# Effects of Ozone Layer on humans and the environment

Researcher name: Ahmed Khaled Al-gazi

Al-Balqa Applied University – Jordan

Email : gaziahmed82@outlooc.com

**Abstract:**

"The ozone layer" refers to the ozone within stratosphere, where over 90% of the earth's ozone resides. Ozone is an irritating, corrosive, colorless gas with a smell something like burning electrical wiring. In fact, ozone is easily produced by any high-voltage electrical arc (spark plugs, Van de Graaff generators, Tesla coils, arc welders). Ozone is a tri-atomic form of oxygen, i.e., each molecule of ozone has three oxygen atoms and is produced when oxygen molecules (O2) are broken up by energetic electrons or high energy radiation. Thus, it is formed naturally in the upper levels of the Earth's atmosphere by high energy ultraviolet radiation from the Sun. The researcher illustrate the air we breathe from ozone can harm our health. People most at risk from breathing air containing ozone include people with asthma, children, older adults, and people who are active outdoors, especially outdoor workers. In addition, people with certain genetic characteristics, and people with reduced intake of certain nutrients, such as vitamins C and E, are at greater risk from ozone exposure.

**Keywords:** Ozone, tri-atomic, atmosphere, human, environment

## Introduction

"The ozone layer" refers to the ozone within stratosphere, where over 90% of the earth's ozone resides. Ozone is an irritating, corrosive, colorless gas with a smell something like burning electrical wiring. In fact, ozone is easily produced by any high-voltage electrical arc (spark plugs, Van de Graaff generators, Tesla coils, arc welders). Ozone is a tri-atomic form of oxygen, i.e., each molecule of ozone has three oxygen atoms and is produced when oxygen molecules (O2) are broken up by energetic electrons or high energy radiation. Thus, it is formed naturally in the upper levels of the Earth's atmosphere by high energy ultraviolet radiation from the Sun. As, the radiation breaks down oxygen molecules, releasing free atoms, some of which bond with other oxygen molecules to form ozone. About 90 per cent of all ozone formed in this way lies between 15 and 55 kilometres above the Earth's surface – the part of the atmosphere called the stratosphere. Hence, this is known as the 'ozone layer'. Even in the ozone layer, ozone is present in very small quantities; its maximum concentration, at a height of about 20-25 kilometres, is only ten parts per million.

Ozone is an unstable molecule. High-energy radiation from the Sun not only creates it, but also breaks it down again, recreating molecular oxygen and free oxygen atoms. The concentration of ozone in the atmosphere depends on a dynamic balance between how fast it is created and how fast it is destroyed.

Depletion of stratospheric ozone (O3), as commonly known as 'the hole in the ozone layer', is an issue of international concern. Most ozone is found in the stratosphere (upper part of the atmosphere), more than 10 to 16 kms from the surface of the Earth. The natural distribution of ozone around the Earth is not uniform, as seasonal winds and formation patterns contribute to lower concentrations at the equator and higher concentrations at the poles. Ozone in the stratosphere protects life on Earth as it limits penetration of ultraviolet radiation through the atmosphere, but it is considered a pollutant in the troposphere (close to the ground). The amount of ozone in the atmosphere is measured in Dobson units (DU). One DU is about twenty-seven million molecules per square centimeter. The average thickness of the atmospheric ozone layer at any place varies from month to month, but is generally between 260 and 330 DU.

**What is Ozone?**

Ozone (O3) is a molecule made up of three atoms of oxygen (O), and is mostly found in the stratosphere, where it protects us from the Sun's harmful ultraviolet (UV) radiation. Although it represents only a tiny fraction of the atmosphere, ozone is crucial for life on Earth. Ozone in the stratosphere—a layer of the atmosphere between 15 and 50 kilometers (10 and 31 miles) above us—acts as a shield to protect Earth's surface from the sun's harmful ultraviolet radiation. Without ozone, the Sun's intense UV radiation would sterilize the Earth's surface. With a weakening of this shield, more intense UV-B and UV-A radiation exposure at the surface would lead to quicker sunburns, skin cancer, and even reduced crop yields in plants. However, near the surface where we live and breathe, ozone is a harmful pollutant that causes damage to lung tissue and plants. This "bad" ozone forms when sunlight initiates chemical reactions in the air involving pollutants, particularly a family of gases called nitrogen oxides (released from vehicles and industry during the combustion process) and with volatile organic compounds (carbon-containing chemicals that evaporate easily into the air, such as petroleum products.

