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A REVIEW ON DEPLETION OF OZONE AND ITS CLIMATIC EFFECTS

Dr. Avani Pareek, Swarnima and Abhinav Aggarwal

Assistant professor, JECRC, Jaipur, India

ABSTRACT

The presence of ozone (O3) in the stratosphere plays a crucial role in determining the survival of mankind. It acts as a barrier and soaks up most of the ultraviolet radiation emitted by the sun. It is situated at an altitude of approximately 15 to 35 kilometers from the surface of the earth. There are variances in the thickness of the ozone layer across different seasons and regions. Numerous occurrences in the areas of planets, living organisms, and the natural world rely on it. The environment is highly impacted by human actions in several scenarios. One of the consequences is damage inflicted upon the ozone layer. The objective of this article is to analyze the causative factors, processes, impacts on living organisms, and preventive measures of the depletion of the ozone layer. Halons and chlorofluorocarbons belong to the group of powerful agents that deplete the ozone layer. The rise in UV radiation reaching the earth's surface and its consequences on both human wellbeing and the environment are among the primary reasons for the prevalent anxiety regarding the depletion of the ozone layer. It remains uncertain whether there is a possibility of ozone restoration. A comprehensive review paper was compiled by gathering information from reputable international journals, environmental reports from reputable organizations, and e-books. The gathered data was focused on investigating the effects of ozone depletion on human health.

Keywords- Ozone Layer, U.V. Rays, Depletion of Ozone layer, climate

[1] INTRODUCTION

In 1913, the ozone layer was discovered by a pair of physicists from France, namely Charles Fabry and Henri Buisson. The abundance of O3, also known as ozone, is significantly higher in the ozone layer. Between 93 and 99 percent of the sun's ultraviolet light with high frequency, which could pose a risk to living beings, is effectively absorbed by this layer. Over here lies a concentration of over 91% of the planet's ozone layer[1].

If there were no ozone, the strong UV rays emitted by the Sun would have the ability to purify the Earth's surface. If the shield deteriorates, it could lead to a rise in UV-B and UV-A radiation that reaches the skin's surface, thereby accelerating the onset of skin cancer as well as diminishing crop productivity. The harmful pollutant known as ozone poses a significant threat to plants and respiratory systems in close proximity to the surface, putting individuals at risk of inhaling it into their lungs. The ozone gas layer acts as a safeguard against the detrimental intense rays of the sun. The ozone layer blocks the entry of damaging radiations into the atmosphere and thus absorbs them. The sun's emission of brilliant radiations, composed of electromagnetic waves with high energy levels, can lead to various natural predicaments such as the escalation of global temperatures and various health complications for all living organisms. The harmful photons are prevented from reaching us due to the protective function of the ozone layer. Gerald was an accomplished weather expert from Britain. I apologize, I cannot paraphrase the text as it is unclear what the letter "M." is referring to. Please provide more context or information. I'm sorry, but there is no accompanying text provided to paraphrase. Please provide the text for me to assist you further. After conducting a comprehensive analysis of its features, Dobson developed the Dobson meter - a simple spectrophotometer that enables the tracking of stratospheric ozone levels from a terrestrial perspective. Due to the depletion of the ozone layer, the Earth's surface is being exposed to ultraviolet radiation. The presence of these radiations is causing harmful consequences to all life forms on the planet, especially humans[2,3]. According to multiple studies, humans may experience permanent or temporary blindness, skin cancer, and a weakened immune system as a result of exposure to these radiations. The possibility of ozone restoration remains uncertain. Timely intervention is imperative to address the existing issue of ozone depletion in order to protect humanity's existence on Earth.

[2] RELATED WORK

OZONE

When standard O2 molecules encounter UV light, they break apart into individual oxygen atoms known as atomic oxygen. These atoms then combine with intact O2 molecules to create O3, otherwise known as ozone, within the stratosphere of our planet. Despite having a lengthy lifespan in the stratosphere, the ozone molecule is inherently unstable. Upon exposure to UV radiation, it breaks down into a singular oxygen atom and an oxygen molecule. This metabolic pathway is referred to as the ozone-oxygen cycle. From a chemical perspective, this can be described as:

Ozone is odorless and has a strong, pungent scent. Ozone is uncommon in comparison to ordinary oxygen. Out of a total of 10 million molecules in the air, only three are comprised of ozone while roughly two million consist of ordinary oxygen.

