

Ozone Depletion

In the present 21st century world, one does not need to say about ultra violet rays, it is the most ignited topic in this era. From the common man to the Academicians, UV rays hold an important place in their debate.

UV rays have been discussed for a long time all around the world especially after the discovery of the hole in the ozone layer in 1990s. The hole meant the approaching slow death of our mother earth. A host of studies on this topic has been undertaken by many people and organizations such as the United Nations, Green Peace, etc.

At the United Nations Conference on Environment and Development (UNCED) in 1992, it was declared under Agenda 21 that there should be activities on the effects of UV radiation. In response to Agenda 21, WHO in collaboration with the United Nations Environment Programme, the World Meteorological Organization, and The International Agency on Cancer Research and the International Commission on Non-Ionizing Radiation Protection set up Intersun, The Global UV Project.

Even when the whole world only speaks about this great calamity that has befallen on our mother earth, it would surely be a great injustice on part of the young generation as this slow killer is growing old with the young generation and they are the one who should live on this earth with this growing menace. Thus taking into consideration of these points, this project has been taken up not only to know about UV rays but also how it affects the bio diversity of our planet and how its effect can be minimized.

Here, this project deals with the above mentioned points. Also the project aims to give a comprehensive picture on the impending disaster that would take place if we be ignorant on this issue.

In 1801, the German Physicist Johann Wilhelm Ritter, found that there is existence of some invisible rays beyond the violet end of the visible spectrum of the light. Those invisible rays darken silver chloride even more efficiently than visible light. This spectra region between visible light and X-rays was found to be more chemically active than visible light, and was named as the ultraviolet region.

Ultraviolet (UV) light is electromagnetic radiation with a wavelength shorter than that of visible light, but longer than x-rays, in the range of 10 nm to 400 nm, and energies from 3 eV to 124 eV.

Effects of UV Radiation on Nature

The effects of UV radiation on earth's ecosystems are not completely understood. Even isolating the effects of UV-A versus UV-B is somewhat arbitrary. Studies have shown that increased UV radiation can cause significant damage, particularly to small animals and plants. Phytoplankton, fish eggs, and young plants with developing leaves are particularly susceptible to damage from over exposure to UV. Solar UV radiation levels are highest during the middle of the day. In total, almost half the daytime the total UV radiation is received during the few hours around noontime. The sunlight reaching us consists of approximately 0.5% of UV-B radiation in terms of radiant energy. Clouds, as well as ozone have a tremendous effect on UV radiation levels. However, cloudy skies generally do not offer significant protection from UV. Thin or scattered clouds can have minor impacts on UV and even, for a short time increase in UV, it would be on a blue sky day by further scattering the radiation and increasing the levels that reach the surface.

- DAMAGE TO MARINE LIFE

The penetration of increased amounts of UV-B light has caused great concern over the health of marine plankton that densely populates the top 2 meters of ocean water. The natural protective response of most chlorophyll containing cells to increased light-radiation is to produce more light-absorbing pigments but this protective response is not triggered by UV-B light. Another possible response of plankton is to sink deeper into the water but this reduces the amount of visible light that they need for photosynthesis, and thereby reduces their growth and reproduction rate. In other words, the amount of food and oxygen produced by plankton could be reduced by UV exposure without killing individual organisms.

- DEGRADATION OF PIGMENTS, POLYMERS AND DYES

Many polymers used in consumer products are degraded by UV light. The problem appears as discoloration or fading, cracking and sometimes disintegration of total product, if cracking has proceeded sufficiently. The rate of attack increases with exposure time and sunlight intensity. It is known as UV degradation, and is one form of polymer degradation. Sensitive polymers include thermoplastics, such as polypropylene and polyethylene as well as special fibers like Aramids. There are several other considerations:

