Ozone Layer Depletion and its Environmental Issues

Dr. W. L. Sumathipala[1]
Director
&
I. P. Safinas

National Ozone Unit, Ministry of Environment and Natural Resources

Ozone Layer and its Depletion

The ozone layer is a region of the stratosphere which contains most (about 90%) of the Earth's atmospheric ozone. It is about 10-25 miles (15-40 km) above the Earth's surface, which acts as a protective shield for Ultra Violet (UV) radiation emanating from the sun (Fig.1). Ozone is a special form of oxygen, made up of three oxygen atoms rather than the usual two oxygen atoms. Ozone is produced at the lower region of the stratosphere from oxygen with the help of high energetic radiation emitted from the sun. Stratospheric ozone layer makes the planet habitable by absorbing harmful solar ultraviolet (UV) radiation before it reaches the earth surface. Scientists have been working to understand the nature and functions of the ozone layer since its discovery in the 1920s.In 1974 chemists, Sherwood Roland and Mario Molina, identified a major threat to the ozone layer (thinning of the ozone layer) as a result of human-made substances emitted into the atmosphere.

Causes of Ozone Depletion

Depletion of ozone layer is caused by Ozone Depleting Substances (ODS) emitted into the atmosphere. ODS are mainly man made and no significant natural sources have been identified. Substances used or generated in industrial and agricultural activities such as Chlorofluorocarbon (CFC), Halons, Carbon tetrachloride, Hydro Chloro Flouro Carbon (HCFCs) and Methyl Bromide (MeBr) are mainly responsible for ozone depletion.

These substances reach the upper atmosphere and high energy UV reaching from the sun breaks them apart in to atomic constituents of which they are made up. Chlorine and Bromine atoms released from these, act as catalysts to accelerate the ozone destruction process. Each atom can destroy thousands of ozone molecules due to its recombining ability, before being removed from the atmosphere.

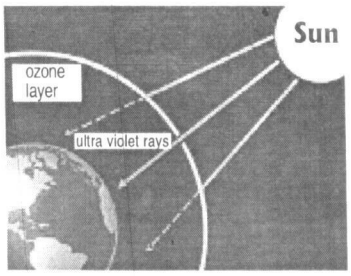

Fig.1 - A diagram showing ozone layer and its effect on the earth.

Source: NASA

Accumulation of Chlorine and Bromine atoms in the upper atmosphere makes ozone destruction process fast resulting in lowering of ozone level especially in polar regions (Figure 2). The severe depletion of ozone, caused by destructive reactions of halogen, was first observed in 1980s and was known as "ozone hole" (Fig. 2).

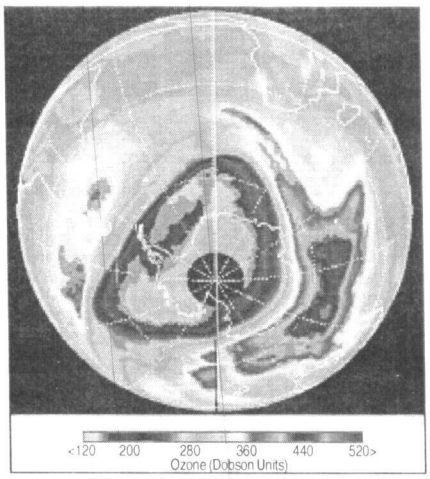

Fig.2 The Antarctic ozone hole, seen from space, Sept.16, 2000 as observed by the NASA (More Dobson units = more ozone.)

Source: NASA

Consequences of Ozone Depletion on Human Health and the Environment

Ozone layer acts as a protective shield for the earth and especially its biological systems. It absorbs UV-B rays from the sun, hence reducing the amount of UV radiation reaching the earth surface. Increased surface UV-B levels due to decreased ozone levels bring about adverse consequences on human health and the environment.

Studies have shown that, there is a strong relationship between skin cancers and UV-B exposure. There would be a high possibility of having eye diseases such as cataracts due to UV radiation reaching earth from the sun. Increased UV levels reaching the surface of the earth lead to increased ground-level ozone which is known to be toxic; if inhaled, it can produce problems in the respiratory system. It is also known to reduce the human immune system with increased exposure to UV rays. Surface UV radiation is dependent on many complex scattering and absorbing processes (Ozone at ground-level is produced mainly by the action of UV radiation on combustion exhaust gases of vehicles).

Higher UV levels affect the survival of some microorganisms, e.g. Cyanobacteria, a microorganism which plays a major role in the Nitrogen fixation process in many plants, is highly sensitive to UV rays. Increased UV also reduces plant growth thus lowers agricultural productivity. Planktons are particularly susceptible to the effects of UV rays and are vital to food webs as primary producers. Reduced plankton levels in oceans lead to diminish fish stock, through a chain of reactions in the biological cycle of the ocean environment.