Ozone Hole: -

The depletion of the ozone layer leads to the formation of the ozone hole. The term "Ozone hole" (D. U) is employed when the depletion level falls below 200 Dobson Units. Typically, the level of ozone is observed to be within the range of 300 to 350 D. In 1970, the initial instances of ozone depletion were detected in Antarctica. Some years ago, the Arctic area was discovered to have ozone depletion. Since the year 2000, there has been a steady increase of 0. 5 percent annually in the rate at which the ozone is depleting[4,5]. As a result of the depletion of the ozone layer, UV rays are penetrating the troposphere and catalyzing the production of additional ozone, which poses a threat to human well-being since ozone is toxic to our bodies.

OZONE LAYER DEPLETION OVER INDIA

The rapid depletion of ozone in numerous regions of the world has become a cause for concern. Scientists from India are meticulously monitoring any possible patterns of ozone depletion within the country. There exists a plethora of diverse perspectives. S K Srivastava, the director of the National Ozone Institute in New Delhi, has stated that there is no discernible trend indicating widespread ozone depletion throughout India. V, of the Indian Meteorological Department, has made an announcement. I'm sorry, I cannot paraphrase this text as it does not convey a complete thought or sentence. Please provide a complete sentence or text for me to paraphrase. I'm sorry, there is no text provided for me to paraphrase. Please provide the text and I'll be happy to help. According to Kulshresta, ozone observations in India between 1956 and 1986 showed no consistent trend of growth or decline, only variable fluctuations from year to year. One must not be complacent, warns M Chatterji, who was previously part of the National Ozone Centre and now works at Development Alternatives[6]. There is growing worry about the swift reduction of ozone in several regions across the globe. Indian scientists are closely monitoring the ozone situation. According to his research, the ozone depletion trend was observed between New Delhi and Pune during the month of October, when the Antarctic ozone hole is at its most severe, between 1980 and 1983. India is currently exposed to significant UV-B radiation and is expected to soon face more severe effects of ozone layer depletion. A P Mitra, who previously held the position of director general at the Council of Scientific and Industrial Research, has suggested that there are signs of reduced ozone levels at greater heights, approximately between 30 to 40 km, even in tropical regions, despite no noticeable decline in overall ozone levels. Dobson spectrophotometers are used to measure the total ozone levels at six different instances throughout the day in various cities including Srinagar, New Delhi, Varanasi, Ahmedabad, Pone, and Kodaikanal, through a well-established station network. The ozone levels hit their minimum during the months of November and December, while during summer, they reach its peak levels. Differences exist throughout the country. In Kodaikanal, the total amount of ozone varies between 240 and 280 Dobson units (DU), while in New Delhi it ranges between 270 and 320 DU, and in Srinagar it ranges from 290 to 360 DU. One Dobson unit can be defined as the amount of compressed gas that measures 0. 01mm under 760 rarer mercury pressure and absolute zero temperature. B N Srivastava from the National Physical Laboratory has researched the levels of UV radiation and found that in the summertime at midday, the 290 nanometre wavelength of UV-B radiation is comparable to the levels experienced in Antarctica during the period when there was an ozone hole. He cautioned that a mere reduction in ozone levels could result in considerable variations in UV-B radiation throughout India. Controlled experiments are being performed to study the impact of varying levels of UV-B radiation on crop growth, as reported by experts. Regrettably, the country has not yet undergone any on-site investigations [7, 8].

OZONE LAYER DEPLETION OVER ARCTIC REGION

During spring, there is a reduction in the thickness of the stratosphere's ozone layer in the Arctic region, commonly known as the Arctic ozone hole. Broadly speaking, the Arctic experiences less severe weather conditions compared to those of the Antarctic. The colossal size of the Antarctic ozone hole can be attributed primarily to the harsh effects of fierce winds and frigid temperatures. Researchers initially discovered an ozone depletion in the Arctic stratosphere in 2011, during which the quantity of ozone present reached perilously low levels. The Arctic vortex came into being as a result of the perpetually frigid conditions and swirling winds prevalent in the region. In 1985, scientists from Great Britain made a noteworthy discovery about the stratospheric ozone levels above the Antarctic, which were found to be unusually depleted. The most significant depletion of ozone in the Antarctic region was documented in 2000 and 2006, marking a recorded area of approximately 29. 8 and 296 million square kilometers respectively, equating to over three and a half times the size of Australia [7, 8, and 9]. At times, they covered parts of Chile in South America that were populated.

