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The Journey of Ozone layers against the main Ozone depleting component-CFCs.

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Abstract: *The Ozone layer formed by Ozone gases known to all as a protector of all the organisms from the high frequency and highly harmful Ultraviolet Ray, and saves the living organisms. But around 50 years ago when CFCs are induced into the air and deeply damages the ozone layer by producing free chlorine atom. It breaks the Ozone formation process and affects the Ozone layer. The main source of this free chlorine atom is the arbitrary use of CFCs in refrigeration and various coolant machines. It is a big issue in the present situation that the Ozone layer becomes depleted by the chlorine atom produced from CFCs. Since CFCs absorb produce the free chlorine atom, it further reacts with the oxygen atom which produce the Ozone gas and finally the Ozone layer. But due to the reaction between chlorine and oxygen atom the cycle of formation of Ozone gas break. As a result the Ozone layer deplete day by day and the highly energetically UV ray entre into the earth surface and damage the living cell and organisms. But science 1987 by the Montreal Protocol we reduce the use of CFCs which has a great impact on the Ozone hole. Various organisations put restriction on the use of CFCs into any machinery instruments for any purpose and ordered them to replace it with less harmful or eco-friendly components. According to the various organisations of environmental science as well as earth science it is clear that in 2019 the hole reach to minimum, which may be fully recovered on mid of the 21st century. This is the great news to us.*

Keywords: *Chlorofluorocarbons, Free chlorine, Ozone depletion, Ozone depleting substances, Ozone layer, UV Rays.*

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Ozone layer is a layer of ozone gases between the stratosphere and mesosphere. It is a layer with average thickness about 300 Dobson units or 3 mm. In this layer generally the UV light is absorbed which is produced from the sun and comes to the earth to damage the active cell of the body. But due to the presence of ozone layer the UV light produced by the sun can't reach the earth surface since it absorbs the UV light to produce O_2 gas from O_3 gas and vice versa. So the UV light is fully utilized by the Ozone layer for this process and also save the organisms from its harmful effect.

$$O_2 \text{ (Oxygen molecule)} + h\nu_{UV} \longrightarrow 2\ O \text{ (Oxygen atom)}$$

$$O \text{ (Oxygen atom)} + O_2 \text{ (Oxygen molecule)} \longleftrightarrow O_3 \text{ (Ozone molecule)}$$

According to McMichael et al. a half billion years ago, when the living organisms could not inhabit the land surface and generally their life was restricted to the world's oceans and deep waters, which protected them from the harmful unfiltered solar ultraviolet radiation. Around 2 billion years ago ozone (O_3) started being formed gradually in the atmosphere and all organisms on the Earth protected from the solar ultraviolet radiation by the ozone layer formed on the stratosphere as a shield for the Earth.

In the year of 1969 Dutch Scientist Paul Crutzen said that the nitrogen oxide catalytic cycle may affect the ozone level over the earth, according to his research nitrogen oxide reacts with free oxygen and reduces the formation of ozone. In the early 1970s, on the basis of scientific evidence, it showed that the ozone shield was being depleted by natural processes. Again in 1970 a group of scientists and environmentalists argued that nitrogen oxides and water vapour can damage the ozone layer. Though in future, their program American SST was cancelled.

But in the 1970s a group of scientists noticed that the presence of CFC and various global warming pollutants the ozone layer began depleting. These compounds contribute to ozone depletion, and are called ozone-depleting substances (ODS). All over, we all have heard that the ozone hole is caused by CFCs (chlorofluorocarbons). These CFCs came into the atmosphere from refrigeration and various propellant devices. Due to their long lifetime in the lower atmosphere, it eventually reaches the stratosphere. In the stratosphere, ultraviolet rays dissociate the CFCs molecule and produce chlorine atoms (Cl). This free chlorine atom goes on to participate in a series of chemical reactions to destroy ozone and return the free chlorine atom. According to

the thesis a single free chlorine atom can destroy over 100,000 ozone molecules before it is removed from the stratosphere. That's why the layer becomes thin and there is some hole through which the UV ray enters into the earth and damages the tissue. As for example, UV-B radiation which has wavelength 280-320 nm can alter DNA in living cells, causing skin cancers and producing eye cataracts. UV-B radiation is also susceptible to damage Phytoplankton in the surface waters.

$$CFCs\ (\ CCl_mF_{4-m}\ or\ C_2Cl_mF_{6-m}\ ) \longrightarrow Cl^{\cdot}\ (free\ chlorine\ radical)$$

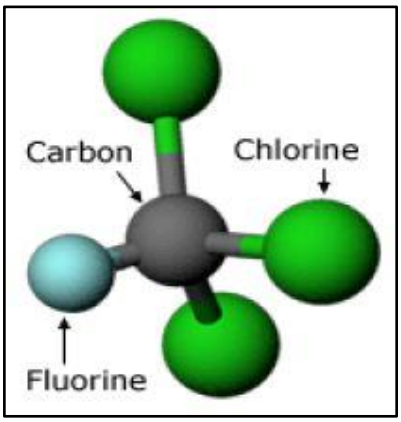
$$Cl.\ (free\ chlorine\ radical) + O_3 \rightarrow ClO\ (chlorine\ monoxide) + O_2$$

