ISSN: 2278-4632
Vol-10 Issue-5 No. 3 May 2020

A brief analysis of the cause and effect of tropospheric ozone on the built environment due to Anthropological activities.

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Abstract.

Everything in this universe has a properly allotted place with a specific defined function. It is the same with ozone. The right place for ozone is the stratosphere. Ozone in the stratosphere acts as an atmospheric filter. The adequate blanket of ozone here is vital for life on our planet. Anthropological activities on the ground damage the ozone layer. The thinning of the ozone layer in the stratosphere puts the entire planet at the risk of being subjected to harmful UV (Ultra Violet) radiation. The same ozone at the ground level can pose a huge risk to all forms of life in general and biodiversity in particular. Ozone is formed at the ground level is formed due to anthropological activities. The various activities which cause the formation of this ozone is discussed and presented. The consequences of this ozone formation are enumerated. It is emphasized here that a holistic approach is necessary to address this issue. The human race is the root cause of this problem and unless they become an integral part of any proposed solution the situation cannot and will not improve. Simple, practical and logical mitigation measures are proposed to tackle this problem. If the problem is ignored any further then the sixth extinction of our planet is a mere formality. It is ensured that all the measures proposed are sustainable, Eco-friendly and have the least impact on the environment.

Keywords. : Anthropological activities, Holistic approach and ground level ozone.

Introduction.

Oxygen occurs in three states –monoatomic, diatomic and triatomic. Monoatomic oxygen also termed as “monoxides” have only a single atom of oxygen and are represented as “O”. Oxygen which is prevalent in our atmosphere and sustains all forms of life and is a dioxide is represented as O2 which is a molecule. Ozone which is a trioxide is represented as O3. Among all these three forms of oxygen only the diatomic O2 is safe for humans. Monoatomic oxygen is a critical

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component in many compound like water (H2O) and Ferrous oxide (FeO).However in the gaseous state it can form harmful compounds like Carbon Monoxide (CO).

Definition of ozone.

The word ozone is derived from the Latin word "ozein" which means "smell". It was discovered in 1839 by a German scientist Christian Friedrich Schonbein and is an allotrope of oxygen. The word allotrope is derived from the Greek word "allos" which means "other" and "tropos" meaning "form". Ozone is therefore another form of oxygen.

Composition of ozone.

Ozone is a bluish colored gas .it has a boiling point of -119.5 °Cand a melting point of -192.5 °C. Its atomic weight is 48. At STP (Standard Temperature and Pressure) its solubility is thirteen times more than oxygen. It is fairly unstable in water and its half-life in water is about 20minutes.It is more stable in the air and is a very strong oxidizer.it is pungent and has a very sharp smell.

Formation of ozone.

Ozone is naturally formed by the photolysis of normal oxygen by ultraviolet solar radiation. The UV (Ultra Violet) rays from the sun break up the oxygen atom into two independent atoms of oxygen. The sequence is as follows.O2= O+O. This free atoms of oxygen again bond with the oxygen molecules in the atmosphere as follows. O2+O=O3.This results in the formation of ozone. This process is termed as the ozone-oxygen cycle and it happens continually in the stratosphere. This is also termed as the "Chapman Cycle" in honor of Dr. Sydney Chapman who articulated the chemistry behind this process.

Layers of the earth.

The surface of the earth is known as the lithosphere." Lithos" is a Latin word which means "Rock" and "Sphiria" is a Latin word which means "Globe". This is the hard surface or "terra firma" which is understood as land. Life on the planet is understood in terms of bio-diversity and this area of influence is known as "Biosphere"." Bios "is a Latin word which means "Life". The layer above the earth which has life forms is known as troposphere. The region above it is known as the stratosphere. Most aircrafts are known to fly in the stratosphere.

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Relevance of stratosphere.

This portion of the earth's layer has a layer of gas known as ozone. The IUPAC (International Union of Pure and Applied Chemistry) name for it is Trioxygen. Solar radiation from the sun is an EMR (Electro Magnetic Radiation) and it can pass through any medium. This EMR has a spectrum which ranges from UV (Ultraviolet) to IR (Infrared).the spectrum of visible light happens in between. The visible light comprises of 7 (seven) colors VIBGYOR (Violet, Indigo, Blue, Green, Yellow, Orange and Red).UV is the radiation which happens above the violet band and IR happens below the red band. The stratosphere has a range of influence of about 35km above the troposphere.

