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Ozone Layer Depletion

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ABSTRACT - There are many situations where human activities have significant effects on the environment. Ozone layer damage is one of them. The objective of this paper is to review the causes, and effects of ozone layer depletion as well as the protective measures of this vanishing layer. The chlorofluorocarbon and the holes are potent ozone depletors. One of the main reasons for the widespread concern about depletion of the ozone layer is the anticipated increase in the amounts of ultraviolet radiation received at the surface of the earth and the effect of this on human health and on the environment. The prospects of ozone recovery remain uncertain. In the absence of other changes, stratospheric ozone abundances should rise in the future as the halogen loading falls in response to regulation. However, the future behaviour of ozone will also be affected by the changing atmospheric abundances of methane, nitrous oxide, water vapour, sulphate aerosol, and changing climate.

KEYWORDS- Ozone, Ozone Depletion, Chloroflourocarbons (CFCs), Ultra Violet (UV) Radiations, Bio-Effects

INTRODUCTION -Ozone (O3) was first discovered by C. F. Schnbein in 1839. It is a triatomic allotrope of oxygen (a form of oxygen in which the molecule contain three atoms instead of two as in the common form). It is an irritating, pale-blue gas that is explosive and toxic, even at low concentration (Encyclopaedia Britannica). It occurs naturally in small amounts in the Earth's stratosphere, where it absorbs solar ultraviolet radiation. Under certain conditions, photochemical reaction between nitrogen oxides and hydrocarbon in the lower atmosphere can produce ozone in concentrations high enough to cause irritation of eyes and mucous membrane (Encyclopaedia Britannica).

Ozone Layer-The ozone layer refers to a layer in the atmosphere, which spreads in the stratosphere and is in high concentration. This layer has its maximum partial pressure in the lower stratosphere at a level of 19-23 Kms above the Earth. The stratosphere

contain 90 % of all ozone in the atmosphere. If all the ozone molecules in the atmosphere were transferred to the Earth surface, they would assume a thickness of only 2.5-3.5 mm at average surface temperature and pressure (WMO 1992). Ozone, being a molecule composed of more than two atoms has many absorption bands and particularly in the UV range at wavelengths less than 0.3 μm. Stratospheric ozone layer plays a very important role for the protection of human life and the whole ecosystem. It filters most of the **ultraviolet beta** radiations from the sun, buffer the ecosystem from harmful ultraviolet rays and also absorbs the solar energy for warming the stratosphere to maintain the present climate conditions familiar to the ecosystem.

Current Status:

The ozone values, in different parts of the world, recorded in 1992 are very alarming. The regional average ozone in January over Northern Europe was 20% below the normal values, Canada 16%, andRussia, during whole of February and March it was 15% (UNEP 1991). At the end of January 1992, for a few days, total ozone values as low as 190-210 m atm cm were observed over Central Europe and the European part of the Russia which is 40-45 percent below the normal, thus showing a more negative deviation over the entire period of systematic ozone measurements since 1950 (UNEP 1991).

The ozone layer is a layer in Earth's atmosphere which contains relatively high concentrations of ozone (O3). This layer absorbs 93-99% of the sun's high frequency ultraviolet light, which is potentially damaging to life on earth . Over 91% of the ozone in Earth's atmosphere is present here. It is mainly located in the lower portion of the stratosphere from approximately 10 km to 50 km above Earth, though the thickness varies seasonally and geographically. The ozone layer was discovered in 1913 by the French physicists Charles Fabry and Henri Buisson. Its properties were explored in detail by the British meteorologist G. M. B. Dobson, who developed a simple spectrophotometer (the Dobson meter) that could be used to measure stratospheric ozone from the ground. Between 1928 and 1958 Dobson established a worldwide network of ozone monitoring stations which continues to operate today. The "Dobson unit", a convenient measure of the total amount of ozone in a column overhead, is named in his honor.

Ozone Layer The ozone layer is basically naturally occurring gas in the region of

stratosphere where ozone particles are accumulated . Ozone layer is also naturally broken down but there is a balance between its formation and natural depletion. As a result the total amount of ozone remains constant. But ozone layer thickness varies with altitude and seasonal change. Ozone concentration is highest between 19 - 23 km. Most of ozone is formed at equator where there is maximum sunshine but with winds it travels at high altitude and get accumulated in stratosphere.

Ozone depletion describes two related phenomena observed since the late 1970s: a steady decline of about four percent in the total amount of ozone in Earth's stratosphere (the ozone layer), and a much larger springtime decrease in stratospheric ozone around Earth's polar regions. The latter phenomenon is referred to as the **ozone hole**. There are also springtime polar tropospheric ozone depletion events in addition to these stratospheric phenomena.

