Ozone essay

Ozone (O_3) is a molecule consisting of three oxygen atoms, similar to the oxygen we breathe (O_2), however oxygen consists of only two oxygen atoms. In the stratosphere, a region high up in the upper atmosphere, light rays are responsible for the breaking down of oxygen (O_2), breathable oxygen into its two separate oxygen atoms. Lone oxygen atoms are markedly reactive. When a lone oxygen atom comes into contact with a breathable oxygen molecule (O_2) it combines to form ozone (O_3). The ozone layer is a small residual amount of ozone concentrated in a band in the upper atmosphere. This band of concentrated ozone resides approximately between twenty and forty kilometers high in the stratosphere. The ozone layer reactions that both create and destroy ozone has come into a dynamic equilibrium.

This dynamic equilibrium is very delicate and resulted during atmospheric formation (Environment Canada, 1996). Ozone, however, is very rare even in the ozone layer. Oxygen makes up approximately twenty percent of air and ozone makes up only 3 x 10-5 percent of air. Furthermore, this minuscule amount of ozone is enough to protect the earth from most ultraviolet light. Ozone prevents most UV-B radiation from reaching the surface of the earth (Environment Canada, 1996). Ozone is very important to life on earth because the harmfulness of high-energy UV-B radiation stems from the high energy of these light rays, enabling them to penetrate deeply into water, plant tissue and epidermal tissue of animals. Increased UV-B radiation results in harming the metabolic system of cells and ultimately damage to genetic material present in effected cells.

Living organisms on the surface of the earth have always been exposed to some, and only slightly differing levels of UV-B radiation depending of geographic location and season. Through evolution, cellular repair mechanisms have evolved to safeguard cells against damage done by UV-B radiation. With the increase in the UV-B radiation, more damage is done to cellular functions then the natural protection system can deal with (Environment Canada, 1996). Life on earth would more or less be void if not for the formation of the ozone layer during atmospheric formation (Porter, 1996). With out the ozone layer the harmful UV-B radiation would not allow the growth of autotrophic plants, resulting in reduction in oxygen production; ultimately the destruction of most living organisms on the earth surface would result. Increased UV-B radiation has been linked to many incidence of increased health problems among humans.

UV-B radiation leads to increase skin cancer, eye damage, and possible inhibition of the immune system (Health Canada). These incidence have been noticed in humans, and it is presumed that these problems will occur in other animals as well. Terrestrial plant life is of great vulnerability to increased UV-B radiation, it can cause the destruction of chlorophyll in plant leaves resulting is less growth, and ultimately reduction in crop yields, forest annual increments and a general decline in forest ecosystem health. The UV-B radiation also causes the potential for the decrease in the populations of phytoplankton in the world’s oceans, causing yet more problems when one analyzes phytoplankton in the oceans food chain (Clair, 1996). Humans are responsible for almost all activities and pollutants that deplete the ozone layer.

Humanity has damaged the ozone layer by adding synthetically made molecules containing both chlorine and/or bromine to the atmosphere. Both chlorine and bromine are attributed to ozone destruction. The most commonly know group of these are called CFCs, chlorofluorocarbons. Chlorofluorocarbons are utilized for many industrial and domestic applications. At the earth surface, these molecules remain stable. However, with their release into the atmosphere they are subject to global air currents, winds aloft and atmospheric mixing, causing them to drift up into the stratosphere. Other chemicals such as halons, carbon tetrachloride and methyl chloroform, also attribute to ozone depletion.

However some naturally found molecules in the stratosphere, such as nitrous oxide, also a by product of the burning of fossil fuels, attribute to the break down of ozone (O3). Natural factors include the quasi-biennial oscillation of stratospheric winds which occurs approximately once every 2. 3 years, and the 11 year sunspot cycle. However the observation of the sunspot cycle reveals that the total global ozone levels should not decrease more than one to two percent (Environment Canada, 1996). In the stratosphere such molecules are effected by energetic UV-C radiation. UV-C radiation breaks down chlorine, freeing an atom of chlorine (Cl). Chlorine atoms will react with ozone (O3) by splitting of one oxygen atom to form Chlorine oxide (ClO) and Oxygen (O2).

