Ozone: Good and bad

The problems of stratospheric ozone depletion and tropospheric ozone production are mostly due to anthropogenic activities that release manmade chemicals containing millions of tonnes of ozone depleting substances and tonnes of air pollutants.

MD. ABU SAYED

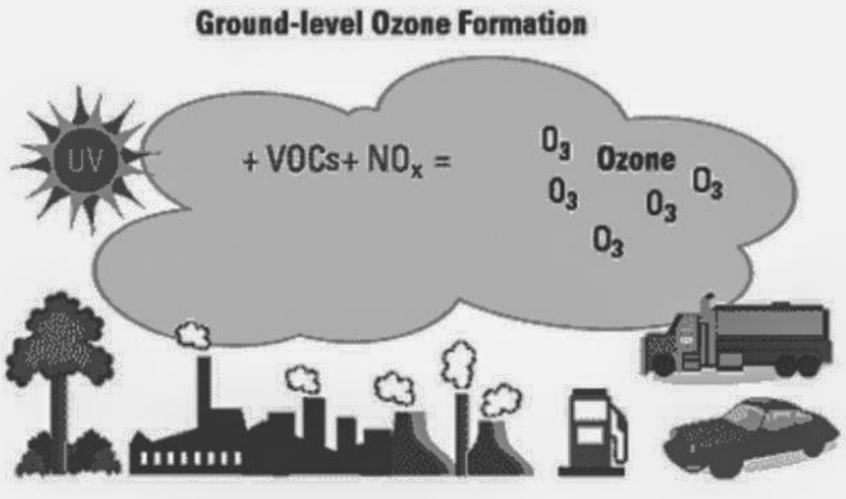
Ozone is a relatively unstable form of molecular oxygen containing three oxygen atoms (O3) and its production occurs in two layers of the atmosphere, i.e. troposphere and stratosphere. It is blue in colour and has a strong odour. The production of ozone in ground level atmosphere (troposphere) is regarded negatively because it comes from pollutants, which result from industrial activities, transport operation and some natural sources. On the other hand, the natural production of ozone in the stratosphere is necessary because it plays a key role in protecting life on Earth from the ultraviolet rays of the sun. The major environmental problems we are facing now is its decreasing level in the stratosphere and the increasing level in the troposphere due to anthropogenic activities.

Stratospheric ozone

Stratosphere is a region of the atmosphere about 15 to 50 kilometres above the Earth's surface and about 90 percent of Earth's ozone production occurs in this layer. In the stratosphere the ozone layer extends from roughly 20 km to 48 km where the concentration of ozone range from about 2 to 8 parts per million. If all of the ozone were compressed to the pressure of air at sea level, it would be only a few millimeters thick. Ozone molecules are constantly created in chemical reactions caused when the ultraviolet radiation from the sunlight strikes the stratosphere.

