

A Study: Importance of the Ozone Layer in the Present Context

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ABSTRACT

The ozone layer is located in the stratosphere at an altitude of 15–35 kilometres and protects life on Earth by absorbing harmful ultraviolet rays coming from the Sun. It is also called the life-protecting layer. For millions of years, there had not been major changes in the atmospheric composition, but during the last few decades humans have disturbed the atmospheric balance through emissions of harmful chemical substances. The ozone layer consists of ozone (O₃), whose molecules contain oxygen atoms. Ozone is a poisonous, unstable gas with a pale-blue colour and a sharp smell, and it is also rare in the environment. About 90 percent of atmospheric ozone is found in the upper atmosphere, in the stratosphere. If ultraviolet radiation reaches the Earth's surface, it can cause skin cancer, cataracts, weakness of the digestive system, reduced crop yields and decline in fish production in marine ecosystems. The maximum concentration of ozone occurs at an altitude of about 20–25 kilometres and is measured in Dobson Units. Ozone thickness is lowest during the rainy season and highest during spring.

Introduction:-

The largest contribution to damage to the ozone layer comes from gases called CFCs(chlorofluorocarbons). Other substances include nitrous oxide, chlorine, carbon tetrachloride and methyl chloride. Increasing use of

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these gases is damaging ozone. CFCs have commonly been used in refrigerators, foam-producing agents and air conditioners. When ozone is broken down, chlorine and bromine are also involved in reactions that threaten the ozone layer. A single chlorine atom has the capacity to destroy a very large number of ozone molecules. The harmful effect can be understood from the fact that the greatest seasonal ozone destruction occurs during March–April in the Northern Hemisphere and September–October in the Southern Hemisphere. The most severe destruction has been observed in the polar region of Antarctica. One important reason is the slow development of ozone-related processes over the polar region.

For an ordinary person, the term “ozone hole” may suggest a hole in the atmosphere that is growing day by day. Its scientific meaning, however, is a reduction in ozone concentration. The issue was first discussed internationally at a United Nations Environment Programme meeting in 1976. Intergovernmental negotiations for an international agreement began in 1981 and culminated in the Vienna Convention in 1985. British scientist G. Farman discovered the ozone hole over Antarctica in 1985. In 1987, the international community adopted the Montreal Protocol and decided to reduce CFC emissions, with the intention of ending CFC use by 1996. In 1995, the United Nations declared 16 September as the International Day for the Preservation of the Ozone Layer, intended to raise public awareness about the possible consequences of ozone depletion. Timely efforts should be made to reduce ozone-depleting emissions associated with refrigerators, air conditioners, fire extinguishers and spraying equipment. The agreement was opened for signature on 16 September 1987, signed initially by 35 countries, and entered into force on 1 January 1989. Its first meeting was held in Helsinki in 1989.

Ozone is a rare atmospheric substance: among approximately ten million atmospheric molecules, only about three are ozone molecules. Despite its very small quantity, it has an important role in the atmosphere. Ozone is found in two atmospheric layers. Approximately 90 percent is found in the stratosphere and is called “good ozone”, whereas about 10 percent is found in the troposphere and is sometimes called “bad ozone” because ground-level ozone contributes to harmful atmospheric effects, including warming and air pollution. Because of ozone, only a very small fraction of ultraviolet radiation reaches the Earth's surface; much of it is absorbed in the ozone layer. Without this absorption, ultraviolet radiation reaching Earth would cause severe damage to life. India joined the Montreal Protocol on 19 June 1992. The Montreal Agreement/Protocol is widely regarded as one of the most successful environmental agreements in history and received strong global support. Countries around the world approved it, and it helped unite the international community in protecting the ozone layer. The Montreal agreement was the result of decades of research.



Developed countries began using hydrofluorocarbons (HFCs). Although HFCs do not damage the ozone layer in the same way as CFCs, many HFCs contribute to global warming. Since countries such as India were not immediately able to shift technologies, the Protocol provided for phased arrangements for such countries. As living standards rise, India and China are emerging as large markets for air conditioners and refrigerators. The United States and the European Union have expressed concern that increased sales of such products could greatly increase greenhouse-gas emissions. Consequently, HFCs were brought within the framework of the Montreal Protocol through later amendments.

For protection of the ozone layer, the Vienna Convention was signed on 22 March 1985. Subsequently, on 16 September 1987, the Montreal Protocol was adopted to control substances responsible for ozone-layer depletion (ODS). India joined the Vienna Convention on 18 March 1991 and the Montreal Protocol on 19 June 1992. The Montreal Protocol is considered highly successful from an environmental perspective. It has received broad global support and brought the world community together for ozone protection. Research demonstrated that chlorine- and bromine-containing chemicals released into the atmosphere damage the ozone layer.

Depletion of the ozone layer allows more of the Sun's ultraviolet radiation to penetrate the atmosphere and reach the Earth's surface. These rays have harmful effects on humans, plants and animals. According to the World Health Organization, 12 to 15 millions of people worldwide suffer visual impairment or blindness due to cataracts each year, with ultraviolet exposure being an important contributing factor in some cases.

The ozone-layer issue has received recognition at the global level, which has helped efforts to protect the layer and address the damage already caused. After becoming a party to the ODS regime, India has been an important participant in global efforts related to ozone-layer protection and has played a role in reducing ODS. Ozone-depleting substances have been widely used in industrial processes, fire extinguishing, cleaning applications, pesticide-related uses and preservation of perishable export products.