Reduction of the Carbon Dioxide (CO_2) sink (CO_2) fixation by green tissues during photosynthesis) causes an increase of CO_2 in the atmosphere, which in turn enhances global warming and climate change.

Global Significance of Preventing Measures

Protection of the ozone layer is vital to ensure survival of life on the earth in the future.

[1] *Dr. Sumathipala recently won a special award presented by the Montreal Convention at the 2008 Ozone Protection International Awards Ceremony at the Kennedy Centre in Washington for his individual contribution towards efforts to conserve the Ozone layer. Economic Review wishes to congratulate Dr. Sumathipala for this achievement.*

Stratospheric ozone blocks harmful UV radiation from reaching the earth surface where it can harm ecosystems. As described in the previous section, overexposure to UV radiation can cause range of harmful effects on human health, biological and physical environment and finally threatens our existence. The use of refrigerators, air conditioners which emit ODS such as CFCs and HCFCs threatens the earth's life sustaining environment. If the global community does not take actions to prevent ozone layer depletion, our future generations would have to face the repercussions. The effects will not be confined to a region or a particular nation, where the emissions occur. The whole global community will be affected and will have to face the consequences.

Thus prevention of Ozone Depletion is vital for the survival of Life on the Earth.

International Response to Ozone Depletion

After the warning by scientists, the whole world community got together and established the Vienna convention in 1985 to protect the ozone layer. Since the evidence was clear within that period of time, in 1987, the Montreal Protocol on the substances that deplete the ozone layer was proposed and significant process was initiated. Obligations set under the protocol discouraged the use of CFCs, HCFCs and other ODS while encouraging the use of environmentally-friendly alternatives having low/ zero impacts on ozone depletion. The main obligations under the Montreal Protocol are:

- Creation and implementation of control measures regarding production and consumption of ODS.
- Restriction of international trade in ODS.
- Maintaining and reporting data on annual production and consumption of ODS to ozone secretariat by the parties of the protocol.
- Financial contribution by developed countries to Multi-lateral Fund (MLF) of the Montreal Protocol for providing assistance to developing countries and development of technological substitutions to the existing ODS based industries.

There are many regulations to prohibit the use of any substance that has ozone depleting potential. The MLF financed by developed countries assists developing countries to comply with the Montreal protocol obligations to phase out ODS. The Montreal protocol has achieved success through its strong scientific foundation, clear regulatory signals to the market that encourage technological innovation and its funding mechanism for financing the incremental cost for designing alternative technologies.

The Montreal protocol has made great strides in the global effort to protect the ozone layer, by providing an easy-to-use communication tool to help the various stakeholders to get across their messages about multilateral fund and its access to a wider public. The Montreal Protocol has been in place for 20 years and it is considered to be the most successful multilateral environmental agreement. This achievement is mainly due to the unique features of the protocol where a special fund (MLF) was established by contributions of the developed countries to assist developing countries (Article 5). The Fund is managed by an Executive Committee with an equal representation of seven members each from industrialized countries and developing countries, elected, annually by the Meeting of the Parties (MOP). The Committee reports the operation of the fund to the MOP annually.

To date, 192 countries are parties to the Protocol and decisions are always taken with the consensus of all parties at the MOP. Every country works with dedication because ozone layer depletion affects every one. The global alliance of nations to protect the ozone layer represents the single most effective body working towards achieving a common goal. Annual MOP allows countries to review progress, maintain and update scientific information and make decisions in compliance with the Protocol.

The Montreal protocol was strengthened with the amendments and adjustments made with improved safety methods, new controlled substances and accelerated control measures. The initial protocol was developed based on CFC and halon products. In 1990, the London Amendment was brought to phase out production of the most damaging ozone depleting substances by developed countries. In 1992, this was accelerated for 1996, by Copenhagen Amendment. Further controls were made in 1995 (Vienna), 1997 (Montreal), and 1999 (Beijing) (Figure 3). Protocol expects the countries to have a focal point within their governments to deal with ozone issues. The focal points are responsible for sharing experiences, exchanging knowledge and skills development at international and regional level.