The Chlorine oxide however will again be broken down into Chlorine and a free oxygen atom to allow the chlorine to continue destroying ozone. One Chlorine atom (Cl) can destroy ten thousand ozone molecules (Environment Canada, 1996). With the identification of the human-produced chemicals that have lead to the destruction of the ozone layer the extent of the threat to stratospheric ozone has been realized. With the emergence of the scientific evidence on the ozone depletion threat, the international community agreed to regulate ozone destructive chemicals, and setup a timetable for their complete phase-out. The 1987 Montreal Protocol, and subsequent London 1990, and Copenhagen 1992 amendments was an agreement that stipulated this timetable. The Montreal Protocol was a monumental achievement in international environmental cooperation and protection.

The Protocol allowed for the refinement of the timetable as the on-going process of scientific understanding on ozone depletion improved, the phase-outs cloud be expedited. In the spring of 1989, eighty countries met in Helsinki, Finland to assess new information. Unanimous agreement to a five point “ Helsinki Declaration”. The Declaration stipulated that all countries join both the Vienna convention for the protection of the ozone layer and the Montreal Protocol, phase out of CFCs by 2000, phase out halons as soon as feasible, commit to the development of alternative environmentally acceptable chemicals and technologies, and make information accessible to developing countries. In 1995, over one hundred and fifty countries had ratified the Montreal Protocol.

In compliance, chlorofluorocarbons, carbon tetrachloride and methyl chloroform production was to be phased out at the end of 1995; methyl bromide is currently scheduled for United States phase-out by 2001; and all hydorchlorofluorocarbons will be phased out by 2030 (Environment Canada, 1993). Environment Canada has implemented a UV index to provide information to the general public on specific UV hazards daily. Constant monitoring, global awareness and the eventual phase-out of all ozone depleting substances are all part of Canada's measures for the protection of the ozone layer. Environment Canada highlights five measures being taken to control Canada's ozone depleting substances: Canada's ozone depleting substance phase-out plan, developed as a result of the Montreal Protocol, has accomplished many of its goals already.

Most new cars with air conditioning manufactured in Canada are now fitted with hydrofluorocarbon air conditioning systems that use HFC-134a (hydrofluorocarbon 134-a). HCFCs and HFCs have been introduced to replace CFCs. On average, HCFCs have about 5% of the ozone-depleting potential of CFCs. Recovery and recycling regulations for ozone depleting substances (not including methyl bromide) are in place in 9 out of the 10 provinces, while Newfoundland and Yukon are in the process of drafting regulations. Guidelines are being prepared in the Northwest Territories. On August 10, 1995, the Zer-O-Zone project was launched at Winnipeg City Hall. The project, which is an initiative of the Sierra Club, is intended to foster public awareness of and support for Manitoba's Ozone Protection Regulation.

Canada has established bilateral agreements for ozone depleting substance technology and information transfer with China, Brazil and Venezuela. A Multilateral Fund has been set up by industrialized countries under the Montreal Protocol to assist developing countries in the phase-out of controlled substances. (Environment Canada, 1996) Acid rain, the widely used term for precipitation acidified by atmospheric pollutants may be either dry or wet deposition. Acid rain is caused by pollutants such as sulphur dioxide (SO_2) and nitrogen oxides (NO_x), these pollutants originate from fossil fuel burning utilities, industrial and automotive sources. In the atmosphere sulphur dioxide (SO2) and nitrogen oxides (NOx) are converted chemically to sulphuric acid and nitric acid respectively. Diluted forms of these acids fall to the earth surface as rain, hail, drizzle, freezing rain, snow or fog (wet deposition), they are also deposited as acid gas or dust (dry deposition).