There are some gases that damage the ozone layer, for which there had been no proper system of restrictions for many years. India was also required to reduce the production of these gases by January 2010, according to its own circumstances. The Montreal Agreement/Protocol is an important agreement for the world. However, it has demonstrated that its actual impact on the Earth can be achieved only through the active cooperation of all the parties involved in the agreement, industries, and environmental programmes.

Since January 2010, the production and use of halon gases on Earth has been reduced. However, their limited use in the pharmaceutical/medical sector has been permitted since 1983. Under this provision, their



use has also been allowed for treating diseases caused by fungi in patients and for treating certain other respiratory diseases. However, the CFC gas used in this context is generally not considered to be highly harmful in terms of its effects.

Montreal Agreement and India :-

India has implemented the arrangements of the Montreal Protocol and has restricted the production and use of CFCs in accordance with the applicable phase-out schedule. Some limited uses in the pharmaceutical sector have been permitted for essential medical applications, including inhalers used by patients with respiratory diseases. The source text also discusses special categories and exemptions for essential uses of CFCs.

The Montreal Protocol has progressively phased out CFCs, CTC and halons. In September 2007, the parties agreed on measures to accelerate the phase-out of CFCs and other ozone-depleting substances. The Protocol is an international treaty designed to protect the ozone layer by phasing out substances considered responsible for its depletion. It was opened for signature on 16 September 1987 and entered into force in January 1989, after which its first meeting was held in Helsinki in May 1989.

After the discovery in the mid-1980s of the ozone hole over the South Pole (Antarctica), governments recognised the need for strong measures to reduce the production and consumption of chlorofluorocarbons (CFC-11, 12, 113, 114 and 115) and several halons (1211, 1301 and 2402). The Protocol was designed so that it could be amended from time to time on the basis of scientific and technological assessments. Following such assessments, the Protocol was adjusted to accelerate the phase-out process through the London Amendment (1990), Copenhagen Amendment (1992), Vienna adjustment (1995), Montreal Amendment (1997) and Beijing Amendment (1999). These amendments introduced additional controls and added new substances to the list. The 1990 London Amendment added additional CFCs (CFC-13, 111, 112, 211, 212, 213, 214, 215, 216 and 217) and two solvents, carbon tetrachloride and methyl chloroform. The 1992 Copenhagen Amendment added methyl bromide, HBFCs and HCFCs. The 1997 Montreal Amendment included measures for phasing out methyl bromide. The 1999 Beijing Amendment included bromochloromethane for rapid phase-out and also introduced controls on HCFC production and trade with non-parties. It is estimated that if the agreement is fully implemented, the ozone layer could recover by around 2050.

Nanoparticles(NPs) and Ozone Depletion :-



Nanoparticles are particles with dimensions comparable to one-billionth of a metre (10^{-9} m). Major natural processes that release nanoparticles into the atmosphere include forest fires, volcanic eruptions, weathering and dust storms from deserts. Naturally occurring nanoparticles vary considerably in size and can be transported thousands of kilometres. They may remain suspended in the air for several days. Nanotechnology has global socio-economic importance, with applications ranging from electronics to biomedical uses, including delivery of medicines to targeted sites. Human-made nanoparticles may be released into the environment unintentionally or deliberately as forms of industrial waste. In recent times contemporary wars, including the Russia–Ukraine war and military actions involving Iran, and links emissions of nanoparticles from such activities with potential damage to the ozone layer.

After being released into the environment, nanoparticles accumulate in environmental matrices such as air, water, soil and sediments, including wastewater sludge. Nanoparticles can influence the formation of dust clouds, environmental hydroxyl-radical concentrations, ozone depletion and changes in stratospheric temperature. When nanoparticles accumulate and form dust clouds, the intensity of sunlight can decrease.

Asian brown clouds affect Himalayan glaciers. They carry large quantities of soot and black carbon (described in the source as nanoparticles) and deposit them on Himalayan glaciers. This can increase absorption of solar heat, reduce albedo and potentially increase glacier melting. Nanoparticles may also increase the production of reactive oxygen species (ROS), including free radicals such as chlorine-related radicals. Chlorine radicals can destroy ozone. In chemistry, a radical (free radical) is an atom, molecule or ion containing an unpaired valence electron.

Effect of Nanoparticles on Stratospheric Temperature :-

According to the source text, molecular hydrogen accidentally released from hydrogen fuel cells in the troposphere can move toward the stratosphere, increasing stratospheric water vapour. This could promote the formation of stratospheric clouds, consisting largely of ice crystals, and lead to stratospheric cooling. Stratospheric clouds can contribute to ozone destruction.

Conclusion:-

The International Day for the Preservation of the Ozone Layer is observed on 16 September, highlighting the importance of implementing Montreal Protocol measures, promoting ozone-friendly products and creating awareness to prevent ozone-layer depletion. Member countries are encouraged to undertake concrete national-level activities consistent with the objectives, targets and amendments of the Montreal Protocol. Governments are not legally bound by amendments until they ratify or otherwise accept the



relevant instruments. The source concludes that although many governments have ratified the Protocol, implementation of amendments and stringent control measures still remains behind the desired targets.

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