To Show How the Ozone Layer Can Be Destroyed as the Responsibility of Chlorofluorocarbons (CFCS) for this Damage

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Abstract

Ozone is a safeguard for the earth. Ozone protects the earth from a dangerous ultraviolet radiation. The ozone layer has been depleted because of chemicals used by human beings. When the concentration of the ozone layer decreases, the amount of UV light reaching the earth increases. As a result, when the amount of UV light reaching the earth increases the incidence of skin cancer and eye cataracts will increase. Chlorofluorocarbon (CFC) is one of the chemical used by humans that cause ozone depletion. CFCs are man-made chemicals which are used as refrigerants, solvents, foam blowing agents, and outside the United States, as aerosol propellants. Since CFCs are volatile and water insoluble, they can easily escape to the upper atmosphere. Then, they can react with ozone and deplete the ozone layer. Therefore, in order to save the ozone layer from being depleted, we should use other alternative chemicals such as butane and propane.

Introduction

> Ozone in the stratosphere is important to life process on earth. Absorbing some of ultraviolet (UV) light reaching the earth from the sun, it acts as a regulation of the amount of UV light reaching the earths surface. This is important because UV causes sunburn and sometimes skin cancer… effect.
>
> – Larry Parker (2003, p. 3)

Continued depletion of the ozone layer which surrounds the planet may cause lasting harmful effects on the planet in general and living organisms in particular. Identifying the chemical factors that may reduce ozone depletion is important to the survival of life on the planet. An expanded review of relevant research will focus on identifying chemical factors that reduce the concentration of the ozone layer. Current research shows that ozone layer is in fact depleting. According to parker (2003),

> The international scientific community, as represented in the executive summary of the Scientific Assessment of the Ozone Layer--- 1998 state that the appearance of ozone hole during the austral springs has continued

> unabated, with ozone column losses of 40-55% during the months of September and October (p. 4).

A decrease in ozone concentration is a problem worthy of investigation for at least one reason. As the concentration of ozone decreases, the amount of ultraviolet (UV) light reaching the earth increases. As a result, the presence of high amount of UV light in the Earth increases the incidence of skin cancer and eye cataracts. According to Anderson and Sarma (2002), "As ozone is depleted, other factors remaining constant, increased transmission of UV-B radiation endangers human health and the environment, for example, by increasing skin cancer and cataracts, weakening human immune system and damaging crops and natural ecosystems" (p. 2).

Consequently, just by realizing how dangerous the UV light is, reducing the factors that contribute to destroying the ozone layer is vital. As an illustration, in 1985, an ozone hole was discovered over Antarctica by the British Antarctic survey. Many scientists were trying to find the cause of the "ozone hole." Three groups of theories were being anticipated to explain the phenomenon. According to parker (2003),

> The first group, dynamics theories, suggested winds were carrying ozone away from the pole, causing the hole. The second group, solar theories, suggested a buildup of naturally caused nitrogen compounds ("odd nitrogen") destructive to ozone was causing the hole. The third group, chemical theories, (like the Molina/Rowland hypothesis), suggested that man-made chlorine and bromine compounds were causing the hole. (p. 4).

However, current research suggests that chlorofluorocarbons (CFCs) are responsible for the hole, depleting ozone concentration in the upper atmosphere. For instance, Hoffmann (2005) states, "Ozone depletion is caused by a simple reaction of ozone molecules and the chlorine found in a certain class of chemicals , the most important of which are chlorofluorocarbons (CFCs)" (p. 9).

This research paper includes discussion and analysis of relevant research and involves recommendations for future research. Identifying and analyzing the chemical factors that reduce depletion of the ozone layer will serve as the foundation for designing an experimental study in the upcoming academic year that will be implemented in summer 2010.

Purpose and Research Question

The purpose of this paper is to understand the chemical factors that contribute to depletion of the ozone layer. Additionally, this paper helps to better understanding of the effect of the chemicals. This research paper is not about climate change, greenhouse effect, or air pollution. The research question is what chemical factors contribute to ozone depletion. Taken together, answering this research question will contribute to current knowledge on chemicals that deplete the ozone layer.

Significance of the Research

Identifying chemical factors that reduce the concentration of ozone which surrounds the planet is significant for two reasons. First, this is a significant topic for better understanding of the damage that is being caused by the depletion of the ozone layer. For instance, as people become more informed about the damage, it is hope that they will change the behavior to reduce the chemicals that lead to the depletion. Additionally, by realizing the harmful effect of the chemicals causing ozone depletion, the government may ban the production of these chemicals. On other hand, it conform the existing theory about chemicals causing ozone depletion.