The UV radiation from the sun can be further classified into three parts depending on its wavelength. Shorter the wavelength more will be the intensity. UV (A) is designated for wavelengths between 320 and 400nm (Nano meter).UV (B) is designated for wavelengths between 280 and 320nm and UV(C) is designated for wavelengths between 200 and 280nm.The ozone in the stratosphere along with the oxygen present absorb most of the UV (B) and UV(C) radiation and by filtering it ensures that only 2(two) % to 3(Three) % of it reaches the earth's surface.

Disturbing the ozone layer.

Reduction and/or thinning and/or depletion of this vital barrier can result in the strong, energetic and potentially harmful UV radiation reaching the earth's surface without due diligence. The energy from this radiation can have grave and fatal consequences for earth's biodiversity in general and human health in particular.

The relevance of position.

In this universe every entity exists at a particular place, at a particular time and to fulfill a particular function. It's the same with ozone. This gas is of utmost importance in the stratosphere as it acts as an atmospheric filter and controls and/or regulates the UV radiation reaching the earth's surface. The same gas at the ground level in the troposphere can be very harmful and disastrous. The additional atom of oxygen in ozone enhances its oxidation potential .This additional atom enhances and augments combustion, deflagration, conflagration and in certain cases detonation. The constituents of ozone and its properties are the same in the troposphere and

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the stratosphere. Yet while it plays a very vital role in the stratosphere its presence in the troposphere is detrimental to all forms of biotic and abiotic components of the planet.

Thus a gas which in the stratosphere ensures life on the planet can become detrimental to life on the planet at the troposphere.it is therefore prudent to ensure that everything in this universe is at its proper place ,is allowed to perform its designated function and is left undisturbed.

The potential of oxidation.

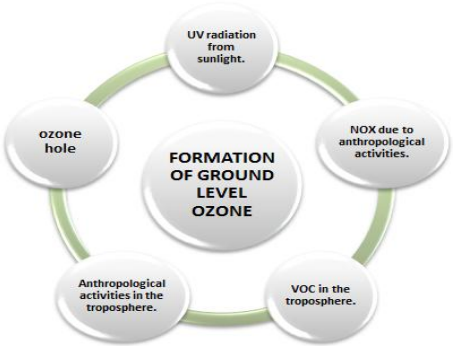
Due to the fact that it has an extra atom of oxygen ozone is a very potent oxidizing agent and can also aid combustion.an oxidant, oxidized or an oxidizing agent is a substance which can get into a reaction with other substances –in terms of chemistry it can easily accept their electrons. This makes ozone a very potent gas and it has the ability to severely affect and eventually destroy and/or annihilate the biotic components of our planet.

Ground level ozone.

The earth's atmosphere comprises of the troposphere, biosphere, and the lithosphere. The tropospheric ozone has an average range of 0-15km from the earth's surface. The desirable level of ozone is about 10-20 ppb (parts per billion).The five main factors which contribute to the formation of ground level ozone beyond the desirable levels are

1. Ozone hole or thinning of the ozone layer in the stratosphere.
2. Anthropological activities in the troposphere.
3. VOC (volatile organic compounds) in the troposphere.
4. NOX in the troposphere due to anthropological activities.
5. UV radiation from sunlight.

This is schematically illustrated in flowchart no-1



Flowchart 1-A schematic depiction of the various parameters which contribute to ground level ozone.
Source. : The author.

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1. Ozone hole or thinning of the ozone layer in the stratosphere.

The thinning of ozone layer was first cited by Joe Farman, Brian Gardiner, and Jonathan Shanklin in May 1985 and the extent of damage was assessed by NASA (National Aeronautical Space Agency).Specific measures to tackle this issue led to the Montreal protocol in 1987.

In order to conceptualize the scales and proportions involved lets imagine the earth to be an apple. The outer skin of the apple is the ozone layer. Just like the slightest disturbance to the skin affects the whole apple similarly the slightest affliction to the ozone layer will affect the entire planet.