The main cause of ozone depletion and the ozone hole is man-made chemicals, especially man-made refrigerants, solvents, propellants, and foam-blowing agents (chlorofluorocarbon (CFCs), HCFCs, halons), referred to as **ozone-depleting substances** (**ODS**). These compounds are transported into the stratosphere by the winds after being emitted at the surface. Once in the stratosphere, they release halogen atoms through photo dissociation, which catalyze the breakdown of ozone (O_3) into oxygen (O_2). Both types of ozone depletion were observed to increase as emissions of halocarbons increased.

Ozone depletion and the ozone hole generated worldwide concern over increased cancer risks and other negative effects. The ozone layer prevents most harmful UVB wavelengths of ultraviolet light (UV light) from passing through the Earth's atmosphere. These wavelengths cause skin cancer, sunburn, and cataracts, which were projected to increase dramatically as a result of thinning ozone, as well as harming plants and animals. These concerns led to the adoption of the Montreal Protocolin 1987, which bans the production of CFCs, halons, and other ozone-depleting chemicals.

The ban came into effect in 1989. Ozone levels stabilized by the mid-1990s and began to recover in the 2000s. Recovery is projected to continue over the next century, and the ozone hole is expected to reach pre-

1980 levels by around 2075. The Montreal Protocol is considered the most successful international environmental agreement to date.

CAUSES OF OZONE DEPLETION:

Chlorofluorocarbons Ozone depletion occurs when the natural balance between the production and destruction of stratospheric ozone is disturbed. Although natural phenomenon can cause ozone depletion but human activities such as CFCs are now accepted as major cause of depletion. All ozone depleting chemicals contain chlorine and bromine. CFCs are highly volatile and non combustible so they are very quickly evaporated and can easily reach in stratosphere where ozone is present here they start depleting ozone molecules. These CFCs have also adverse affects on human health . According to the chemical model for ozone destruction proposed about 20 years ago, the photolysis of Cl2O2 is key to ozone depletion reaction. But now atmospheric researchers studied that the rate of this reaction is not extremely high as it was thought previously so we can no longer say that CFCs are the main cause of ozone depletion .

Unregulated Launches of Rockets Another major cause of large scale ozone depletion is Rocket launches. It has been studied that unregulated rocket launches can result in much more ozone depletion than CFCs. It is estimated that if rocket launches will be let unregulated then it would cause huge ozone loss by the year 2050 than the CFCs have done.

Global Warming Global warming also leads to ozone layer depletion. Due to global warming and green house effect most of the heat is trapped in troposphere which is the layer below the stratosphere. As we all know ozone is present in stratosphere so heat don't reaches troposphere and it remain cold as recovery of ozone layer requires maximum sunlight and heat so it leads to depletion of ozone layer.

Nitrogenous Compound Nitrogenous Compounds emitted by human activities in small amount like NO, N2O and NO2 are considered to be greatly responsible for the depletion of ozone layer .

EFFECTS OF OZONE DEPLETION:

Ozone depletion is affecting the human health and environment negatively, as it allows the penetration of UV radiations to reach the Earth. These radiations can cause severe diseases in humans such as skin cancer, eye damage and genetic mutations

etc. Furthermore the ozone depletion is affecting the aquatic life, biogeochemical cycles, air quality and also contributing in Global warming but in this review paper our main focus is on the effects of ozone depletion on human health.

Effects on Eyes The major cause of blindness in this world is cataracts. There would be 0.3% - 0.6% increase in risk of cataract if there will be 1% decrease in Ozone level. Eye lens can be damaged by oxidative agents. Oxidative oxygen produced by UV radiation can severely damage eye lens and cornea of eye is also badly damaged by UV radiation. Photokeratitis, cataract, blindness all are caused due to UV rays.

Effects on Skin Exposure to UV radiations can cause skin cancer. UV radiations alter the structure of biomolecules and thus lead to different diseases. Skin is the most often exposed part of body to UV radiations.There is two types of skin cancer, Melanoma and Non-melanoma. Melanoma is most serious form of cancer and is often fatal, while non-melanoma is most common type and less fatal. Depletion of ozone layer leads to both Sun burn and skin cancer . UV radiations are also responsible for breast cancer and leukemia.

Effects on Human Immunity Exposure to UV radiations can also result in suppression of immune response to skin cancer, infectious diseases and other antigens. The immuno supression is due to changes in skin photoreceptors and antigen presenting cells that are brought by UV radiations More increase in depletion of ozone results in more decrease in immune system .