Review of the Literature

In addition to explaining chemicals that affect the ozone layer, this chapter addresses several broad areas. First, it explores literature on the ozone layer and its importance for the life processes of the Earth. Then, it covers literature on harmful effects of ozone depletion. Finally, the chapter addresses literature on chemical factors that reduce ozone concentration.

Literature on the Ozone Layer and its Importance

Understanding what ozone means is imperative before studying ozone depletion. As explained earlier, ozone is a molecule composed of three oxygen atoms. Smith (2008) states, "Ozone is formed in the upper atmosphere by reaction of oxygen molecules with oxygen atoms" (p. 449). The equation below shows the synthesis of ozone (O_3) layer below.

$$O_2 + O \rightarrow \mathbf{O_3} + \text{heat}$$

Ozone

As illustration, the name ozone was given by a Swiss chemist. Andersen and Sarma (2002), "In 1840, Swiss chemist Christian Schonbein identified this gas as a component of the lower atmosphere and named it "ozone", for the Greek word *ozien*, 'to smell' " (p.2).

Ozone is one of the important nature's gifts for this world that serves as an earth protector. Ozone acts like a safeguard protecting the earth's surface from destructive ultraviolet radiation. Dessler (2002),

> For wavelengths, between 200 and 300 nm, ozone (O_3) is the primary absorber, and without O_3 much of this radiation would reach the ground. The role O_3 plays in absorbing there photons is crucial because a photon of 250 nm wavelength has an energy of ~5 ev, enough to break chemical bonds in DNA or interfere in other ways with biological processes. (p. 2)

This statement of Dessler indicates that ozone is vital for the life process on earth. The Ozone layer screens the hazardous radiation from UV light.

Literature on Harmful Effects of Ozone Depletion

Numerous studies reveal that human's behavior is the first and the only to be accused for ozone depletion. However, the consequence of ozone depletion continues to affect not only human beings, but also living organisms in general.

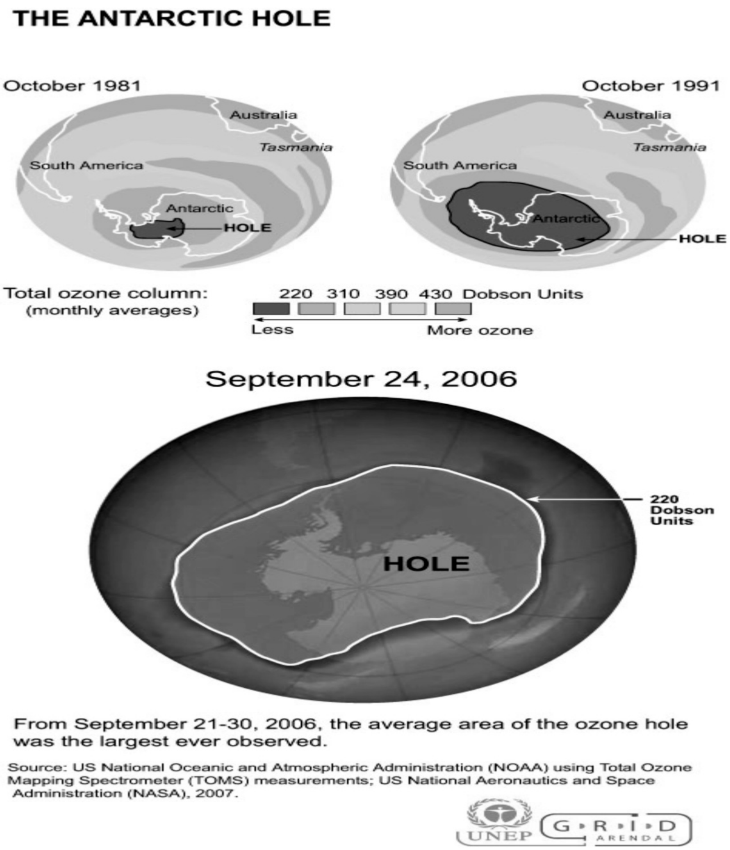
In addition, researches are showing the continuous lost of this protective layer, ozone. Parker (2003),

Ozone losses have been detected in the Arctic winter stratosphere. In early 1995, the WMD reported that, according to data from dozens of northern hemisphere monitoring stations, ozone levels were 10% to 15% below long-term average, with 35% depletion over Siberia. (p. 4).