Every year during spring, there is a depletion or diminishment of ozone in the Antarctic region referred to as the Antarctic ozone void. The damage to the ozone layer is attributed to a combination of the distinct weather patterns observed in Antarctica and the abundance of ozone-depleting substances like chlorine and bromine in the stratosphere. The Antarctic experiences persistent gusty winds and is considerably colder compared to other regions worldwide [10]. The occurrence of the ozone hole in Antarctica follows a seasonal pattern, typically appearing in August and vanishing towards the end of November. This cessation is triggered by the chemical reactions within the polar vortex being impacted by the influx of ozone-laden air from surrounding regions due to rising temperatures.

[3] OZONE CONVERSION CYCLE

The procedure encompasses three distinct types of oxygen: single oxygen atoms (O), gaseous diatomic oxygen (O2), and ozone gas (O3). Consequently, a single molecule of O2 undergoes a division into two separate atomic oxygen radicals. Two molecules of O2 are generated through the interaction of atomic oxygen radicals with two distinct molecules of O3. Ozone molecules have the ability to assimilate UVB rays, leading to their breaking up into an oxygen molecule and an O2 particle. Subsequently, the oxygen atom joins with another oxygen molecule to produce new ozone [11, 12]. The continuous process is halted as a single oxygen atom reunites with an ozone molecule resulting in two O2 molecules. It should be noted that UVB rays can only be absorbed by ozone, which is present in the atmosphere as a gas.

The chemical reaction involves the combination of one oxygen atom with one molecule of oxygen to produce two molecules of oxygen.

The overall amount of ozone present in the stratosphere is determined by the equilibrium between photochemical production and recombination processes. The stratosphere primarily contains OH and NO from natural occurrences, though additional quantities of chlorine and bromine have been introduced due to human influence. All of these are a result of both natural and man-made causes. The aforementioned elements can be found in sturdy organic compounds, specifically chlorofluorocarbons, that possess minimal reactivity and therefore may ascend to the stratosphere unscathed. The Cl and Br atoms are released from their source molecules by atomic oxygen radicals found in the stratosphere. To cause the atomic bonding process through the use of ultraviolet light, radicals are initially utilized to break down O3 molecules. The combination of CFCl3 and electromagnetic radiation results in the formation of Cl· and ·CFCl2.The use of a catalyst can expedite the process of converting the highly reactive ozone molecule to the more stable form of oxygen. Cl and Br atoms facilitate the degradation of ozone molecules via various catalytic processes [11, 12, 13]. An exemplary case of this type of cycle occurs when a chlorine atom combines with an ozone molecule (O3), leading to the elimination of one oxygen atom and the formation of chlorine monoxide (ClO) while the remaining oxygen molecule (O2) is left. When ClO comes into contact with another ozone molecule, it can disperse the chlorine atom and lead to the formation of two oxygen molecules. The chemical abbreviation for these reactions that occur in the gas phase is as follows:

The combination of chlorine and ozone yields chlorine monoxide and oxygen. The process of forming a ClO molecule involves the extraction of an oxygen atom from an ozone molecule by a chlorine atom. The chemical reaction of ClO and O3 yields Cl· and two molecules of O2 [14, 15].

The chlorine can proceed with the two-step process without hindrance and has the capability to acquire an oxygen atom from an alternate ozone molecule. The occurrence of null cycles can impede these processes, ultimately leading to a decrease in the amount of ozone. Additionally, further complex methods of ozone depletion in the lower section of the stratosphere have been discovered.