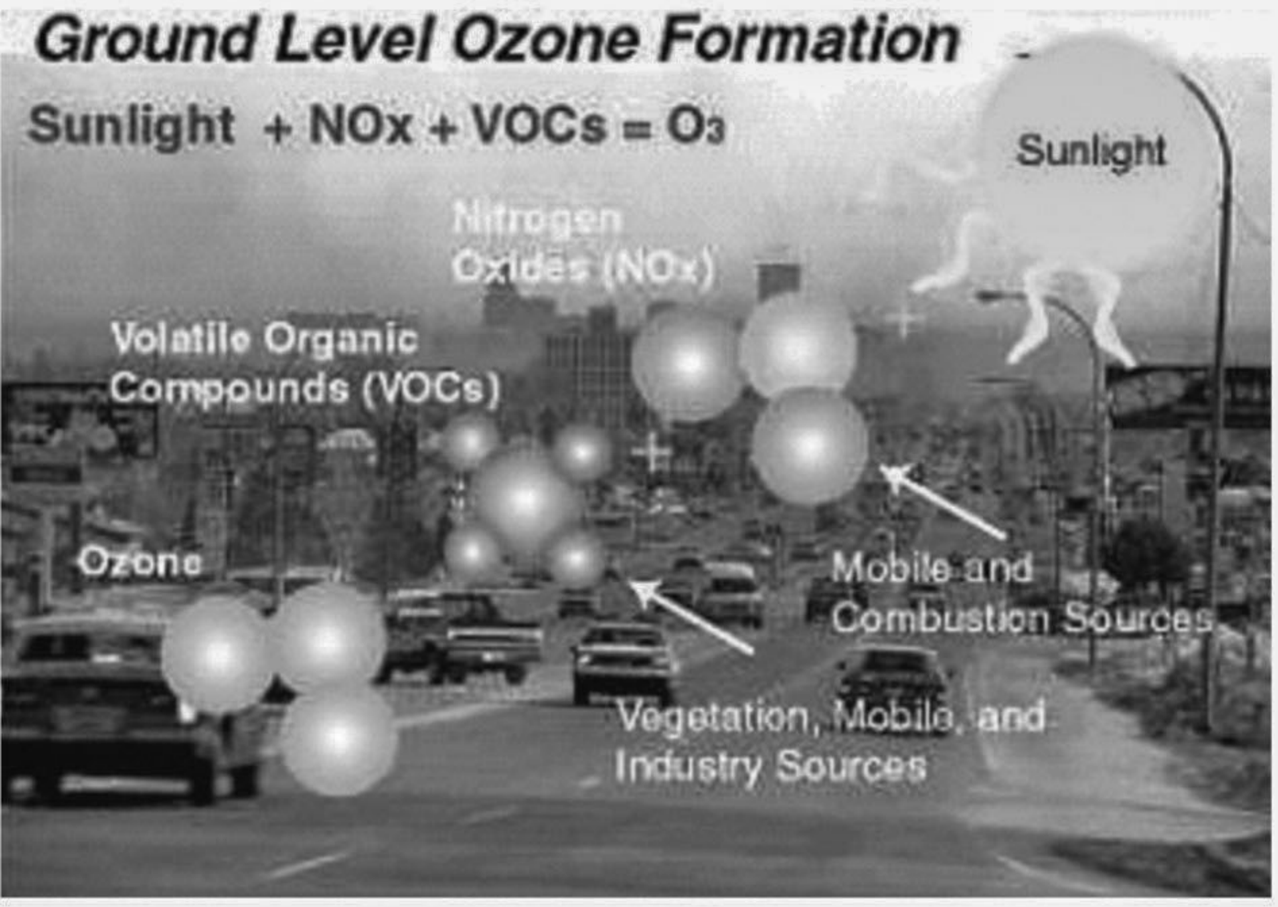
At any given time, the average amount of ozone in the stratosphere remains fairly constant when the creative and destructive forces occur naturally. But this natural ozone has gradually been depleted by various human activities that release ozone-destroying chemicals into the atmosphere. The chemicals released into the atmosphere by industrial activities include chlorocarbon compounds (CCl4 and CH3Cl3), chlorofluorocarbon compounds or CFCs (CFCl3 and CF2Cl2) and halon compounds (CF3Br and CF2ClBr). Most of these chemical substances remain unchanged long enough to drift up to the stratosphere because they are chemically stable compounds containing halogen atoms, i.e. chlorine or bromine.

CFCs are used for a wide variety of industrial purposes, e.g. in refrigeration systems, air conditioners, aerosols, solvents and in the production of some types of packaging, because they are relatively inexpensive, highly effective, stable in the atmosphere and non-toxic to humans. But once CFCs reach the stratosphere, the solar ultraviolet radiation strikes them and release chlorine (Cl), which acts as a catalyst. The chlorine atom repeatedly combines with and breaks apart ozone molecules forming the single oxygen molecule and one chlorine monoxide molecule (ClO). Then, the chlorine monoxide molecule can combine with an oxygen atom to form an oxygen molecule and release the chlorine to begin the process all over again. Through this cycle, one chlorine atom can destroy up to 100,000 ozone molecules and deplete ozone much faster than nature can replace it.



Ozone effectively absorbs the Sun's harmful ultraviolet radiation(i.e. the most energetic ultraviolet light UV-C and UV-B). The protective role of the ozone layer is so vital that life on land probably would not have evolved - and could not exist today - without it.

As the stratospheric ozone layer is depleted, higher ultraviolet radiation reaches the earth's surface and harms human health, freshwater and marine ecosystems, reduces crop yields, and affects forests. The impacts of the increased UV levels include the increasing cases of skin cancers, cataracts, and impaired immune systems; decreasing growth and yields of some crops, such as corn, rice, cotton, beans, wheat, canola, barley, oats and soybeans; decreasing amount of single-celled plants, known as phytoplankton in the ocean, which could ultimately affect fish populations; reducing the construction materials used outdoor.



