

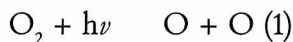
PROTECTING THE OZONE LAYER

Where do we stand today?

WHAT IS OZONE (O₃)?

Ozone (O₃) is a naturally occurring gas made of a triple form of oxygen. Therefore, it can be considered as another form of oxygen. Relative proportion of ozone in the atmosphere is 0.000007% by volume as compared to 21% of oxygen. Ozone is not uniformly distributed in the atmosphere. More than 90% of it is found in the stratosphere 10 to 50 km above the earth's surface. The region in the stratosphere where ozone is concentrated is commonly known as the ozone layer. This ozone layer acts as a protective shield for the earth which filters harmful ultraviolet (UV) rays.

Formation of Ozone -

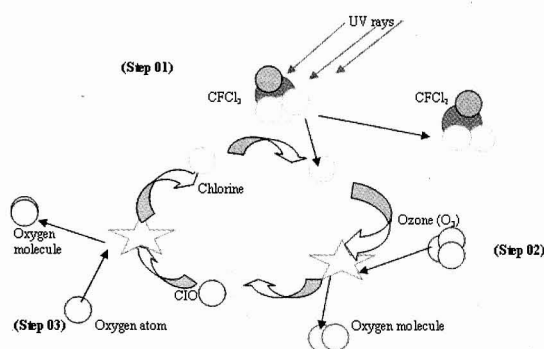


UV radiation from the sun splits the oxygen molecule in to two oxygen atoms. A free oxygen atom then combines with an oxygen molecule and forms ozone (O₃) molecule. In the same way, with the help of UV radiation, O₃ molecule is broken down to form oxygen. In this natural process, two reactions take place and there is a dynamic equilibrium of ozone and oxygen in the atmosphere. However, in mid 1970s it was discovered by the scientific community that man-made chemicals, which comprise of chlorine and bromine atoms in an organic form, are depleting the ozone layer.

Causes of ozone depletion

In late 1970s it was proved that the most commonly used Ozone Depleting Substances (ODS) are Chlorofluorocarbons (CFCs) and Halons, which are used in industries such as air conditioning, refrigeration and as a fire fighting agent. When these man made, non-reactive ODSs are released to the atmosphere, they

slowly move up and reach the ozone layer in the stratosphere and are split by UV radiation from the sun. This process sets highly reactive chlorine and bromine atoms free. These chlorine and bromine atoms act as a destroying agent of ozone molecules i.e. ozone is broken in to oxygen and chlorine monoxide. This chlorine monoxide is very unstable and reacts with a free high-energy oxygen atom producing an oxygen molecule while releasing the chlorine atom again. The released chlorine atom goes after another ozone molecule and destroys it. By this way, a single chlorine atom can destroy up to 100,000 ozone molecules. The aforesaid chemical reaction is illustrated in Figure below.



Step 01- CFCs are broken down in to chlorine and dichlorofluoromethane by the UV rays.

Step 02 - Ozone molecules are broken down in to oxygen (O₂) and chlorine monoxide (ClO) by these chlorine atoms. This process reduces the ozone (O₃) in the stratosphere.

Step 03 - a free oxygen atom reacts with chlorine monoxide and a chlorine atom is set free. Repetition of this process gradually thins out the ozone layer.

Bromine radicals produced in the same way also act in a similar manner and destroy ozone, thinning the ozone layer. Some chemical compounds like nitrous oxide (N_2O) and other nitrogen compounds also have a minute damaging affect on the ozone layer. The impact a chemical has on the ozone Layer is identified through the Ozone Depleting Potential (ODP). Trichlorofluoromethane (CFC11) and dichlorodifluoromethane (CFC12), which are widely used refrigerants, have an ODP of 1.0 and bromochlorodifluoromethane (halon 1211) has an ODP of 3.0. Therefore, it is evident that halon used as a fire fighting agent is more damaging to the ozone layer, when compared with CFCs. This weakening of the earth's protective shield, the ozone layer will cause health problems, environmental damages, and influence the global climate, and many other aspects directly threatening the life existence on planet Earth.

The ozone hole

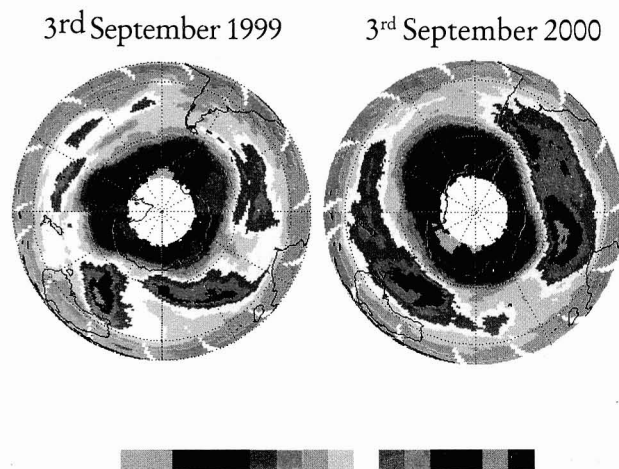
What is referred to as the ozone hole is a thinning of the ozone layer, and not an actually visible hole. Due to the global circulation system, the ozone concentration in the equator is naturally low (around 150 Dobson Units) and the concentration in the polar regions are natural high (around 400 Dobson Units). The thinning of the ozone layer is prominent in the South Polar region. It has been observed that ozone concentration in the polar regions has dropped from around 400 Dobson units to 150 Dobson Units. This phenomenon is at its peak in the southern hemisphere spring and summer, September to December. Ozone hole mapping had revealed that the hole has even reached a maximum of 28.3 million square km in year 2001.