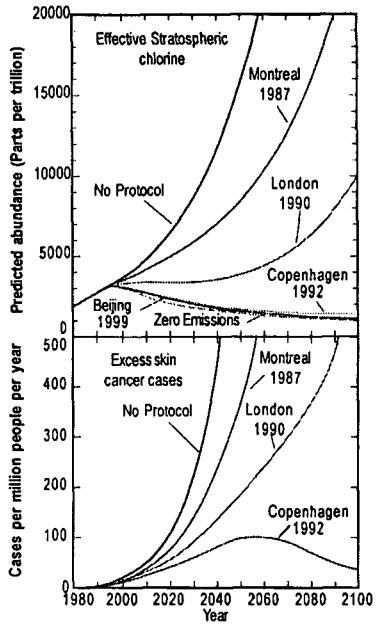

Fig. 3 - Effects of the Montreal Protocol.

Produced from Scientific Assessment of Ozone Depletion: 2002, World Meteorological Organization, Global Ozone Research and Monitoring Project report.

Recovery Measures to Overcome Depletion

Ozone is constantly produced and destroyed in a natural cycle, maintaining a dynamic balance between the production and destruction process. Anthropogenic (man made) emissions disrupts this balance and make the ozone destruction process faster than production. The obligations set under the Montreal protocol help to restore production as well as destruction processes to normal level through emission reduction.

Financial and technical co-operation including transfer of technologies to developing countries enable them to compliance with the control measures set out in the protocol. Industry groups that continue to use CFCs and other ODSs, have taken recovery measures to substitute environmentally-friendly methods. Necessary steps required for promoting and facilitating collection, storage and disposal of all ozone depleting substances have been identified and implemented. Recovery efforts to encourage industries are considered to be vital. Transfer of technologies is one of the compliance incentives to assist developing countries to implement their environmental obligations.

With the assistance and guidance of the Montreal Protocol, modifications (retrofitting/ replacement) are made to the existing operation systems. This requires preparation of equipment specifications, procurement of retrofitted equipment and their installation commissioning.

Training of the production staff is required to facilitate enhancing their working skills in relevant fields. The Montreal Protocol has demonstrated many ways of promoting innovations and diffusions of technologies and removing legal and institutional barriers. The world wide automotives equipped with Mobile Air Conditioners (MAC) are changed to environmentally-friendly technology to protect the ozone layer and at the same time to minimize the climatic changes through reduced emissions. Recovery measures are implemented at country levels to ensure its national compliance. MLF meets all costs of designed project activities for phasing out ODS in developing countries. Atmospheric computer models show that recovery of ozone depletion to 1970 level could be expected by another 5-6 decades, provided that the Montreal protocol controls are adhered to in the future (Figure 4).

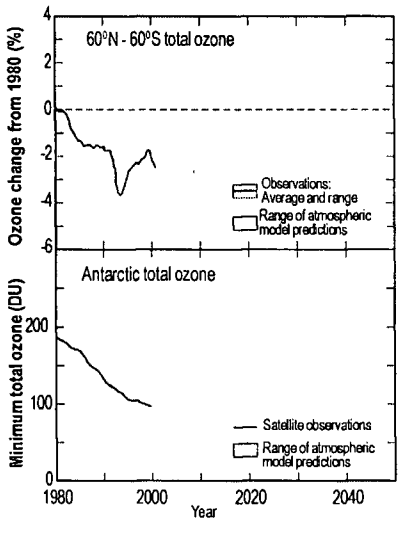

Fig. 4 - Recovery of Global Ozone

Adapted from Scientific Assessment off Ozone Depletion: 2002 Meteorological Organization, Global Ozone Research and Monitoring Project

Transferring Technology

Successful technology transfer is required to phase out ODS and meet other global environmental challenges. ODS-based industries are very diverse ranging from large-scale industries on air conditioning, refrigeration, fire fighting, solvents, agriculture, aerosols foams, etc to thousands of other small industries. The large enterprises have the resources to innovate new ozone-friendly technologies but the small entrepreneurs need to be educated on such technologies and how to access them.

The authors examined how governments of industrialized countries innovated and implemented policies, regulations, awareness and education campaigns, and used financial incentives and disincentives to achieve success. With regard to the RMPs (Refrigerant Management Plan), a significant reduction of CFC production and consumption can be achieved by introducing better servicing practices and appropriate equipment for the servicing and maintenance of refrigeration equipment. The establishment of a country-wide system for recovery and recycling would also be helpful to reduce CFC production. This will give local industries another business opportunity to produce refrigerant recovery machines for the RMPs. Apart from the favourable environmental impact, other benefits will include improved working conditions, including occupational health and safety, and the long-term employment of service technicians at service workshops where the changes in refrigerant technology will be implemented. The Montreal Protocol commits parties to transfer the best available environmentally-friendly safe substitutes and related technologies to developing. countries

Dual Benefits

The Montreal protocol implements policies to minimise impacts by of ODS that are harmful to the environment. It contributes significantly to mitigate climate change. The Montreal Protocol facilitates development of new strategies to reduce the impacts on the climate. Further, it helps to reduce production of Greenhouse gases (GHG), which in turn provides environmental benefits to the people.