Normal rain (pH 5. 6) is slightly acidic, but acid rain can be as much as 100 times more acidic (Watt, 1987). With the burning of fossil fuels these chemicals are released into the atmosphere, acidic pollutants may be transported great distances by the prevailing winds, winds aloft and weather systems before being deposited. It is estimated that more than 50% of the acid rain that falls in eastern Canada comes from US. sources (U. S. Environmental Protection Agency, 1991). Natural sources of SO2 and NOx do exist. In comparison though more than 90% of the SO2 and NOx emissions occurring in North America are from human activity. In Canada, the largest sources of SO2 are the smelting or refining of sulphur-bearing metal ores and the burning of fossil fuels for energy.

NOx pollutants are formed during the combustion of fossil fuels in transportation (responsible for 35% of total emissions), industrial processes/fuel combustion (23%), power generation (12%) and other sources (30%) (River Road Environmental Technology Centre, 1991). Of Canada’s total land area, about 4 million km2 or 43% is highly sensitive to acid rain (Hughs, 1991). With little ability to neutralize acidic pollutants eastern Canada is more seriously affected by acid deposition. Eastern Canada being composed of thin, coarsely textured soil (glacial till) and granite bedrock (characteristic of the Canadian Shield) do not have the buffering ability found in the deeper organic soils of western Canada. Further, eastern Canada receives more acidic deposition than any other region in Canada.

Acid rain is a less serious problem in western Canada because of lower overall exposure to acidic pollutants and a generally less acid-sensitive environment. However, the northern parts of Manitoba and Saskatchewan, along with the north eastern corner of Alberta remain in the Canadian Shield region, and are more affected by acid deposition. Acid rain may contribute to declining growth rates and increased death rates in trees. For example, instances of dieback and deterioration have been noted in white birch in southeastern New Brunswick caused by acid fog, and acidic cloud precipitation (Hughs, 1991). High levels of acidic deposition result in the acidification of acid-sensitive lakes, rivers and streams and cause metals to leach from surrounding soils into the water system.

High acidity and elevated levels of metals (notably aluminum) can seriously impair the ability of water bodies to support aquatic life, resulting in a decline in species diversity. Lakes and streams in areas that receive high levels of acidic deposition are currently being monitored to check their acidification status. Over the past decade, 33% of the monitored Canadian lakes showed evidence of improvement, 11% continued to acidify and the rest remained unchanged in acidity (Environment Canada, 1996). Aquatic sensitivity, with respect to aquatic sensitivity classes (high, moderate, low) New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland are among the top six provinces with eighty plus percent of their lakes in the moderate to high sensitivity classes.

Table 1. 0 AQUATIC SENSITIVITY, BY PROVINCE Freshwater Areas in Aquatic Sensitivity High Mod. Low %High/mod. British Columbia 32 44 18 73% Alberta 6 21 70 28% Saskatchewan 37 3 56 42% Manitoba 30 2 38 46% Ontario 34 20 20 73% Quebec 32 8 7 94% New Brunswick 31 49 12 87% Nova Scotia 54 33 19 82% Prince Edward Island 26 56 <1 99% Newfoundland 56 30 4 96% (Union of Concerned Scientists, 1996) In Newfoundland the lack of water treatment in some rural communities has resulted in an increase of potable water acidity. With the use of copper piping for water main use in Newfoundland, acidic water can cause serious problems. The acidity causes the leeching of the copper away from the water main pipe and into the water system causing increased copper content in the water as well as problems dealing with water main leaks and breakage's.

The same problem is evident with the use of asbestos cement pipe. However the leeching of cement away from the pipe allows the release of the asbestos fibers into the water system. Asbestos is carcinogenic, and therefore this problem arises serious health concerns. Human exposure to particulate matter, including sulphate and acidic aerosols, which penetrate deep into the lungs and leads to increased respiratory problems. Recent research indicates a relationship between decreased lung function, increased cardio-respiratory mortality and long-term exposure to ambient acidic aerosols. SO2 and its by-products have been linked with rates of deterioration in building materials, such as cement, limestone and sandstone.