Health and environmental impact of ozone layer depletion

The direct result of the ozone layer depletion will be an increase of the amount of UV radiation that will reach the earth's surface. These UV rays have a damaging effect on humans, terrestrial ecosystems, marine life, crops and other living creatures.

It can cause sun burns, skin aging and skin cancer, cataract leading to blindness and suppression of the immune system. Since UV rays are of energy, it can penetrate much deeper in oceans, seas and fresh water bodies. Therefore, UV destroys fish eggs and amphibian eggs and larvae.

UV destroys the Phytoplanktons, the primary producers (of food chain) of the oceans. Food chains of the oceans are affected and population of fish will be reduced. Genes (DNA) are sensitive to UV rays. Mutations can occur in genes causing cancer. UV destroys phytoplanktons which absorb CO_2 for photosynthesis. This indirectly increases global warming. CFCs are powerful greenhouse gases and, as such, directly influences global warming. Global warming leads to mean sea level rise, melting glaciers and polar ice caps and changes in global and local weather patterns. UV rays at the lower atmosphere produce ground level ozone. This highly reactive and toxic ozone causes respiratory diseases. This ground level ozone also reacts



with unburned hydrocarbons which are emitted from vehicles and produces photo chemical smog. This smog also causes respiratory diseases.

Towards preserving the ozone layer

United Nations Environment Programme (UNEP) initiated the issue of protecting the ozone layer in 1976. As a result, the Vienna Convention for the protection

of the ozone layer was adopted in 1985. However, commitments of member nations were not binding. The necessity was felt to have a binding policy to protect the ozone layer. To provide the necessary platform, from which, detailed international binding action could be taken and to implement the measures to protect the ozone layer the *Montreal Protocol on Substances That Deplete The Ozone Layer* was promulgated on 16th September 1987. It has a membership of 189 countries to date. Sri Lanka ratified the Vienna Convention and the Montreal Protocol on the 15th December 1989, and subsequently, ratified all the amendments to it. Under the protocol, all countries are required to gradually reduce the consumption and production of ODS. For this purpose, member countries are categorized in to Article 2 and Article 5 countries. Developed countries fall under Article 2. Developing countries (countries with annual ODS per capita consumption below 0.3 kg), are defined in Article 5. Article 2 countries were required to phase out CFC in 1996 and Article 5 countries were required to phase out CFC in 2010. Although Sri Lanka is categorized as an Article 5 country, considering the effects on the environment, Government of Sri Lanka has taken a policy decision to phase out CFC by 2008, two years ahead of the original protocol dead line.

To help the implementation process of the Montreal Protocol in Article 5 countries a Multilateral Fund was established in 1990. Contributions made by the Article 2 countries are allocated to fund phasing out and other related projects in Article 5 countries. To achieve Protocol targets and to fulfill the other obligations in Sri Lanka, the Montreal Protocol Unit was set up under the Ministry of Transport, Women's affairs and Environment in 1994. As of January 2003 the Montreal Protocol Unit changed its name to 'National Ozone Unit' for easy comprehension of the general public.

W.L. Sumathipala



Dr W.L. Sumathipala (BSc PhD) is the Director, National Ozone Unit of the Ministry of Environment & Natural Resources

What have you learnt?

Try your hand at MCOs

1. True or false?

- The fossil skeleton of the miniature human called hobbit is *Homo floresiensis*
- It was discovered in Australia
- Hobbit lived over a million years ago
- They are believed to have used fire for cooking
- The female fossil Lucy discovered in 1974 belong to the same genus as Hobbit

2. True or false?

- Obesity is becoming an important health problem among urban children in Sri Lanka
- Overweight children, when compared to others, are more likely to develop diabetes when they grow into adults
- Vitamin C releases free oxygen, which damages tissues
- A healthy diet should include plenty of sugar to provide enough energy
- Antioxidants are believed to prevent cancer

3. True or false?

- The rain fall during months of March-April is due to the southwest monsoon
- Tropical cyclones are caused by high pressure systems in the atmosphere
- Most of the cyclones in Sri Lanka occurs during November - December period
- Thunderstorms are more frequent during inter monsoon period
- El-Nino* phenomenon is caused by changes in the wind direction over the Indian Ocean

4. True or false ?

- In a bee hive, worker bees are females
- The majority of bees in the world are honey bees, living in colonies
- Solitary-pollen bees are an important source of bee honey
- Over 100 species of solitary-pollen bees have been identified in Sri Lanka
- Carpenter bee (*Xylocopa*) is the largest solitary pollen bee found in our country