**How ozone works**

The sun emits electromagnetic radiation at different wavelengths, meaning energy at different intensities. The atmosphere acts like a multi-layer shield that protects Earth from dangerous solar radiation.

Ozone is found in two different parts of our atmosphere. Ground level or "bad" ozone is a human health irritant and component of smog. It is found in the lower atmosphere (troposphere) and has nothing to do with the "ozone hole. "High level or "good" ozone occurs in the stratosphere and accounts for the vast majority of atmospheric ozone. The stratospheric ozone layer absorbs ultraviolet (UV) radiation, preventing dangerous UV rays from hitting Earth's surface and harming living organisms. UV rays cannot be seen or felt, but they are very powerful and change the chemical structure of molecules.UV radiation plays a small role in global warming because its quantity is not enough to cause the excess heat trapped in the atmosphere. UV radiation represents a small percentage of the energy from the sun, and is not highly absorbed or scattered in the atmosphere—especially when compared with other wavelengths, like infrared. But, ozone depletion is also concerning because it directly impacts the health of humans, and other living organisms. The Earth's atmosphere is divided into several layers. The lowest region, the troposphere, extends from the Earth's surface up to about 10 kilometers (km) in altitude. Virtually all human activities occur in the troposphere. Mt. Everest, the tallest mountain on the planet, is only about 9 km high. The next layer, the stratosphere, continues from 10 km to about 50 km. Most commercial airline traffic occurs in the lower part of the stratosphere. For nearly a billion years, ozone molecules in the atmosphere have protected life on Earth from the effects of ultraviolet rays.

It is a form of oxygen (O2). We all know that, oxygen we need to live and breathe. Normal oxygen consists of two oxygen atoms. Ozone, however, consists of three oxygen atoms and has the chemical formula O3. Ozone is formed when an electric spark is passed through oxygen. Over millions of years the action of sunlight and specifically the action of ultra violet light or UV on oxygen has created a layer of ozone high up in the atmosphere. This ozone layer resides in the stratosphere and surrounds the entire Earth. The action of UV light on this layer both destroys and creates ozone, a constant process going on silently. Thus, this process of absorbing portion of UV light, protecting us from the harmful exposure. In fact, UV-B radiation (280- to 315- nanometer (nm) wavelength) from the Sun is partially absorbed in this ozone layer. As a result, the amount of UV-B reaching Earth's surface is greatly reduced. UV-A (315- to 400-nm wavelength) and other solar radiation are not strongly absorbed by the ozone layer.

**Statement of the Problem**

The problem of the current study can be noticed in Manifestations of the impact of the ozone layer on the environmental life of the earth and on humans. The researcher illustrate the air we breathe from ozone can harm our health. People most at risk from breathing air containing ozone include people with asthma, children, older adults, and people who are active outdoors, especially outdoor workers. In addition, people with certain genetic characteristics, and people with reduced intake of certain nutrients, such as vitamins C and E, are at greater risk from ozone exposure.

## Research Questions

This research is guided by the following questions:

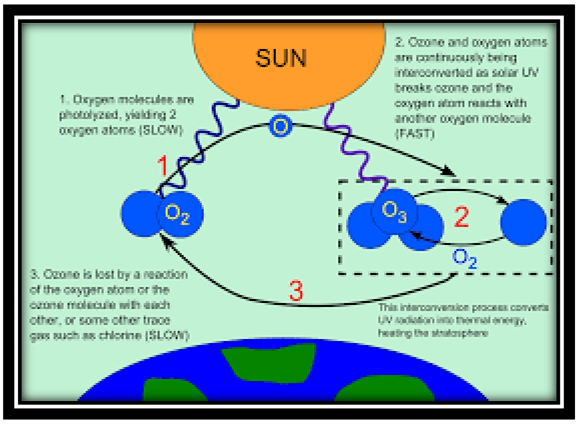
1- Explore how ozone works

2- What are the harmful effects of ozone?