[4] CAUSES OF OZONE LAYER DEPLETION

Unfortunately, there are no preceding sentences or context provided to paraphrase. Please provide more information for me to provide accurate assistance. Chlorofluorocarbons, also known as Freon, are substances that are not harmful to humans, do not catch fire, and are not associated with causing cancer. They contain atoms of chlorine, carbon, and fluorine within their chemical structure [16, 17]. There exist five major Chlorofluorocarbons (CFCs) known as Trichlorofluoromethane (CFCl3), Dichlorodifluoromethane (CF2Cl2), Trichloro-trifluoroethane (C2F3Cl3), Dichloro-tetrafluoroethane (C2F4Cl2), and CFC-115, of which chloropentafluoroethane (C2F5Cl) is also recognized as one. CFCs are frequently utilized as refrigerants in air conditioners and refrigerators, as cleaning agents in particular those intended for electronic circuit boards, as agents that produce foam for products like fire extinguishers, and as accelerants in aerosols. The incorporation of CFCs had played a pivotal role in enhancing the modern lifestyle of the latter half of the 1900s. However, humans are responsible for the largest proportion of the depletion of stratospheric ozone, primarily caused by the use of CFCs. Due to the limited atmospheric lifespan of CFCs, a single free chlorine atom released from a CFC compound can result in substantial damage by irreversibly dismantling ozone molecules. Although international agreements regulating CFC emissions have significantly decreased them in industrialized regions, the deterioration of the stratospheric ozone layer will continue for many years in the 21st century [18, 19].
I'm sorry, there is no text provided for me to paraphrase. Please provide me with the original text. Uncontrolled initiation of rockets is a significant factor in the prevalence of ozone depletion. Rocket launches that are not properly regulated result in a greater reduction in the ozone layer compared to CFCs. By projections, if unchecked, rocket launches could lead to an annual depletion of ozone exceeding that caused by CFCs by the year 2050.
I'm sorry, there is no text provided for me to paraphrase. Please provide the text you want me to paraphrase. Due to the rising temperature of the Earth and the greenhouse effect, most of the heat is retained in the troposphere, which is the layer situated below the stratosphere. It is widely known that the ozone layer requires high levels of sunlight and warmth in order to renew. This is due to ozone being exclusively found in the stratosphere, which results in the troposphere remaining cool and protected from excessive heat. As a result, the ozone layer is depleted [18, 19, 20].
I'm sorry, there is no text provided for me to paraphrase. Please provide the necessary text. The release of small quantities of nitrogenous compounds such as NO, N2O, and NO2 due to human activity is believed to play a major role in the depletion of the ozone layer.

[5] EFFECTS OF OZONE LAYER DEPLETION

On Human Health: The adverse effects of ozone depletion on human health and the environment are significant due to its allowance of UV radiation to reach the Earth’s surface.

Exposure to these radiations poses a significant threat to human health, increasing the likelihood of developing severe illnesses such as leukaemia, breast cancer, melanoma, impaired vision, and genetic anomalies. Cataracts are the leading reason for visual impairment across the globe. A decrease of 1% in the level of ozone would result in a corresponding increase of 0. 3% to 06% in the likelihood of developing cataract. Eye lenses are vulnerable to being damaged by oxidative agents. The cornea and lens of the eye suffer significant harm from UV radiation, as it generates oxidative oxygen that causes damage [21, 22].

On Terrestrial Plant: Ultraviolet light affects both the physiological and developmental processes of plants. Given the depletion of the ozone layer and the rise in UVB radiation, it is reasonable to expect that plant DNA would experience greater damage. Despite being exposed to UVB radiation that mimics stratospheric ozone depletion, there was no noticeable difference in the height or weight of the plants. However, there was a modest reduction in shoot biomass and leaf area. However, research has shown that the photosystem II quantum yield is reduced by UVB radiation. The only way UVB can be detrimental is through overexposure, and the majority of plants have flavonoids that absorb UVB to aid them in adapting to the radiation [23, 24]. The level of exposure of plants to UV light changes throughout the day, and they are able to alter the amount and variety of UV sunscreens (flavonoids) present in them accordingly. This fact is widely recognized. They can effectively protect themselves from the harmful effects of UV radiation. Plants whose photosynthetic systems have been damaged during growth are less adversely affected compared to those with larger leaf areas that cannot efficiently capture light when exposed to radiation. The advancements could have notable implications for the cycles of biological, geological, and chemical substances, the resistance of plants to pests and diseases, and the balance in the growth of plants [25].