Several ozone depleting substances are extremely harmful GHGs. The protocol's phase out of CFCs and other ozone depleting substances has made a huge contribution to mitigation of adverse climatic impacts. The parties have an opportunity to take immediate actions to strengthen their ability to protect the ozone layer as well as to enhance its ability to mitigate climate impacts. Multilateral fund of the Montreal protocol provides financial assistance to developing countries to replace ODS with substances which have lower Ozone Depleting Potential (ODP) and also generally have lower Global Warming Potential (GWP). Climate strategies give us not only climate mitigation but other environmental and public health benefits as well. Technological innovations in substitutes, manufacturing processes and equipment have increased energy efficiency and reduced leakages.

Efforts of Sri Lanka to Meet Global Challenges

Sri Lanka does not produce ODS or ODS-based equipment. However, being a developing country and signatory to the Montreal Protocol, Sri Lanka has to comply with the targets given under the protocol. The refrigeration factories which were based on CFC have been converted to non-CFC technology with the grants of multilateral fund. Replacement of the existing systems with alternatives based on environmentally-friendly technologies seems to be beneficial to the country in many ways. Implementation of policies and regulations at country level is done by the National Ozone Unit (NOU). The National Ozone Unit of Sri Lanka has banned import of CFC from January 2008, which was a great achievement.

Sri Lanka has introduced a regulatory framework to control import of ODS and taken necessary steps to introduce a licensing system with regard to the import of ODS under the Import and Export control Act. Sri Lanka has also introduced an internationally recognized coding system called Harmonized System (H.S code) to monitor and restrict the import of ODS to Sri Lanka. The NOU plays a major role in recording data on ozone depleting substances. A database has been prepared and monitored on regular basis using information on import of ODS collected by the Department of Customs.

Towards Sustainable Development through Environmentally - friendly Technologies

Technology is an indispensable tool in facilitating the development process of any country. Being a developing country, Sri Lanka has to achieve its development sustainably through economic development with environmental protection. Industrial development can be achieved through modified technologies introduced by the Montréal Protocol. Building human capabilities along with technology transfer contributes to enhancing the country's economy in a sustainable manner. Many governments prohibited the purchase of ODS-based products and started large-scale production of new environmentally-friendly technologies. However, these innovations primarily support the growth of small and medium-size enterprises which makes a significant contribution to the country's economy.

Better designs and improved quality of products have helped many firms to improve their market access. It facilitates and enhances the competitiveness of the product while minimizing production cost. MLF projects also encourage the growth of manufacturing sectors which in turn expands employment opportunities. The MLF has taken steps to assist less developed countries to meet all incremental costs including the cost of conversion of the existing equipment and product manufacturing facilities, design, replacement or modifications of used equipment, etc. The key component of this assistance is building the capacity of developing countries to comply with their obligations. Successful transfer of ODS phase out technology is based on building of the required skills.

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The protocol has provided significant net benefits to human health, fisheries, agriculture and building material sectors. Technological innovations have led to creating additional economic and environmental benefits. Studies have shown that, there is a considerable reduction in the incidence of having skin cancers after implementing this treaty alone (see Figure 3). By providing incentives and information in technology sourcing, the protocol has brought non-CFC technology to the front. The ozone layer has begun to recover as a result of these efforts.

Conclusion

Stratospheric ozone layer protects the life on the earth by absorbing harmful radiation coming from the sun and keeps the planet habitable. Ozone depletion has become a global issue since it has significant deleterious effects on human health and ecosystems. The Montreal protocol on substances that deplete the ozone layer has come into force in international level to reduce or effectively eliminate emissions of substances, which have or are likely to have adverse effects on the ozone layer.

Reducing ODS emissions may also bring climatic benefits since most of the ODS are powerful greenhouse gases, which causes climatic changes. Global measures on prevention should be adapted considering this ozone-climatic interaction. The mitigatory measures adopted on ozone depletion can have positive effects on global warming.

The Multilateral fund developed under the Montreal protocol is financed by developed countries to assist developing counties through transferring technology and knowledge. Laws and regulations related to reduction in production and consumption of ODS are operated at country level to comply with obligations given under the protocol. Cooperation among parties in the legal, scientific and technical fields facilitate and encourage the exchange of scientific, technical, socio-economic, commercial and legal information relevant to the protocol.

Protection of the ozone layer with international co-operation will help to make the earth habitable and thus benefits all countries in the world.

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