Anthropological activities release Halocarbons (Chlorine, Fluorine and Bromine), CFC (Chloro Flouro Carbons) and HCFC (Hydro Chloro Flouro Carbons) into the stratosphere. Although most of these are very stable in the troposphere and considered safe in the stratosphere tend to react with ozone and in the process deplete the ozone layer.

The basic reaction is

$CCL3F + Ultraviolet\ light = Cl + CCl2F$

$Cl+O3= ClO+O2$

$ClO+O=Cl+O2.$

This free chlorine atom the reacts with ozone to generate chlorine monoxide and diatomic oxygen. The free oxygen atom also reacts with chlorine monoxide to generate chlorine and diatomic oxygen. The free chlorine atom once again reacts with ozone and the process goes on. This then becomes an endless cycle. There is actually no hole as such in the ozone layer. It is the thinning of the ozone layer which scientists refer to as an “ozone hole”.

2. Anthropological activities in the troposphere.

The anthropological concept of economics, progress and development is the root cause for generation of ground level ozone. Almost all anthropological activities contribute to this ozone formation in one way or the other. Industries, cleansing agents and motorized forms of transport and are among the major contributors of SOX (oxides of sulphur) and NOX (oxides of Nitrogen).the three main constituents for ground level ozone are NOX, VOC (Volatile organic Chemicals) and UV radiation in the form of sunlight. This is schematically illustrated in Flowchart no.2. In the present situation the ground level ozone formation is almost a continuous cycle.

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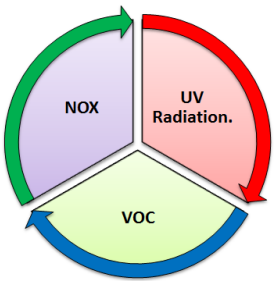

Flowchart 2- The cycle of ground level ozone.
Source. : The author.

3. VOC (volatile organic compounds) in the troposphere.

Volatile can be understood as a rapid, unexpected, and unpredictable change under normal circumstances. The science of anything which works on its own is termed as organic. A combination of elements is called a compound.in chemistry VOC are defined as those classes of organic chemicals which develop a high vapor pressure even at ordinary room temperature. This vapor pressure is developed due to a low boiling point which causes evaporation or sublimation.

VOC can be natural or man-made. The natural sense of smell among all biotic elements is due to VOC.in fact most creatures on this planet use smell as a means of identification and communication. Industrial activities and even daily normal activities like painting release VOC in the air.in fact any and every type and kind of human activity release VOCs in the air.

4. NOX in the troposphere due to anthropological activities.

Almost any and every kind and type of human activity releases NOX in to the atmosphere. The predominant use of fossil fuels as a source of energy is one of the main causes for formation of ground level ozone. Solvents, disinfectants, paintings and surface coatings and all such allied activities contribute to the formation of ground level ozone. The chemical process involved is as follows.

NO_2 + UV radiation (wavelength 280mm-450mm) = NO + O

O+ O_2 = O_3 + an additional molecule of Nitrogen (N_2) or Oxygen (O_2).

5. UV radiation from sunlight.

The energy required for ozone formation is generally UV radiation from the sun. Electrical energy from lightning can also triggers the formation of ozone. The formation of ozone is generally highest during mid-day when the solar radiation is the maximum. UHI (Urban Heat Island) effect in most of our urbanized areas can act as a catalyst for the formation of ground level ozone.

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Popular conceptions and misconceptions about ozone.

It is a popular perception and misconception that ozone is better than oxygen as it's more powerful. Before scientific studies established the presence of ozone it was thought to denote freshness. Ozone was also thought to have a fresh smell and purifying properties.

Primary and Secondary pollutants.

Any substance which aids and abets contamination is termed as a pollutant. "primus" in Latin means "First" and the immediate pollutant formed as a result of any process is known as "Primary Pollutant". Ground level zone is a secondary pollutant as it is formed due to the union of two or more primary pollutants-NOX and VOC.

Earths Metabolism.

The earth is not a static entity but a dynamic one. Heat, pressure, and gravitational pull have resulted in the formation of our planet as we know it today. The difference between the temperature at the core and the surface is very high. This incubates the convection currents in the mantle and core. It also ensures that the inside of the earth is in a constant state of flux and it also ensures regeneration on the surface of the earth. Desertification of the earth's surface due to formation of ground level ozone disturbs this delicate balance as the temperature differentials are reduced.

