**OZONE AND OZONE DEPLETION AS AN EMERGING ISSUE IN CHEMISTRY/ CHEMISTRY EDUCATION IN ENVIRONMENTAL / SPACE CHEMISTRY.**

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**Abstract**

**Ozone depletion is an emerging issue as it occurs with variation of weather in the Globe. The Weather changes in the Atmosphere is automatic.That causes ozone depletion in hot and cold regions that cause adverse effect on animals and plants in the regions.**

Ozone and Ozone depletion should be seen as an emerging issue in environmental / space chemistry. This article describes in detail of ozone depletion, and effect on human and marine environment. Firstly it defines ozone and its features. Ozone is a colorless unstable toxic gas with a pungent odour and powerful oxidizing properties, formed from oxygen by electrical discharges or ultraviolet light. It differs from normal oxygen (O2) in having three atoms in its molecule (O3) (Aisbett, E.K., and Pham, Q.T. 1998).

A form of oxygen, O3, with a peculiar odor suggesting that of weak chlorine, produced when an electric spark or ultraviolet light is passed through air or oxygen. It is found in the atmosphere in minute quantities, especially after a thunderstorm. It is a powerful oxidizing agent, and thus biologically corrosive. In the upper atmosphere, it absorbs ultraviolet rays, thereby preventing them from reaching the surface of the earth. It is used for bleaching, sterilizing water, etc.

Allen, D.J., Nougues, S., and Baker, N.R. 1998 stated that A triatomic very reactive form of oxygen that is a bluish irritating gas of pungent odor that is a major air pollutant in the lower atmosphere but a beneficial component of the upper atmosphere, and that is used for oxidizing, bleaching, disinfecting, and deodorizing.

Ozone is formed throughout the atmosphere in multistep chemical processes that require sunlight. In the stratosphere, the process begins with an oxygen molecule (O2) being broken apart by ultraviolet radiation from the Sun. In the lower atmosphere (troposphere). Ozone is formed by a different set of chemical reactions that involve naturally occurring gases and those from pollution sources.

Stratospheric ozone is formed naturally by chemical reactions involving solar ultraviolet radiation (sunlight) and oxygen molecules, which make up 21% of the atmosphere. In the first step, solar ultraviolet radiation breaks apart one oxygen molecule (O2) to produce two oxygen atoms. In the second step, each of these highly reactive atoms combines with an oxygen molecule to produce an ozone molecule (O3). These reactions occur repeatedly whenever solar ultraviolet radiation is present in the stratosphere. As a result, the largest ozone production occurs in the tropical stratosphere. The production of stratospheric ozone is balanced by its destruction in chemical reactions. Ozone reacts continually with sunlight and a wide variety of natural and human produced chemicals in the stratosphere. In each reaction, an ozone molecule is lost and other chemical compounds are produced. Important reactive gases that destroy ozone are hydrogen and nitrogen oxides and those containing chlorine and bromine. Some stratospheric ozone is regularly transported down into the troposphere and can occasionally influence ozone amounts at Earth’s surface, particularly in remote, unpolluted regions of the globe.

Tropospheric ozone is near earth’s surface, ozone is produced by chemical reactions involving naturally occurring gases and gases from pollution sources. Ozone production reactions primarily involve hydrocarbon and nitrogen oxide gases, as well as ozone itself, and all require sunlight for completion. Fossil fuel combustion is a primary source of pollutant gases that lead to tropospheric ozone production. The production of ozone near the surface does not significantly contribute to the abundance of stratospheric ozone. The amount of surface ozone is too small in comparison and the transport of surface air to the stratosphere is not effective enough. As in the stratosphere, ozone in the troposphere is destroyed by naturally occurring chemical reactions and by reactions involving human-produced chemicals. Tropospheric ozone can also be destroyed when ozone reacts with a variety of surfaces, such as those of soils and plants. Balance of chemical processes. Ozone abundances in the stratosphere and troposphere are determined by the balance between chemical processes that produce and destroy ozone. The balance is determined by the amounts of reactive gases and how the rate or effectiveness of the various reactions varies with sunlight intensity, location in the atmosphere, temperature, and other factors. As atmospheric conditions change to favor ozone-producing reactions in a certain location, ozone abundances increase. Similarly, if conditions change to favor other reactions that destroy ozone, abundances decrease. The balance of production and loss reactions combined with atmospheric air motions determines the global distribution of ozone on timescales of days to many months. Global ozone has decreased during the past several decades because the amounts of reactive gases containing chlorine and bromine have increased in the stratosphere.