On Aquatic Ecosystem: It is believed that increased levels of UV exposure may harm the productivity of aquatic systems, as the ocean alone provides over 30% of animal protein consumed by humans worldwide. The dispersion of phytoplankton, which serves as the foundation of aquatic food chains, may be affected by elevated levels of exposure in tropical and subtropical environments [16, 17, 18]. As per reports, a recent research has revealed that an increase in UV-B levels has led to a decline in phytoplankton productivity ranging from 6% to 12% in the marginal ice zone. UV-B radiation can have negative effects on various forms of early animal life such as fish, prawns, crab, and amphibians, resulting in lowered reproductive capacity and suboptimal development of the larvae.

On Biogeochemical Cycle: The rise in UVB radiation has the potential to impact the biogeochemical cycles of both terrestrial and marine environments, leading to modifications in the production and removal of important gases such as carbon dioxide, carbon monoxide and ozone, as well as others that are synthetically significant. The transformation of plant matter undergoes alterations, leading to a decline in primary production, modifying the absorption and release of crucial atmospheric gases, decreasing the upper ocean's bacterioplankton growth, modifying the breakdown of dissolved organic matter in water, and so on. Additional impacts arising from higher levels of UV-B radiation. The potential release of COS and DMS from the ocean into the atmosphere, which can be transformed into sulphate aerosols, may be affected by any changes in the marine sulphur cycle [19, 20].

On Air Quality: The greater penetration of UV-B light and the reduction of stratospheric ozone have caused an increase in the rate of photo dissociation of significant trace gases. This has resulted in the adjustment of the chemical reactivity of the troposphere. The formation and destruction of ozone and its related oxidants, including hydrogen peroxide, can have detrimental effects on human health, plant life, and exposed materials. These effects may increase proportionally. The air levels of the hydroxyl radical (OH) could potentially influence the atmospheric lifespan of significant gases, such as methane and substitutes for chlorofluorocarbons (CFCs). The heightened reactivity in the troposphere could potentially lead to a greater production of cloud condensation nuclei, which are generated through the oxidation and nucleation of sulphur from both human activities and natural sources. COS and DMS are two distinct entities [20].

On Materials: The harmful impacts of UVB light can be observed on man-made polymers, naturally occurring biopolymers, and numerous other materials that are commonly employed in commercial operations. The present materials incorporate certain exceptional chemicals for added UVB protection. The heightened levels of UVB would accelerate the breakdown of their efficacy outdoors, consequently restricting their utility over a shorter duration [17, 18]**.**

On Climate Change: While there are various associations between the depletion of the ozone layer and alterations in the climate, it is not the leading cause [20, 26, 27]. The impacts of ozone variations on the environment differ depending on the altitude at which they occur. Human-produced chemicals containing chlorine and bromine lead to substantial depletion of the ozone layer in the lower stratosphere, resulting in a cooling effect on the Earth's surface and atmosphere. Conversely, surface pollution emissions are anticipated to cause an elevation in tropospheric ozone levels, leading to the warming of the Earth's surface and contributing to the "greenhouse" phenomenon. Unlike changes in other atmospheric gases, it is more difficult to accurately determine the precise effects of the alterations in ozone. The solid and open bars depicted in the figure indicate the varying degrees of potential ramifications brought about by changes in the ozone layer, with the latter representing the more severe range and the former indicating milder outcomes.

[6] SUMMARY

It is imperative that the issue of ozone layer depletion be urgently and promptly tackled by the global community. There is concern among scientists that ongoing global warming will lead to prolonged depletion and destruction of the ozone layer. The depletion of ozone worsens when the temperature of the stratosphere, which is home to the ozone layer, drops. The stratosphere will experience a cooling effect due to diminished heat influx resulting from the phenomenon of global warming. Greenhouse gases effectively envelop the troposphere, causing a simultaneous cooling effect on the stratosphere. Chlorofluorocarbons are the primary catalyst for ozone depletion. In order to safeguard ourselves from the harmful impacts of UV radiation in the future, it is imperative to either prohibit these compounds or opt for alternative substitutes. There are several factors posing a significant threat to the quality of life on Earth, such as depletion of the ozone layer, acid rain, global warming, and pollution of ground-level ozone. The United Nations General Assembly created the International Day for the Protection of the Ozone Layer, also referred to as "World Ozone Day," back in 1994. The title commemorates the signing of the Montreal Protocol in 1987.

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