Asexual Reproduction.

Most of the flora on the earth's surface reproduce asexually –reproduce without direct physical contact. Pollination is one of the key ways for this promulgation. VOC generated by plants and/or animals are the main medium for incubating the force of attraction. Pollution due to anthropological activities depletes and/or annihilates this VOC by using it for the formation of ground level ozone. This affects the cross pollination process and could lead to the depletion of flora. This in turn affects the fauna and the eventually the entire food chain.

Augmented warming.

Formation of ground level ozone leads to the depletion of green cover augments soil erosion and desertification and reduces oxygen levels by using up the available oxygen for ozone formation.

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All these processes augment the heating up of the earth's surface and eventually enhance global warming.

A planet without life.

If anthropological activities continue unchecked and unabated in the present manner the day is not far off when eventually like most planets in our solar system we will also become a planet without life. Ozone in the stratosphere ensures life on the planet while the same ozone 15 miles away in the troposphere ensures annihilation of life. The following image no-1 schematically depicts this paradox.

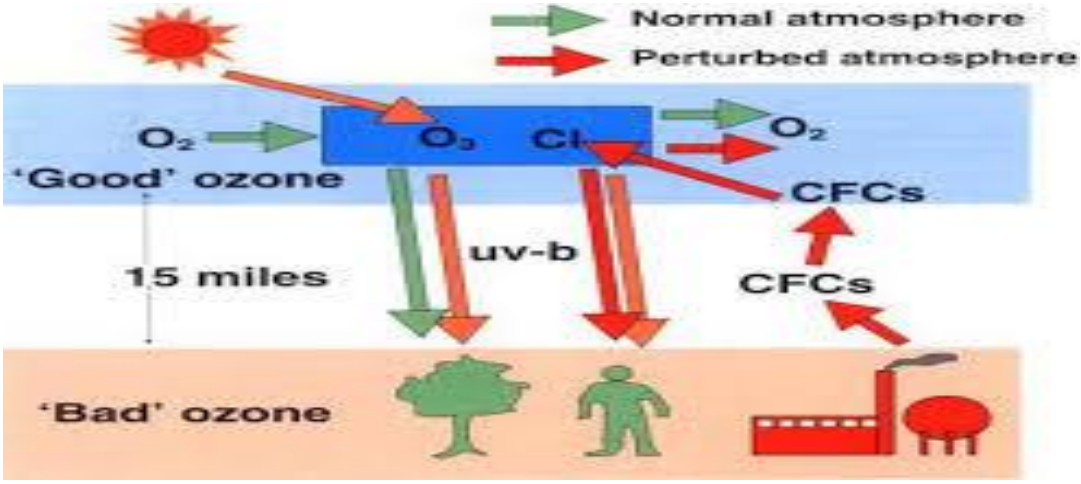

Image 1- A schematic depiction of good and bad ozone.
Source.https://encrypted-tbn0.gstatic.com/images?q=tbn%3AANd9GcQilfenCV4PPmBIk_VkXXMPfb_imZOETDyBkyI6y1RbXWOaFrPX

Disturbing the food pyramid.

GLO (Ground level ozone) affects plants by damaging the leaf openings (Stomata), oxidizing plant tissues and compromising on their ability to perform photosynthesis. Animals and humans are dependent on these plants for food. Certain species of animals are in turn dependent on other animals for their food. Humans are dependent on both plants and animals for their food. Humans are also severely affected by GLO .when their remains are buried in the soil they also tend to contaminate the soil and in the process affect the complete food chain. This ballooning effect is schematically represented in flowchart no-3.

