

15.6. as ozone layer.
approximately 97% of
all

[Economics](#), [Trade](#)



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BUSTER**

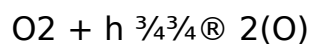
15.

6. Stratospheric Pollution Ozone is present at different altitudes of atmosphere. Layer of ozone is present in upper region of stratosphere, known as ozone layer. Approximately 97% of all the ozone in the atmosphere (10 km to 50 km) is present in the stratosphere. The highest concentration of ozone is between the altitudes of 12 km and 35 km in the stratosphere.

This zone (12 km to 35 km) of atmosphere is called ozonosphere or the stratosphere ozone layer and is considered as a protective shield on the earth's surface. This layer shields the earth from the harmful ultraviolet radiation of the sun. Depletion of the ozone layer is considered as a threat to all forms of life. 15.

6. 1 Depletion of Ozone Layer (Ozone hole) When UV light from the sun strikes the earth's atmosphere, it causes photolysis of oxygen molecules

into reactive oxygen atom.

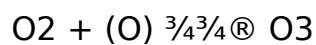


(1)

This reaction is followed by another in

which a reactive oxygen atom recombines with an oxygen

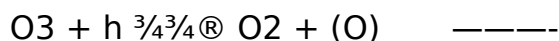
molecule producing ozone.



(2) The ozone formed in reaction distributes itself in the

stratosphere forming a layer. Stratosphere ozone then absorbs harmful

ultraviolet radiation.



(3)

The ozone layer filters the incoming UV radiations and provides

natural protection. The reaction (3) destroys ozone but it also produces

reactive oxygen (Reaction-2) producing more ozone to compensate the loss.

Thus in the stratosphere, ozone is continuously created and destroyed by the sun's radiation.

This results in equilibrium concentration of ozone. The equilibrium is disturbed when reactive chlorine atoms, released from photolysis of CFC's, enter into the atmosphere. Fig. 15. 3 Ozone hole These atoms create an imbalance by destroying ozone molecules.

Generally substances that cause depletion of ozone or make it thinner are called Ozone Depletion Substances abbreviated as ODS. The loss of ozone molecules in the upper atmosphere is termed as depletion of stratospheric ozone. When this happens, the ozone layer's capacity to filter out harmful U-V rays from the sun decreases.

Nitric oxide and Chloro Fluoro carbon are found to be most responsible for depletion of ozone layer. i) Oxides of Nitrogen: Nitrogen oxides introduced directly into the stratosphere by the supersonic jet aircraft engines in the form of exhaust gases. These oxides also released by combustion of fossil fuels and nitrogen fertilizers. Inert nitrous oxide in the stratosphere is photochemically converted into more reactive nitric oxide. Oxides of nitrogen catalyse the decomposition of ozone and are themselves regenerated. Ozone gets depleted as shown below. The net reaction is $2O_3 \rightarrow 3O_2$. Thus ozone decomposition rate increases in stratosphere in the presence of nitrogen oxides.

Reaction of NO_x with ozone causes 40% depletion. ii) Chloro Fluoro Carbons (CFC) Freons The chloro fluoro derivatives of methane and ethane

are referred by trade name Freons. These ChloroFluoro Carbon compounds are stable, non-toxic, noncorrosive and non-inflammable, easily liquefiable gases and are used in refrigerators, air-conditioners and in the production of plastic foams. CFC's are the exhaust of supersonic aircraft's and jumbo jets flying in the upper atmosphere.

They slowly pass from troposphere to stratosphere. They stay for very longer period of 50 - 100 years. In the presence of ultraviolet radiation from sun, CFC's break up into chlorine free radical. The chlorine free radicals formed react with stratospheric ozone to form chlorine monoxide radical and oxygen molecule.

Reaction of chlorine monoxide radical with atomic oxygen produces more chlorine free radical.

Due to this continuous attack of Cl, thinning of ozone layer takes place which leads to formation of ozone hole. It is estimated that for every reactive chlorine atom generated in the stratosphere, 1,00,000 molecules of ozone are depleted.

Nowadays air-conditioning and refrigeration industries use hydrochlorofluoro carbons (HCFC) and hydrofluoro carbons (HFC) as short term ozone friendly substitutes for CFC's.

15.6.2 The Ozone hole over Antarctica
Depletion of ozone layer takes place in all parts of the stratosphere but ozone hole is mainly observed in the stratosphere over Antarctica. In most parts of stratosphere, Cl reacts with nitrogen dioxide and Cl reacts with hydrocarbons as shown below. This prevents the reaction of active chlorine radical with ozone and stops the chain reaction.

The Ozone hole in Antarctica
In Antarctica, the climatic conditions are quite different. In summer season NO₂ and CH₄ react with chlorine

monoxide radical and chlorine radical respectively and prevents ozone depletion. But in winter season special types of clouds called Polar stratospheric clouds (PSC) are formed over Antarctica. PSC's composed of either nitric acid trihydrate at about 196K (Type I) or ice formed at 188K (Type II). These clouds hydrolyse chlorine nitrate to hypochlorous acid and also hydrogen chloride to chlorine molecule as shown in following reaction

During spring season (September and October) sun shines over Antarctica and the sun's warmth break up the clouds. HOCl and Cl₂ undergo photolysis to form reactive chlorine radical. The chlorine free radicals formed initiate the chain reaction of ozone depletion

Due to polar stratospheric clouds, polar vortex surrounds Antarctica.

This rigid and cuts off Antarctica from ozone air of non-polar regions. Hence ozone hole remains unfilled. After the spring the intensity of sunlight increases and polar vortex breakdown. The ozone rich air from surroundings rushes up to fill the ozone hole.

15. 6. 3 Environmental Impact of Ozone Depletion The formation and destruction of ozone is a regular natural process, which never disturbs the equilibrium level of ozone in the stratosphere.

Any change in the equilibrium level of the ozone in the atmosphere will adversely affect life in the biosphere in the following ways.

- (i) Depletion of ozone layer will allow more UV rays to reach the earth surface. Consequently, the temperature of the earth's surface will increase, which would cause melting of continental glaciers and ice sheets.
- (ii) It increases evaporation of surface water and decrease

the moisture content of the soil.(iii) Depletion of ozone layer would cause skin cancer and also decreases the immunity level in human beings.(iv) The heavily fertilised crops would be more adversely affected due to their exposure to UV radiations and hence plants are damaged. Plants give poor yield.(v) UV radiation affects the growth of phytoplankton, as a result ocean food chain is disturbed and even damages the fish productivity.