- Ultraviolet levels are over 1,000 times higher at the equator than at the Polar Regions so it is presumed that marine life at the equator is much better adapted to the higher environmental UV light radiation than organisms in the Polar Regions. The current concern of marine biologists is mostly over the more sensitive Antarctic phytoplankton which normally would receive very low doses of UV. Only one large-scale field survey of Antarctic phytoplankton has been carried out so far [Smith et.al _Science_1992]; they found a 6-12% drop in phytoplankton productivity in Antarctica. Since the hole only lasts from 10-12weeks, this translates into a 2-4% loss overall, a measurable but not yet a catastrophic loss.
- Both plants and phytoplankton vary widely in their sensitivity to UV-B. When over 200 agricultural plants were tested, more than half of them showed sensitivity to UV-B light. Other plants showed a small increase in vigor or even negligible effects. Even within a species there were marked differences. For example, one variety of soybeans showed a 16% decrease in growth while another variety of the same soybean showed no effect [R. Parson]. An increase in UV-B could cause a shift in population rather than a large die-off of plants.
- An increase in UV-B will cause a decrease in production of Ozone at lower levels in the atmosphere. While some have hailed the protection offered by this 'pollution-shield'. Many plants have shown themselves to be very sensitive to photochemical smog.

Harmful Effects on Humans

Being the one which commonly affects our health, we usually discuss the harmful effects of UV-B. The consequences of increased exposure of the human body to UV-B radiation will in the first instance be characterized by the physical properties of this type of radiation. UV-B radiation does not penetrate far into the body as most of it is absorbed in the superficial tissue layers of 0.1 mm depth. This limits the primary effects to the skin and the eyes. However, there are also systemic effects. These start with a primary reaction in the superficial layers, but have consequences throughout the body. It is the main cause of sunburn and tanning and it has some influences on the immune system too. UV-B radiation is also the main cause of snow blindness and an important factor in the induction of cataracts. UV-B radiation contributes significantly to the ageing of the skin and eyes and it is the UV-B range that is most effective in causing skin cancer.

- GENETIC

Ultraviolet photons harm the DNA molecules of living organisms in different ways. DNA absorbs UV-B light and the absorbed energy can break bonds in the DNA. Most of the DNA breakages are repaired by proteins present in the cell's nucleus. These may mend the damage or part of the damage. The repair systems may, however, themselves be damaged by increased UV-B exposure. But unrepaired genetic damage of the DNA can lead to skin cancers. In one common damage event, adjacent thymine bases bond with each other, instead of across the "ladder". This makes a bulge, and the distorted DNA molecule does not function properly.

- EFFECTS ON SKIN

"Ultraviolet (UV) radiation present in sunlight is an environmental human carcinogen. The toxic effects of UV from natural sunlight and therapeutic artificial lamps are a major concern for human health. The major acute effects of UV irradiation on normal human skin comprise sunburn, inflammation, erythema, tanning and local or systemic immune-suppression.

1. Sunburn:

One of the most common effects of UV exposure is “erythema” also known as sunburn. Sunburn occurs when skin cells are damaged by the absorption of energy from UV rays. To compensate for this injury, the skin sends extra blood to the damaged skin in an attempt to repair it. Thus, accounting for the redness that is associated with sunburn, the amount of time it takes for sunburn to occur is dependent mostly on the relative amounts of UV rays that are hitting the skin and on a person’s skin type. People with naturally dark skin already have inherently high levels of melanin, and so are able to spend a longer amount of time in the sun before burning. Fair-skinned people don’t have it quite so easy as burning can occur within a relatively short amount of time.

2. Sun tan:

As a defense against UV radiation, the amount of the brown pigment melanin in the skin increases when exposed to moderate (depending on skin type) levels of radiation. This is commonly known as sun tan. The purpose of melanin is to absorb UV radiation and dissipate the energy as harmless heat, blocking the UV from damaging skin tissue. UV-A gives a quick tan that lasts for days by oxidizing melanin that was already present and triggers the release of the melanin from melanocytes. UV-B yields a tan that takes roughly 2 days to develop because it stimulates the body to produce more melanin. The photochemical properties of melanin make it an excellent photo protectant.