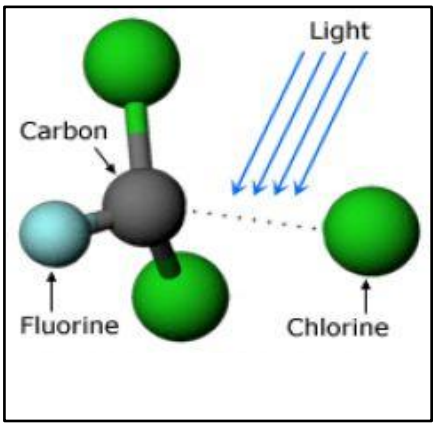
$$ClO + O.(free\ oxygen\ atom) \rightarrow Cl\ (free\ chlorine\ atom) + O_2$$

$$O_3 + O. \rightarrow 2O_2$$

In 1974 American chemists Mario Molina and F. Sherwood Rowland proposed that CFC molecules produced by the human highly affected the ozone layer. According to their theory CFC liberate chlorine atom on UV-radiation which reacts with oxygen atom to produce chlorine monoxide (ClO) as well as also with Bromine atom and produce bromine monoxide (BrO) and split the ozone molecule by taking a oxygen atom. Further research shows that bromine molecules or some bromine compounds are more effective in ozone depleting.

José Mario Molina and Rowland's findings were published in 1974 and shocked the entire world by their famous publication. They explained that Chloro fluoro methane is being added to the environment in steadily increasing amounts and these compounds are chemically inert which remains in the atmosphere for 100 years (approx) and the concentrations can reach 10 to 30 times from the present levels. The chloro-fluoro-methanes further dissociate in the stratosphere by photochemical reaction to produce significant amounts of chlorine atoms, and leads to the destruction of atmospheric ozone. Though their findings were later confirmed by scientists around





the world and led to the Montreal Protocol of 1987 that banned CFCs around the world.

A brief study says that a large decrease of ozone concentration began at least in 1980, after measurements from various methods it is said by the scientists that total integrated column levels of ozone decreased globally by roughly 5% in between 1970 to 1990s.

In 1985 ozone depletion was first documented by the British Scientists Joseph C. Farman, Brian G. Gardiner, and Jonathan D. Shanklin. Beginning in the late 1970s, a large and rapid decrease in total ozone, often by more than 60 percent relative to the global average, has been observed in the springtime (September to November) over Antarctica. This phenomenon was first documented by Farman and his colleagues over their BAS station at Halley Bay, Antarctica. Further studied by various satellite techniques it shows that there was a decrease in more than 50% of total ozone.

A campaign held on special measurement conducted in 1987 by the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA), proved that chlorine and bromine chemistry were actually responsible for the ozone hole. Another reason also responsible for the hole, is that the products formed by chemical reactions occurring on particles that make up polar stratospheric clouds (PSCs) in the lower stratosphere. The international effort working on restricts the production as well as the use of CFCs and other halocarbons. As a result from 1987-1998 there was a 50% reduction in use of CFCs all over the world.

Grooβ and Müller argued that when the stratospheric temperatures are low enough, polar stratospheric clouds are formed that are composed of water ice, nitric acid hydrates, and super cooled liquid ternary $HSO_4/HNO_3/H_2O$ droplets. These cold binary sulphate particles provide the surfaces that foster the heterogeneous reactions through which the ozone-destroying form of chlorine is produced from the so-called reservoir species. Ozone depletion takes place in catalytic cycles; generally in the Antarctic stratosphere

chlorine peroxide (ClOOCl) cycle involves. When the temperature rises the ozone-depleting process is terminated.

According to the scientists about 80% of the chlorine and bromine, in the stratosphere over Antarctica today comes from human, not natural, sources. Scientists found out that chlorofluorocarbons (CFCs) which are long-lived chemicals had been used in refrigerators and aerosol sprays since the 1930s. So in the closest layer of the atmosphere that is in the troposphere CFCs circulated for decades without degrading or reacting with other chemicals which only break down by ultraviolet light and releasing chlorine that repeatedly catalyzes ozone destruction.

I. Conclusion:-

In the year 1987 the international community signed the Montreal Protocol on Substances that deplete the Ozone layer. This protocol regulates the production as well as consumption of ozone-depleting compounds. Models suggest that in pre-1980 the concentration of chlorine and other ozone-depleting substances in the stratosphere was minimum approx zero, and it will take the middle of the 21st century to reach such a situation. We can use HCFCs as an alternative of CFCs in refrigerators; they have shorter lifetimes and lower ozone depleting potential than CFCs and comparatively less hazard for ozone layer, known as a brand name Freon. Substitute by CO2 in electronics, by water, hydrocarbons, or HCFCs in foam-blowing, by hydrocarbons, HCFCs and ammonia in air-conditioning; replace methyl bromide by 1, 3-dichloropropene, chloropicrin, and methyl iodide and sulfuryl fluoride. If we banned chlorine containing synthetic compounds which are used as coolants, the Ozone hole over Antarctica is expected to gradually become less severe and may recover back to the 1980 level around 2070. We can also replace the less hazardous HCFCs by hydro fluorocarbon (HFC) in refrigerant equipment, which contain no chlorine and are much eco friendly. Scientists have already seen the first definitive proof of ozone recovery, observing a 20% decrease in ozone depletion during the winter months from 2005 to 2016. In 2019, abnormal weather patterns in the upper atmosphere over Antarctica dramatically limited ozone depletion, leading to the smallest hole since 1982. During Covid-19 pandemic situation the density of CFCs as well as the air pollutant was reduced in a great extent which has a positive impact on the Ozone layer or Ozone hole. But currently there are no replacements for Halons as fire retardants in civilian aircraft. Though it is no longer being manufactured but due global stockpiles it will affect the Ozone layer. So we should search for alternatives to Halons.

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