3- What are the environmental effects of ozone?

## The health effects of ozone

Ozone in the air we breathe can harm our health. People most at risk from breathing air containing ozone include people with asthma, children, older adults, and people who are active outdoors, especially outdoor workers. In addition, people with certain genetic characteristics, and people with reduced intake of certain nutrients, such as vitamins C and E, are at greater risk from ozone exposure. Ozone layer depletion increases the amount of UVB that reaches the Earth's surface. Laboratory and epidemiological studies demonstrate 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.




Breathing ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and airway inflammation.

It also can reduce lung function and harm lung tissue. Ozone can worsen bronchitis, emphysema, and asthma, leading to increased medical care.

Ozone layer depletion causes increased UV radiation levels at the Earth's surface, which is damaging to human health.

An increase in solar UV-B may result in shortening of useful lifetimes of plastics and increase the cost of using plastics, particularly in building applications.

Studies reported during the past year have added significantly to the understanding of spectral sensitivity of several widely used plastics. These included polyethylenes, acrylic polymers, nylon and textile materials. The findings are consistent with those for other polymers already investigated and quantify the spectral dependence of photodegradation. These data are useful for future cost estimates on the impacts of increased UV radiation in relation to materials damage. A report on the effect of nine types of common brominated flame retardant additives on the spectral sensitivity of polyolefins and polystyrene indicated a shift in the action spectrum to shorter wavelengths and increase in the UV-B induced degradation of the polymers. Plastics generally include flame-retardants and other additives to ensure processibility and performance, and their effect on the photodegradability of the polymer is of practical interest.

Data on the UV-susceptibility of two biopolymers, chitosan and collagen have also been recently reported, clarifying the chemistry of UV-induced oxidative processes and the spectral sensitivity of the degradation process. However, these findings should be considered preliminary because the sample preparation process may have changed the chemistry of biomaterials used in these studies.

Early data from controlled-temperature outdoor exposure experiments on polyethylene films illustrated the role of temperature in enhancing and supplementing the sunlight-induced degradation. At least in the case of polyethylene, the increased damage by an incremental increase in UV-B in sunlight is likely to be largely influenced by ambient temperature of the exposure location. Effects of stratospheric ozone depletion, and the subsequent increased UV-B radiation, on the useful lifetimes of plastics will be more severe in locations that experience high ambient temperatures. Understanding the role of temperature, together with UV-B irradiation, is scientifically and economically important.

## The environmental effects of ozone

Ozone affects sensitive vegetation and ecosystems, including forests, parks, wildlife refuges and wilderness areas. In particular, ozone harms sensitive vegetation during the growing season. 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.

## Effects on Materials

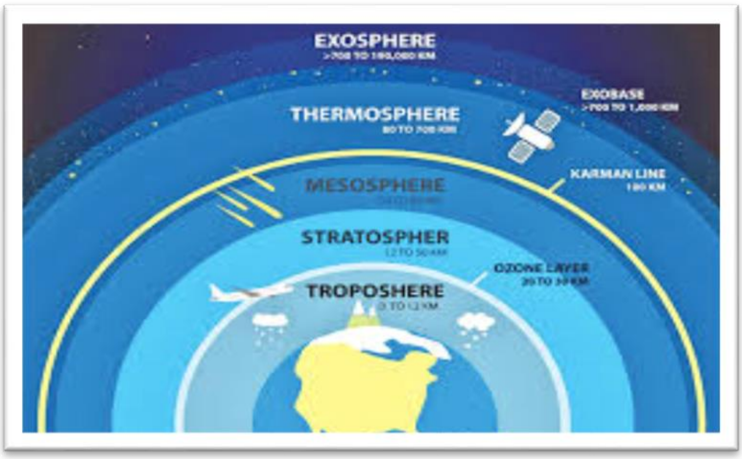
Synthetic polymers, naturally occurring biopolymers, as well as some other materials of commercial interest are adversely affected by UVB radiation. Today's materials are somewhat protected from UVB by special additives. Yet, increases in UVB levels will accelerate their breakdown, limiting the length of time for which they are useful outdoors. Reductions in stratospheric ozone lead to increased penetration of UV-B radiation to the lower atmosphere, and therefore to a general increase in the photochemical reactivity of the troposphere. These changes are believed to affect concentrations of key tropospheric gases such as ozone (the major constituent of urban photochemical smog), peroxides (important contributors to the acidification of rain) and the hydroxyl radical (OH), which is the major oxidant responsible for the atmospheric residence time of species such as carbon monoxide, methane, VOC, nitrogen and sulfur oxides, and other constituents including many substitutes for ozone-depleting substances. However, the magnitude and even the sign of the tropospheric composition responses to increased UV-B levels depend on the chemical environment, especially the local amounts of nitrogen oxides, VOC, and water vapor.