Photo dermatoses:

Photo dermatoses are skin diseases where the skin lesions are caused by light. Such lesions may be itching papules, whaling of the skin, fierce reddening and peeling etc. The more sensitive patients cannot even stand one minute of outdoor daylight. In these diseases the UV-B radiation in sunlight is the predominant causative agent. Loss of adaptation of the skin to light appears to be a predominant factor for these diseases.

Premature Ageing of Skin:

Another effect of ultraviolet rays on the skin is premature ageing of the skin. Recent studies have shown that many of the symptoms commonly associated with mere ageing (i.e. wrinkles, loosening of the skin) may instead be related to UV exposure. Even careful tanning kills skin cells, damages DNA and causes permanent changes in skin connective tissues which lead to wrinkle formation in later life. UV-A, UV-B and UV-C, all these can damage collagen fibers and thereby accelerate aging of the skin. Both UV-A and UV-B destroy vitamin A in skin which may cause further damage.

5. Skin Cancer:

9 0% of the skin carcinomas are attributed to UV-B exposure [Wayne] and the chemical mechanism by which it causes skin cancer has been identified [Tevini]. The above named carcinomas are relatively easy to treat, if detected in time, and are rarely fatal.

There are various types of skin cancer. One main class is formed by the coetaneous melanomas, the cancers of the pigment cells. This appears to be a correlation between brief and high intensity exposures to UV and eventual appearance (as long as 10-20yrs) of melanoma.

The other main types are basal cell carcinomas and squamous cell carcinomas, cancers of the epithelial cells. These carcinomas of the skin are sometimes, collectively, called “non-melanoma skin cancers”. For the present example we will deal with these non-melanoma skin cancers. In white Caucasians, the incidence of these cancers ranks high among the various types of cancer. In some populations it is in fact the highest of all. The incidence is lower in more pigmented populations, typically by a factor of 10 or even 100. The mortality rate is low in comparison with that for other types of cancer approximately 1% in areas with good medical care.

The non-melanoma skin cancers are clearly correlated to sunlight. They occur mostly in light-skinned people and then predominantly on skin areas which are most exposed to sunlight, such as the face. In people of comparable genetic background, the incidences are higher in the sunnier geographical areas.

- EFFECTS ON EYES

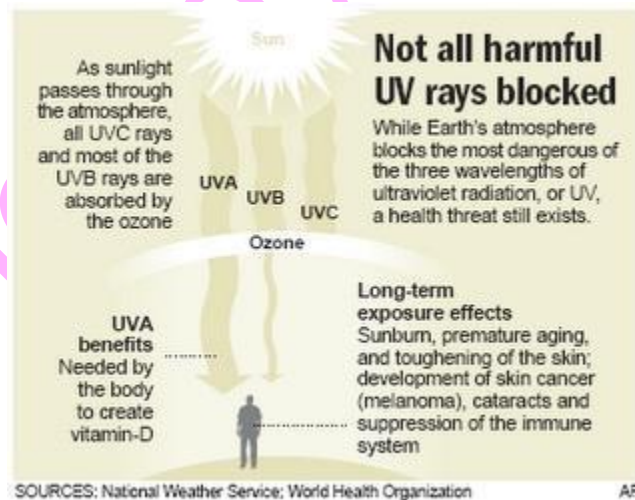
High intensities of UV-B light are hazardous to the eyes and exposure can cause welder's flash (photo keratitis or arc eye) and may lead to cataracts, pterygium, and pinguecula formation. Another possible eye damage that can result from high doses of UV light is particularly to the cornea which is a good absorber of UV light. High doses of UV light can cause a temporary clouding of the cornea called 'snow-blindness' and chronic doses has been tentatively linked to the formation of cataracts. High incidences of cataracts are found at high elevations, Tibet and Bolivia and higher incidences are seen at lower latitudes (approaching the equator). UV light is absorbed by molecules known as chromophores, which are present in the eye cells and tissues. Chromophores absorb light energy from the various wavelengths at different rates – a pattern known as absorption spectrum. If too much UV light is absorbed, eye structures such as the cornea, the lens and the retina can be damaged.