Bekki, S., Law, .S. and Pyle, J.A. 1994 suggested that Ozone depletion has brought about the reduction in the concentration of ozone in the ozone layer.Destruction of the upper atmospheric layer of ozone gas is caused by substances formed from breakdown of ozone depleting substances Ozone layer depletion, is simply the wearing out (reduction) of the amount of ozone in the stratosphere. Unlike pollution, which has many types and causes, Ozone depletion has been pinned down to one major human activity.

The status of depletion of ozone can be obtained by how Ozone measurements fluctuate from day to day, season to season and one year to the next. Ozone concentrations are normally higher in the spring and lowest in the fall. In spite of these fluctuations, scientists have determined, based on data collected since the 1950's till date. Ozone depletion and formation is a repetitive emerging issue. Observations of an Antarctic ozone called "hole" and atmospheric records indicating seasonal declines in global ozone levels provide strong evidence that global ozone depletion is occurring.

Severe depletion over the Antarctic has been occurring since 1979 and a general downturn in global ozone levels has been observed since the early 1980's. The ozone hole over the Antarctic reached record proportions in the spring of 2000 at 28.3 million square kilometres and vertical profiles from stations near the South Pole showed complete ozone destruction in the lower stratosphere. Ozone decreases of as much as 70% have been observed on a few days.

Severe ozone depletion was also measured over the Arctic. Lowest values over the Arctic occurred in 2000 north of Sweden, with about 60% depletion in some layers of the atmosphere. In addition to the Earth's poles, ozone depletion now affects almost all of North America, Europe, Russia, Australia, New Zealand, and a sizable part of South America. However, smaller decreases in stratospheric ozone have been observed in mid-latitude regions of the world.

The ozone layer over southern Canada has thinned by an average of about 7% since the 1980s. In the late 1990s, average ozone depletion in the summer over Canada was between 3% and 7%. Ozone depletion in Canada is usually greatest in the late winter and early spring. In 1993, for example, average ozone values over Canada were 14% below normal from January to April.

In their assessment of ozone depletion in 2006, the Scientific Assessment Panel, a group of experts established under the Montreal Protocol, made the following key findings:

The total abundances of human-made ozone-depleting gases in the troposphere continue to decline from the peak values reached in the 1992-1994 time period.

The total abundances of human-made ozone-depleting gases in the stratosphere show a downward trend from their peak values of the late 1990s.

Large Antarctic ozone holes continue to occur. The severity of Antarctic ozone depletion has not continued to increase since the late 1990s and, since 2000, ozone levels have been higher than in some preceding years.

Arctic ozone depletion shows large year-to-year variability, driven by meteorological conditions. Over the past four decades, these conditions contributed to severe ozone depletion.

The decline in stratospheric ozone over mid-latitude (between 60°S and 60°N) seen in the 1990s has not continued.

Caldwell, M.M and Flint, S.D. 1994 indicated that the health and environmental effect of Ozone in Human, animals and plants are very debilitating. The Connection between Ozone Layer Depletion and UVB Radiation indicates a reduction in ozone levels as a result of ozone depletion. This means less protection from the sun’s rays and more exposure to UVB radiation at the Earth’s surface. Studies have shown that in the Antarctic region, the amount of UVB measured at the surface can double during the annual ozone hole.

Similarly, Blumthaler, M., and Ambach, W. 1990 opined that the effects on human health show that Ozone layer depletion increases the amount of UVB that reaches the Earth’s surface. Laboratory and epidemiological studies demonstrated that UVB causes non-melanoma skin cancer and plays a major role in malignant melanoma development. In addition, UVB has been linked to the development of cataracts, a clouding of the eye’s lens.

EPA uses the Atmospheric and Health Effects Framework model to estimate the health benefits of stronger ozone layer protection under the Montreal Protocol. Updated information on the benefits of EPA’s efforts to address ozone layer depletion is available in a 2015 report, Updating Ozone Calculations and Emissions Profiles for Use in the Atmospheric and Health Effects Framework Model.

Also, the effect on plants indicates that UVB radiation affects the physiological and developmental processes of plants. Despite mechanisms to reduce or repair these effects and an ability to adapt to increased levels of UVB, plant growth can be directly affected by UVB radiation.