Recent modelling studies confirm and extend earlier work showing that remote regions should experience lower tropospheric O3 levels due to enhanced UV-B radiation, and higher OH concentrations leading to shortened lifetimes for many atmospheric constituents as well as to higher levels of peroxides. However, the newest study also suggests that such effects will be rather minor in the upper troposphere due to the low levels of water vapour present at those altitudes. Another recently published study illustrates the effect of stratospheric perturbations on tropospheric chemistry by showing increases in tropical tropospheric methane and carbon monoxide for several months following the Mt. Pinatubo eruption, which injected large amounts of UV-absorbing sulfur dioxide into the stratosphere and thus temporarily reduced tropospheric OH radical production.

## The ozone hole

The term ‘ozone hole’ refers to the depletion of the protective ozone layer in the upper atmosphere (stratosphere) over Earth's polar regions. People, plants, and animals living under the ozone hole are harmed by the solar radiation now reaching the Earth's surface—where it causes health problems, from eye damage to skin cancer.

Stratospheric ozone is constantly produced by the action of the sun's ultraviolet radiation on oxygen molecules (known as photochemical reactions). Although ozone is created primarily at tropical latitudes, large-scale air circulation patterns in the lower stratosphere move ozone toward the poles, where its concentration builds up.




In addition to this global motion, strong winter polar vortices are also important to concentrating ozone at the poles. During the continuously dark polar winter, the air inside the polar vortices becomes extremely cold, a necessary condition for polar stratospheric cloud formation.

Polar stratospheric clouds create the conditions for drastic ozone destruction, providing a surface for chlorine to change into ozone-destroying form. They generally last until the sun comes up in the spring.In the 1980s, scientists discovered that the ozone layer was thinning in the lower stratosphere, with particularly dramatic ozone loss—known as the "ozone hole"—in the Antarctic spring (September and October).

Scientists also discovered that the thinning in the ozone layer was caused by increasing concentrations of ozone-depleting chemicals – chlorofluorocarbons or CFCs (compounds with chlorine and/or fluorine attached to carbon) and to a lesser extent halons (similar compounds with bromine or iodine).

These chemicals can remain in the atmosphere for decades to over a century. At the poles, CFCs attach to ice particles in clouds. When the sun comes out again in the polar spring, the ice particles melt, releasing the ozone-depleting molecules from the ice particle surfaces. Once released, these ozone-destroying molecules do their dirty work, breaking apart the molecular bonds in UV radiation-absorbing ozone.

## Conclusion

Ozone depletion is an ongoing crisis that heavily impacts nature and human lifestyle. The threats posed to the ozone layer by chlorofluorocarbons (CFCs) were definitely not thought possible when they were created. It is important to look back at the past so that we can learn from our mistakes. Without a doubt, the ozone layer needs to be protected, and I am glad that the government is taking measures to do so. However, though HCFCs and HFCs (the leading replacements of CFCs) help solve the ozone problem, they create another issue regarding global warming. This is the case for many substitutes, so I strongly believe that technology now, in the present, must advance so that safe alternatives can be discovered.

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