalyst to work (>400°C).
    - To maintain the temperature, pipes of cold water are used to carry heat away. Steam that is produced is used to generate electricity or for heating.
4. SO_3 is dissolved in Concentrated H_2SO_4 forming Oleum.
    - Dissolved in concentrated acid not water to prevent formation of a mist of acid.
5. Oleum is then added to water to give H_2SO_4.

Uses of H_2SO_4.

1. soaps, shampoos
2. Car batteries
3. Paints, pigments
4. Plastic's, fibers
5. Note that H_2SO_4. is a dehydrating agent. It removes water

(when preparing dilute H_2SO_4. always add the H_2SO_4. to water not other way around or else H_2SO_4. will splash)

Carbon

- Has 3 allotropes
- Thousands of Carbon Compounds are found in nature

Carbon Cycle

- the way in which Carbon moves between compound's in the atmosphere, living things, the soil and the ocean is called the carbon cycle.

- Carbon moves between Atmosphere, soil and ocean in the form of CO_2

- CO_2 is added to atmosphere by respiration, combustion of fuels

- CO_2 is removed from atmosphere by photosynthesis and because CO_2 dissolves in water

(Note – Photosynthesis also happens in tiny plants that float in the ocean called phytoplankton. Hence carbon passes along oceanic food chains)

(Note – when CO_2 dissolves in water it gives Carbonate ions. These are used by Shellfish along with Calcium ions to produce Limestone shells. Fish also use carbon ions to make skeletons.)

(Note – only a certain amount of Carbon will dissolve in water. Once the concentration of Carbon in water and in air are same carbon will stop dissolving)

Formation of fossil fuels

Remains of dead organisms fall to ocean floor and are buried. Soft parts turn into petroleum and natural gas. (hard shells turn into limestone rock)

Vegetation gets buried in warm swamps. Million years later coal forms.

Carbon dioxide

Formed due to:

1. Respiration
2. Adding Carbonates to acids
3. Combustion of fossil fuels
4. Decomposition of carbonates

Properties:

1. It is colorless with no smell
2. It does not support combustion
3. Slightly soluble in Water
4. Heavier than air

Carbon monoxide

1. Colorless, with no smell
2. Poisonous/highly toxic (causes oxygen starvation)
3. Forms when carbon burns in limited air supply

(note. Boilers/gas heaters a home must be checked regularly to make sure that there is no soot in the air supply. This is done because CO is colorless and has no smell, and hence cannot be recognized)

Carbonates

These are compounds that contain CO_3 (2-) ions.

Properties:

1. Insoluble In water (except sodium, potassium, ammonium)
2. Neutralize acids
3. Decompose on heating

Methane

Where is it found:

1. Methane is found in gas deposits in ocean floor and on land
2. Forms wherever bacteria break down plant material in absence of O_2. E.g., in Paddy fields. Landfill sights.
3. Some animals give out methane as a waste product from digestion. Bacteria in stomach break down grass and other foods, methane is one product.

Greenhouse gasses

- Absorb heat in the atmosphere and prevent it from escaping into space.
- CO_2 is increasing because we burn more fossil fuels. Ocean cannot dissolve all CO_2 in the air.
- Methane increasing because animal and rice farming is increasing. Also there are more landfill sites now.

Climate Change

Air temperature affects **rainfall**, **wind patterns** and **cloud cover**. Hence as the temperature rises the climate changes too.

(you should know effects of climate change)

How can we help stop global warming
- global warming cannot be stopped, there is already enough gas in the air to cause further temperature change. We can however stop adding more greenhouse gasses into the air to cause further change.

1. Use public transport/carpool/electric transport/walk
2. Governments aim to switch to renewable resources of energy
3. Some scientists want to trap CO_2 from factories and store it underground.

Limestone

- Most of the creatures that live in the sea have shells made up of limestone. When they die their remains fall to the sea floor. Million years later the layers of shell and bone become limestone rock.
- Powerful forces raise some sea bed up, these form land.

Uses of Limestone:

Crushed Limestone: 1. Road building 2. Iron extraction 3. As chips for concrete/cement shown below	Powdered limestone: 1. Flue gas desulfurization 2. Neutralize acidity in soil
Lime: CaO 1. Neutralize acidity in soil 2. Drying agent in industry 3. Making steel from iron	Slaked lime: $Ca(OH)_2$ 1. Flue gas desulphurization 2. Neutralize acidity in soil AND LAKES

Formation of Lime:

$CaCO_3$ < ==>$CaO + CO_2$

This is a reversible reaction. Reaction is carried out in a rotary kiln. As the limestone is heated air is blown so that CO_2 that forms cannot react with CaO to form limestone in the backward reaction

Formation of Slaked Lime:

Forms when Water is added to Lime. This is an exothermic reaction.
Limewater is just Slaked lime dissolved in water.

Cement

1. Add Limestone to clay
2. Heat mixture strongly in kiln
3. Add gypsum (hydrated Calcium Sulfate)
4. Grind to give powder

Flue gas desulfurization

- removal of SO2 from the waste gasses at power stations, before they go out the flue.

- carried out runny mixture of powdered limestone or with slaked lime and water (i.e. limewater)

- the waste gasses are bubbled through solution or mixture is sprayed through waste gasses

$Ca(OH)_2 + SO_2$ ==> $CaSO_3$ + H20

$2CaSO_3 + O_2 + 4H_2O$ ==> $2CaSO_2.2H_2O$

The hydrated calcium sulfate that forms is gypsum and can be made by power stations to increase profit.

Notes provided by Jeyan Mehta