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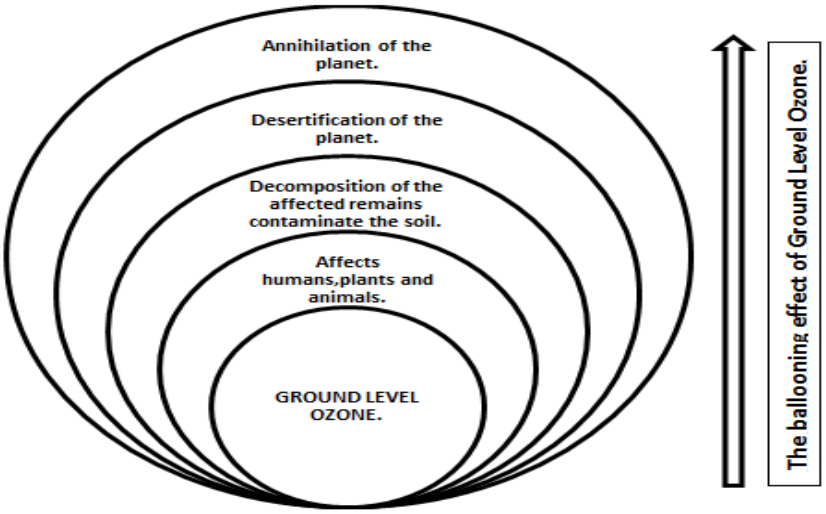

Flowchart 3- A flowchart indicating the ballooning effect of ground level ozone.
Source. : The author.

Cessation of wind patterns.

A concentrated volume of air is termed as wind. About 70(seventy) % of the earth's surface is water and the land mass is about 30(Thirty) %.land mass has a very low specific heat while the water body has a very high specific heat. (specific heat is defined as the amount of heat required to raise the temperature of 1gm of a substance by 1°C).This causes differential heating to the air above and incubates wind movements in the process.

Ground level ozone tends to severely affect biotic and abiotic components and in the process severely affect wind patterns. Enhanced heating of air would lead to rapid and steady evaporation of water bodies and this in turn will make the air dry. Reduction in temperature differentials will reduce movement of air and this would cause a whole set of ecological issues like reduction in cross pollination, depletion of vegetal cover and a host of allied issues.

Enhanced vaporization.

Ground level ozone tends to decimate vegetal growth. This severely affects the process of Evo-transpiration and enhances evaporation from surface water bodies. Precipitation patterns tend to get affected and distorted and in the process the environment and ecology tend to get affected.

Human health, plant health and animal health.

Humans, flora and fauna are an intricate and intertwined part of our fragile and delicate ecosystem. The health of any ecosystem depends on the individual health of each one of these components. A chain is always only as strong as its weakest link. Even if one link weakens the

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entire chain is compromised. Ground level ozone affects all the vital links in this intricate and fragile chain called an ecosystem and also upsets the ecological balance in the process.

Elimination of detrivores and vital micro-organisms.

Ozone is a very strong oxidizing agent and at the ground level can severely affect the various microorganisms .the enhanced heat effect coupled with destroyed vegetation at the ground level can also annihilate the various detrivores which aid in decomposition. This will affect the nutritional quality of the top soil and thus a complete chain of destruction is incubated.

Gas would be the only state of matter.

There are three states of matter –solid, liquid and gas. All these three states seamlessly morph from one phase to another and incubate the various cycles of nature which ensures life on the planet. Ozone being a very strong oxidizing agent would react with every biotic and abiotic component and destroy it. The decomposition of the biotic components would also serve to reduce oxygen levels and act as a catalyst for annihilation of the planet. The excessive heat would melt all solids and turn them in to liquids. These liquids would in turn evaporate to form gases.it would come to a point wherein there would be no solid or liquid state and gas would be the only state of matter.

Solar Dimming.

Formation of ozone at the ground level would reduce the solar insolation at the earth's surface. A good portion of the solar irradiation would also be utilized for the formation of ozone. This gives rise to a phenomenon called solar dimming. Plants would not be able to perform photosynthesis, circadian rhythms would be affected, and a whole host of allied problems would be incubated.

The Way forward.

The root cause of the present predicament is the human lifestyle and economic model which is based on industrialization and consumption. Humans are the major cause of this entire problem. Unless they become an integral part of the solution nothing can and will change.

Conclusion.

Humans by their very presence are becoming a threat to the existence of the very planet which nursed and nurtured them. The absence of an idea to find a solution is termed as a problem. If we create a problem and try to solve it we wind up creating more problems in the process. All we

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need to do is leave the ozone in the stratosphere untouched and not create ozone in the troposphere. Unless there is a paradigm shift in our approach towards our environment the sixth extinction of our planet is a mere formality.

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