Tropospheric ozone

Troposphere is located 0-15 km above the Earth, it is known as the ground-level atmosphere layer. The ozone produced in this ground level is known as bad ozone. This ground-level ozone has two major sources, i.e. intrusion from the stratosphere and production from photochemical reactions. The tropospheric ozone plays several key roles in the atmosphere although it oxidises many chemical substances in troposphere. The tropospheric ozone is also a greenhouse gas (GHG) because it absorbs outgoing longwave radiation that contributes to the global warming.

Tropospheric ozone is formed by the interaction of sunlight, particularly ultraviolet light, with volatile organic compounds (VOCs) and nitrogen oxides (NOx), which are emitted by automobiles, gasoline vapours, fossil fuel power plants, refineries, and certain other industries. VOCs are organic compounds that contain carbon and hydrogen and can evaporate easily, e.g. octane, butane and sugar, which are mostly emitted by motor vehicles, vegetation, industry, commerce, dry cleaners, and paints. Nitrogen oxides like nitric oxide (NO) and nitrogen dioxide (NO2) are released into the atmosphere when fossil fuels like oil, coal and natural gas are burned. It is mostly emitted by motor vehicles, power plants, industrial facilities, biomass burning and lightning.

When released into the atmosphere, both VOCs and NOx can produce ozone and other harmful pollutants that lead to smog, which is sometimes called as photochemical smog or photochemical air pollution. One of the main components of photochemical smog is ozone.

The increased ground-level ozone causes harmful impacts on humans, plants, and materials. It may cause human health problems, e.g. eye irritation, breathing problems, lung damage, chest pain, headache or nausea, intensification of asthma symptoms, and increased cardio-respiratory deaths. Also, the ozone can harm plants, trees, and crops by preventing the plant from being able to use the sun's energy by reacting with the molecular links between the carbon atoms (called the carbon-carbon bonds) in the plant's photosynthetic mechanism. Furthermore, ground-level ozone affects materials by deteriorating and reducing the strength of products made of rubber and certain fabrics because ozone is a strong oxidant.

The problems of stratospheric ozone depletion and tropospheric ozone production are mostly due to anthropogenic activities that release manmade chemicals containing millions of tonnes of ozone depleting substances and tonnes of air pollutants. Although CFCs have been banned in many countries and replaced by HCFCs, which do deplete the ozone layer but not as quickly as CFCs.

In order to avoid those harmful effects, a series of international agreements to reduce the pace of ozone depletion in stratosphere and ozone production in troposphere have been held, e.g. the 1985 Vienna Convention on the Protection of the Ozone Layer and the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer, which are arranged to freeze and decrease the production CFC to certain levels. This treaty entered into force on January 1, 1989. It is believed that if the international agreement is adhered to, the ozone layer is expected to recover by 2050.

But the scientific consensus of researchers is that it should immediately stop producing ozone-depleting chemicals. Even with immediate action, models indicate that it will take 50-60 years for the ozone layer to return to 1975 levels and another 100-200 years for full recovery to pre-1950 levels.

The problem of both stratospheric and tropospheric ozone is not easy to solve. Today, the scientists found that the most dangerous, among the many known "enemies" of the O3 layer, is N2O (nitrous oxide), constantly produced by human activities. Its "banning" will surely be more difficult.

The writer is an agriculturalist and environmentalist
Email: asayedmas@yahoo.com

Emission free power projects

If we include the entire Dhaka city and the surrounding industries around Dhaka, it would be possible to generate more than 500 MW electricity by only the solid waste management. This doesn't relate to any big involvement, government can develop a plan to implement in phases by installing small units in different places in and around Dhaka city.

DR. NASIR KHAN

In recent days, Bangladesh is facing serious problem due to the shortage of natural gas supply. Most of the gas wells are old and need renovation and maintenance. Exploration of new wells in a time-taking matter and also needs huge investment. The natural gas is mainly consumed in power generation 55% (including captive) and the other major uses are industries 17%, domestic 11.5% and fertilizer 11% as per Petrobangla statistics, January 2010. There is no possibility of improving the situation quickly and government has stopped giving gas connection to new users. In this crucial situation, we need to plan for alternative energy source for power generation.

