Reactions involved for ozone layer depletion in the stratosphere

In the stratosphere, ozone is a product of the action of UV radiations on dioxygen as:

(i) $O_{2(g)} \xrightarrow{UV} O_{(g)} + O_{(g)}$

(ii) $O_{2(g)} + O_{(g)} \xleftrightarrow{UV} O_{3(g)}$

Reaction (ii) indicates the **dynamic equilibrium** existing between **the production and decomposition of ozone molecules**. Any factor that disturbs the equilibrium may cause depletion of ozone layer by its decomposition. One such **factor is the release of chlorofluorocarbon compounds** (CFCs). These are non-reactive, non-flammable molecules that are used in refrigerators, air conditioners, plastics, and electronic industries.

Once released CFCs mix with atmospheric gases and reach the stratosphere, where they are decomposed by UV radiations.

(iii) $CF_2Cl_{2(g)} \xrightarrow{UV} \dot{C}l_{(g)} + \dot{C}F_2Cl_{(g)}$

The chlorine free radical produced in reaction (iii) reacts with ozone as:

(iv) $\dot{C}l_{(g)} + O_{3(g)} \longrightarrow Cl\dot{O}_{(g)} + O_{2(g)}$

The $\dot{C}l_{(g)}$ radicals further react with atomic oxygen to produce more chlorine radicals as:

(v) $Cl\dot{O}_{(g)} + O_{(g)} \longrightarrow \dot{C}l_{(g)} + O_{2(g)}$

The regeneration of $Cl_{(g)}$ causes a continuous breakdown of ozone present in the stratosphere, damaging the ozone layer.

Ozone hole and its consequences

In Polar regions, stratospheric clouds provide the surface for chlorine nitrate and hypochlorous acid, which react further to give molecular chlorine. Molecular chlorine and HOCl are photolysed to give chlorine-free radicals.

$$ClONO_{2(g)} + H_2O_{(g)} \longrightarrow HOCl_{(g)} + HNO_{3(g)}$$

$$ClONO_{2(g)} + HCl_{(g)} \longrightarrow Cl_{2(g)} + HNO_{3(g)}$$

$$HOCl_{(g)} \xrightarrow{h\nu} \dot{O}H_{(g)} + \dot{C}l_{(g)}$$

$$Cl_{2(g)} \xrightarrow{h\nu} \dot{C}l_{(g)} + \dot{C}l_{(g)}$$

The chlorine-free radicals lead to the decomposition of ozone as:

$$\dot{C}l_{(g)} + O_{3(g)} \longrightarrow Cl\dot{O}_{(g)} + O_{2(g)}$$

Hence, a chain reaction is initiated. The chlorine-free radical is continuously regenerated, thereby depleting the ozone layer. This phenomenon is known as the as 'ozone hole'.

Effects of depletion of ozone layer

The ozone layer protects the Earth from the harmful UV radiations of the sun. With the depletion of the layer, more radiation will enter the Earth's atmosphere. UV radiations are harmful because they lead to the **ageing of skin, cataract, skin cancer, and sunburns**. They **cause death of many phytoplanktons, which leads**

to a decrease of fish productivity. Excess exposure may even cause **mutation in plants.**

Increase in UV radiations, **decreases the moisture content of the soil and damages both plants and fibres.**