Parker's statement indicates that the concentration of this essential layer has been reduced. A 35% of ozone layer depletion may allow high amount of UV light to reach to the earth. As mentioned earlier, the presence of high amount of UV light increase the incidence of cancer, eye cataracts, and so on.

In addition, figure 2 shows the size difference between the ozone hole of 1981, 1991, and 2006.

Figure 2



As can be seen in the figure above, the ozone hole increases in size from 1981. As ozone concentration decreases, the amount of UV light reaching to the earth increases. Parker (2003) states, "a review of 14 years of data from the satellite-borne Total Ozone Mapping Spectrometer (TOMS) confirms that , over wide areas, UV-B radiation at the surface increase when ozone levels in the stratosphere decline" (p. 5). Accordingly, an increase in UV light that reaches to the earth would have some immediate and long term consequence. Some of the immediate consequence comprises an increase in the incidence of skin cancer and eye cataracts. On the other hand, some of the long term effect includes a reduced immune response, interference with photosynthesis in plants, and harmful effects on the growth of plankton, the mainstay of the ocean food chain. Hader (1997), "In laboratory studies UV-B radiation affects cellular DNA, impairs photosynthesis, enzymes activity and nitrogen incorporation, bleaches cellular pigments, and inhibits motility and orientation" (p. 12). This statement indicates that without the presence of ozone layer living things do not have long time to live on the Earth.

Hader (1997) says,

> We cannot, for instance, predict with confidence for a given degree of stratospheric ozone depletion, what would be: (a) the increase in skin cancer incidence; (b) the changes in terrestrial ecosystems; (c) changes in oceanic productivity; and (d) changes in CO_2 budgets and cycling. (p. 7)

As mentioned previously, the ozone layer screens out some of the sun's harmful UV light, and therefore, regulates the amount of the UV light that reaches the Earth's surface.

Literature on Chemical Factors that Reduce Ozone Concentration

Many studies signify that, the ozone layer can be depleted by different kinds of chemicals. The chemicals that are found to be the cause for ozone depletion have chlorine and bromine in them. Anderson and Sarma (2002) state, "All ozone-depleting substances controlled by the protocol have common chemical ingredients of chlorine and bromine" (p. 187). However, not all compounds which have bromine and chlorine cause ozone depletion. For instance, Chlorofluorocarbons (CFCs), Methyl Bromide, Methyl Chloroform, Carbon Tetrachloride, and Halon are the most common chemicals which deplete the ozone layer.

Although, there is a lot to say about these chemicals, this research paper will only concentrate on CFCs. CFC is a man-made chemical made up of three elements; carbon, chloride, and fluorine. Andersen and Sarma (2002), "In 1928, Thomas Midgley Jr, an industrial chemist working at General Motors, invented a chlorofluorocarbon (CFC) as a non-flammable, non-toxic compound…" (p. 4).

As a result, since CFCs are non-flammable and non-toxic, they have been chosen over other chemicals and used for many purposes. According to Parker (2003), "cfcs have been used as refrigerants, solvents, foam blowing agents, and outside the united states, as aerosol propellants…" (p. 1).

Nevertheless, beside its good characteristics and inexpensive uses, CFC is listed at the first place for its massive destructive of the ozone layer. Although, the ozone layer is far from the Earth, CFC has the ability to escape into the upper atmosphere and destroy ozone. Smith (2008) states, "because CFCs are volatile and water insoluble, they readily escape into the upper atmosphere, where they are decomposed by high-energy sunlight to form radicals…." (p. 550).

Findings from the Literature and Recommendation for Future Research

This chapter will address the findings from the literature and recommendations for future research.

Findings from the Literature

RESEARCH QUESTION:
What chemical factors contribute to ozone depletion?

Chemicals such as Chlorofluorocarbons (CFCs), Methyl Bromide, Methyl Chloroform, Carbon Tetrachloride, and Halon are the most known ozone depleting chemicals. These chemicals have common chemical ingredients of bromine and chlorine. Although all of the above chemicals contribute to ozone depletion, current research suggests that CFCs are responsible for reducing the concentration of ozone mostly. Hoffmann (2005), "Ozone depletion is caused by a simple reaction of ozone molecules and the chlorine found in a certain class of chemicals, the most important of which are chlorofluorocarbons (CFCs)" (p. 9).

Recommendations for Future Research

Completing such study may help people to: (1) better understand the harmful effect of chemicals that contribute to ozone depletion, especially chlorofluorocarbons (CFC), (2) realize how important the ozone layer is, and (3) have enhanced knowledge of the reaction of CFC and O_3 (ozone) after doing an experiment on the process of ozone depletion.

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