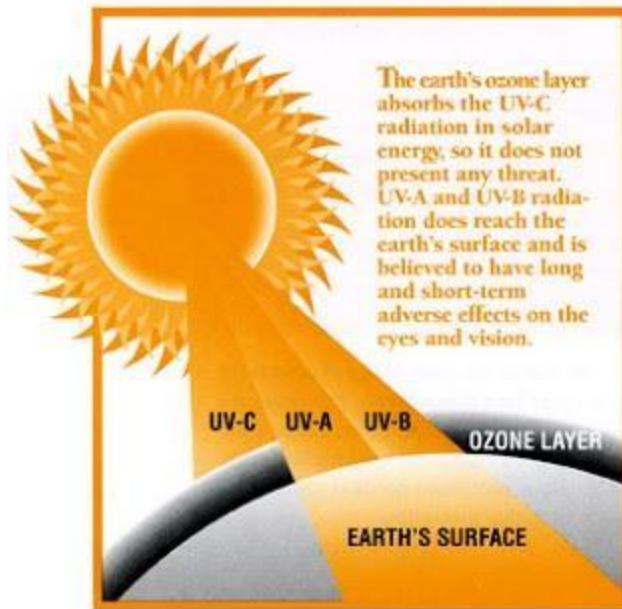
- EFFECTS ON IMMUNE SYSTEM

Prolonged exposure can damage the human immune system. Cells or tissue components which are altered by the radiation may be recognized as foreign material by the immune system and are removed. Certain functions of the immune system are however, suppressed by exposure to UV-B radiation. When skin is exposed to more UV-B radiation then it is accustomed to its ability to adapt.

Ozone Depletion and UV Radiations

Ozone depletion results in an increase of UV-B radiation, but the shorter the wavelength, the stronger the increase within the UV-B range. 1% decrease in the ozone layer will cause an estimated 2% increase in UV-B irradiation; it is estimated that this will lead to a 4% increase in basal carcinomas and 6% increase in squamous-cell carcinomas [Graedel & Crutzen]. Many scientists today believe that this life-protecting stratospheric ozone layer is being reduced by the chlorofluorocarbon (CFCs) gases released into the atmosphere by different sources on the earth. Many environment groups are vehemently protesting against the use of these gases and their use in many places in the world has been banned. Pollution on the earth has already caused a hole in the ozone layer above the Antarctic





CONCLUSION:

Thus we can conclude that UV rays have a disastrous impact on our planet. It will lead to many dangers which would affect not only us but also the entire living community on this earth. UV rays can lead to many unforeseen disasters which can signal the end of life on this beautiful planet.

All the dangers attributed to UV rays reaching our earth reside only on man. Man by his reckless actions has dug graves not only for himself but also for the earth too. It's his only responsibility to restore the earth back to its healthy mode.

Thus, a concerted effort is needed on the side of mankind to quickly address this danger. Steps have to be taken from individual to the international level to protect our earth. From abandoning plastics to decrease the dependence on automobiles, man has to be careful to ensure that he does not push earth to its death. We also need to ensure that we do not create UV rays by machines and their usage must be strongly restricted only to the academic field. Also we need to create awareness among ourselves on the need of the hour to protect life. It's a pity that we try to blame domestic animals for increasing the levels of methane in the atmosphere. What we need to understand is that their methane levels are nothing as compared to our creation of a hole on the ozone layer. Their actions are too small to be compared to our sins.

Being a part of future generation, the student community also needs to be aware about the topic which is a prime reason for me selecting this project. We too should take care not to harm our earth in any way. Always we should remember that "we have not inherited the earth from our fathers but have leased it from our future generations". This alone will make us responsible and be steadfast in our Endeavour to combat the penetration of UV rays.

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