Energy from waste is a traditional concept practiced worldwide since long mainly through incineration or gasification which causes huge air pollution. Technology is developing day by day and now emission free waste-to-energy project has been introduced in Europe and America. Bangladesh is still far behind in waste management compared even to the neighbouring countries. For such a big population, we have no planned waste management system in place for the solid waste generated from domestic, industrial and commercial sources. These are creating serious health problem among the people and making the nation puzzled with concerns day after day.

BNL Clean Energy AB (www.bnlce.com), a Swiss company, has developed and patented a new emission free process for producing energy, power and synthetic fuels from most substances containing carbon. This emission free system uses a thermo-chemical process suitable for most organic feedstock containing sufficient carbon such as biomass, chemicals, hazardous waste, municipal solid waste (MSW), oil and its sludge, plastics, rubber, waste tyres, waste water sludge, wood etc. It does not have any CO2 or GHG emissions and causes no harm to the environment.

The process produces valuable energy and products such as electricity and heating or cooling, synthetic fuels (diesel and jet fuel), chemical residues (which are supplied to the chemical industry) and an inert non-toxic ash (which is used as a filler asphalt on tarmac). Since it doesn't produce any flue gas, no complex and expensive flue gas treatment and scrubber are required, which significantly reduces investment and operational costs compared to conventional technologies.

This power plant can be designed for any size from 1-2000 MW capacity. For example, a 10 MW power output project needs 10 MT domestic and industrial waste per hour which also subsequently produces diesel/kerosene and steam as by product. This technology is also suitable for any kind of fossil fuel like natural gas, furnace oil or coal of any nature, by which we can save 30%-40% fuel unlike other traditional fossil fuel fired power plants. Additionally, BNL has other by-products such as steam, heat, biodiesel etc but no emission. At the end, BNL being an emission free project can claim for carbon benefit from UNFCC.

The gas scarcity in Bangladesh is well known now and we need some power projects that consume alternative energy. Government and any big organisation can think for this type of project. We have some big industries (textile, food, paper & pulp etc) which need electric power and steam both for their production process. At this moment, most of them are using gas based captive power plant for power generation and separate gas fired boiler for steam generation. BNL technology is the best solution for them to produce everything from one operation by coal or coal+waste based emission free power plant, which would ultimately supply them electric power, steam, potable water and bio-fuel at the same time.

Bangladesh government is now planning to import power from India or Myanmar, which might not be a good decision since we shouldn't rely on others for anything which is related to the national security and economic growth. We better plan to import coal from India now and install coal based emission free power project and afterwards these plants can be operated by Phulbari coal when the Phulbari coal mine be in operation.

Dhaka City Corporation is responsible for the waste management in an area of 360 sq. km with a population of 8 million which generates an estimated solid waste of 3000 to 4000 tons everyday. Out of which 40-50 percent is disposed of in the landfills and the rest left unattended or locally dumped. There are many areas in Dhaka city not covered by the DCC and the current estimated population in Dhaka City is around 12-15 million. Even considering the DCC's jurisdiction, it is possible to generate 150-200 MW of electricity from this solid waste by this emission free technology as well as significant amount of diesel/kerosene and steam as by-product.

If we include the entire Dhaka city and the surrounding industries around Dhaka, it would be possible to generate more than 500 MW electricity by only the solid waste management. This doesn't relate to any big involvement, government can develop a plan to implement in phases by installing small units in different places in and around Dhaka city. This concept can be replicated for other district and divisional cities in future.

Process flow chart of BNL emission free power project:

1. Feed
2. High temperature pyrolysis
3. Oxidation / Gasification
4. Catalytic conversion to hydrocarbons, with surplus gas recycling
5. Products such as diesel, kerosene or wax
6. Power generation and energy for heating, cooling and/or sea water desalination
7. Residues such as sulfur, phosphorus and heavy metals
8. Inert ash without contaminations or heavy metals

The process is simpler and consumes 40% less space than traditional power project. The project implementation period is 8-20 months depending on the size of the project.

Dr. Nasir Uddin Khan, writes from UK.
Email: nukhan05@gmail.com