DNA Damage and Lung Diseases Short exposure to UV-B radiations can cause the DNA damage because UV radiations can disturb biomolecules such as lipids, proteins and Nucliec acids. Due to UV-B radiations there would be cryptic transposable elements which may lead towards the mutations which is more dangerous than the immediate DNA damage. Excessive UV-B radiation exposure results in the basal and squamous cells carcinomas. These types of cancers are induced due to transcriptional errors during DNA replication which are caused by changes in pyrimidine bases. The ultimate cause of this whole mechanism is found to be the prolonged exposure to UV radiations. It is estimated that there is increase of 2% of incidence of these cancers by 1% depletion of ozone layer . Exposure to UV radiations equally affects lungs. Bronchitis, obstruction of lungs,

Emphysema, asthma all can be resulted from UV radiations exposure .

Effects of Hydrogen Peroxide on Human Health Due to stratospheric ozone layer depletion UV radiations are penetrating in earth atmosphere which result in the production of reduced oxygen. Highly reactive species like hydrogen peroxide is produced which has bad effects on human health. It is ideal photochemical maker due to its long life and stability . Hydrogen peroxide is toxicant and it pollutes drinking water especially in lakes and makes water toxic and unfit for drinking. IT alters redox chemistry of metals that are used by our body like iron copper and manganese .

Effects on Human and Animal Health Increased penetration of solar UV-B radiation is likely to have profound impact on human health with potential risks of eye diseases, skin cancer and infectious diseases [6]. UV radiation is known to damage the cornea and lens of the eye. Chronic exposure to UV-B could lead to cataract of the cortical and posterior sub capsular forms. UV-B radiation can adversely affect the immune system causing a number of infectious diseases. In light skinned human populations, it is likely to develop non melanoma skin cancer (NMSC). **Effects on Terrestrial Plants** It is a known fact that the physiological and developmental processes of plants are affected by UV-B radiation. Scientists believe that an increase in UV-B levels would necessitate using more UV-B tolerant cultivar and breeding new tolerant ones in agriculture. In forests and grasslands increased UV-B radiation is likely to result in changes in species composition (mutation) thus altering the bio-diversity in different ecosystems

Effects on Aquatic Ecosystems While more than 30 percent of the world's animal protein for human consumption comes from the sea alone, it is feared that increased levels of UV exposure can have adverse impacts on the productivity of aquatic systems. High levels of exposure in tropics and subtropics may affect the distribution of phytoplanktons which form the foundation of aquatic food webs. Reportedly a recent study has indicated 6-12 percent reduction in phytoplankton production in the marginal ice zone due to increases in UV-B. UV-B can also cause damage to early development stages of fish, shrimp, crab, amphibians and other animals, the most severe effects being decreased reproductive capacity and impaired larval development. **Effects on Bio-geo-chemical Cycles** Increased solar UV radiation could affect terrestrial and

aquatic bio-geo-chemical cycles thus altering both sources and sinks of greenhouse and important trace gases, e.g. carbon dioxide (CO2), carbon monoxide (CO), carbonyl sulphide (COS), etc.

Effects on Air Quality Reduction of stratospheric ozone and increased penetration of UV-B radiation result in higher photo dissociation rates of key trace gases that control the chemical reactivity of the troposphere. This can increase both production and destruction of ozone and related oxidants such as hydrogen peroxide which are known to have adverse effects on human

health, terrestrial plants and outdoor materials. Changes in the atmospheric concentrations of the hydroxyl radical (OH)may change the atmospheric lifetimes of important gases such as methane and substitutes of chlorofluoro carbons(CFCs).

Effects on Materials An increased level of solar UV radiation is known to have adverse effects on synthetic polymers, naturally occurring biopolymers and some other materials of commercial interest. UV-B radiation accelerates the photo degradation rates of these materials thus limiting their lifetimes.

Effects on Climate Change Ozone depletion and climate change are linked in a number of ways, but ozone depletion is not a major cause of climate change. Atmospheric ozone has two effects on the temperature balance of the Earth. It absorbs solar ultraviolet radiation, which heats the stratosphere. It also absorbs infrared radiation emitted by the Earth's surface, effectively

trapping heat in the troposphere. Therefore, the climate impact of changes in ozone concentrations varies with the altitude at which these ozone changes occur.

CONCLUSION & RECOMMENDATIONS:

Ozone layer is continuously depleting which is highly alarming situation of today. Chloroflourocarbons are major cause of ozone depletion. These substances should be banned or we should use their alternatives so that in future we can protect ourselves from the harmful effects of UV radiation. Human eye and skin are the most exposed part of the body to these radiations. So there is high degree of incidence of blindness and skin cancer disease increasing day by day with the depletion of ozone layer so we should use sunglasses and full body clothes especially in summer when there is high intensity of sunlight so that we can protect our body from harmful UV radiations. We

should also use sun block creams to our most exposed parts of
body like face. We should also don't consume water from lakes as it may contain high quantity of hydrogen peroxide which is toxic to our bodies, and we should consume water for drinking from clean water sources.

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