Indirect changes caused by UVB (such as changes in plant form, how nutrients are distributed within the plant, timing of developmental phases and secondary metabolism) may be equally or sometimes more important than damaging effects of UVB. These changes can have important implications for plant competitive balance, herbivory, plant diseases, and biogeochemical cycles.

Urbach, F. 1997 state that, Marine Ecosystems of Phytoplankton form the foundation of aquatic food webs. Phytoplankton productivity is limited to the euphotic zone, the upper layer of the water column in which there is sufficient sunlight to support net productivity. Exposure to solar UVB radiation has been shown to affect both orientation and motility in phytoplankton, resulting in reduced survival rates for these organisms. Scientists have demonstrated a direct reduction in phytoplankton production due to ozone depletion-related increases in UVB.

UVB radiation has been found to cause damage to early developmental stages of fishes, shrimps, crabs, amphibians, and other marine animals. The most severe effects are decreased reproductive capacity and impaired larval development. Small increases in UVB exposure could result in population reductions for small marine organisms with implications for the whole marine food chain.

Increase in UVB radiation could affect terrestrial and aquatic biogeochemical cycles, thus altering both sources and sinks of greenhouse and chemically important trace gases (e.g., carbon dioxide, carbon monoxide, carbonyl sulfide, ozone, and possibly other gases). These potential changes would contribute to biosphere-atmosphere feedbacks that mitigate or amplify the atmospheric concentrations of these gases.

Consequently, Gribbin, J. 1994. Stated that the effect on material of Synthetic polymers, naturally occurring biopolymers, as well as some other materials of commercial interest are adversely affected by UVB radiation. Today's materials are somewhat protected from UVB by special additives. Yet, increases in UVB levels will accelerate their breakdown, limiting the length of time for which they are useful outdoors.

Emissions of greenhouse gases can affect the depletion of the ozone layer through atmospheric interaction. In our investigation the increase in emissions of chlorine- and bromine- containing compounds, largely responsible for the depletion of stratospheric ozone at mid-latitudes, was found to be -5.8% per decade from 1980 to 1990. The increase in CH4 (methane) emissions in the same period changes this ozone depletion by + 1.4% per decade to -4.4% per decade, which is close to TOMS and Dobson measurements. The increase in N2O emissions hardly affects this depletion. The decrease in stratospheric temperatures due to increased CO2 emissions also diminishes the ozone depletion; the same may also happen when NOx, x = 1, 2, 3… etc. emissions are increased. The effect of these interactions in coming decades is to accelerate the recovery of the ozone layer. The trend is CH4 emissions described in the business as usual scenario 1992 may yield 1980 ozone column in 2060 compared with 2080 with CH4 emissions fixed at 1990 levels. The temperature decrease in the stratosphere may initially also accelerate the recovery of the ozone layer by several years, ignoring possible large extra ozone depletion by the extra formation of polar stratospheric cloud over large area of the world.

Finally, no one knows for certain how much more ozone depletion will occur. There is a substantial time lag between the time when ODS emissions begin to decline and the point at which the ozone layer begins to recover. It takes years for CFCs and other ozone-depleting compounds to reach the stratosphere. Many of them can persist in the stratosphere for centuries; some have life spans of 25 to 400 years. Almost all of the CFCs and halogens ever released are still in the atmosphere and will continue to destroy ozone for many years to come.

In spite of these uncertainties and substantial time lag, the natural balance between ozone creation and destruction can be restored if concentrations of ozone-destroying chemicals are reduced. However, this might require the complete elimination of ozone-destroying chemicals. In addition, there is some concern that the increase in greenhouse gas concentrations may result in delayed ozone layer recovery. Scientists estimate that they will not be able to measure any recovery until 2030. It is important to note that scientific knowledge of the atmosphere and the processes that deplete the ozone layer is not complete. The sudden and unexpected appearance of the Antarctic ozone hole reveals that the ozone layer does not respond predictably to the quantities of industrial chemicals we are dumping into it.

Ozone and ozone layer depletion is an emerging issue in environmental and space chemistry because it causes flooding, erosion producing terribly erosion gullies e.g. erosion in Nigeria occurring in Agwuru and Obosi area of Anambra State, volcanic effect. It also causes seasonal changes like having late rains than usual and desert encroachment.

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