Some of the Atlantic Province's significant historic structures (for example, the Basilica, St. John's) are slowly being eroded by acidic pollutants. A

Canadian Acid Rain Control Program was formalized in 1985 by establishing federal-provincial agreements with the seven provinces east of Saskatchewan. Participating provinces agreed to reduce their combined SO2 emissions to 2. 3 million tonnes per year by 1994. This target was exceeded in 1993. Total eastern Canadian SO2 emissions were 1. 7 million tonnes in 1994, representing a 56% reduction from 1980 levels. In 1991, Canada signed an agreement with the United States for the reduction of SO2 and NOx emissions. Canada's obligations under this agreement include the establishment of a permanent national limit on SO2 of 3. 2 million tonnes by the year 2000 and a 10% reduction in projected NOx emissions from stationary sources by the same year (NB., NF., NS., Departments of Environment, 1991).

In 1995, Canada began to develop a national strategy dealing with acidic deposition and acidifying emissions. Furthermore, the formulation of new deposition objectives for beyond year 2000. The aim is to protect acid-sensitive ecosystems, human health and air visibility in Canada and ensure the achievement of its international commitments. This strategy will be considered by federal and provincial/territorial Ministers of Energy and Environment in 1997 (Ryan, 1996). The Five major environmental pollution sources in Newfoundland and Labrador are : Municipal Sewage Vehicle Emissions Municipal Solid Waste Total Carbon Dioxide (CO2) output Primary Natural Resource Processing Municipal sewage is a problem affecting all the Atlantic provinces. 150, 000 m3 of untreated sewage is discharged daily in to Halifax harbour (Whelan, 1996).

With a common lack of waste treatment in the Atlantic provinces, except PEI. , actions throughout the Atlantic Provinces should be taken. The St. John's harbour is a similar situation to the Halifax harbour. Although St. John's has a smaller population the narrows at the harbour entrance poses problems as well. The tidal current is impeded by the narrows not allowing the waste products to be totally removed from the harbour. The rural areas of Newfoundland although much smaller still remain with no waste treatment facilities. Sediments are contaminated with organic matter, heavy metals, and organic chemicals such as PAHs and PCBs (Whelan, 1996). Primary treatment plants should be facilitated in major population centers around Newfoundland and possible secondary treatment should be explored as well.

Many small rural communities could maintain there present waste disposal into the Atlantic pending proper environmental study to determine if the area can handle the small volume of decomposing waste. However, with population increase sewage treatment plants should be facilitated in these area's, as they should have been many years ago in St. John's, and other major centers in Newfoundland. Vehicle Emissions are not only a Newfoundland problem but a major global problem. The demand for personal transportation is not likely to change in Newfoundland in the future, and national trends show an increase in the number of vehicles on the roads in Canada (Environment Canada, 1996). The main action that must be taken to minimize vehicle emissions are the adoption of vehicle emissions control program in Newfoundland.

This would cause all vehicles on the road to maintain a minimum standard of fuel emission production. High occupancy vehicle lanes and other similar incentives could be implemented. Testing is going on presently in some Canadian cities to encourage ride-sharing and improving fuel efficiency per passenger-kilometer (Maddocks, 1996). Ultimately research into alternative fuels, electric vehicles, hydrogen fuel cells, and radically redesigned light-weight super fuel efficient automobiles suggest that there is significant potential for improving energy efficiency and reducing vehicle emissions. Although this last point is a broad scope for the Newfoundland vehicle emission problem, this problem is global and therefore global cooperation in research is vital to minimizing this problem. Municipal Solid Waste has been on the increase over past decades. In New Brunswick if trends continue the average waste generated per person will be approximately 550 kg by 1997, up from approximately 350 kg in 1967 (Maddocks, 1996).

Solid waste is disposed of in small dump sites, large landfills and by incineration. In Newfoundland there is a relatively large number of screened incinerators. However with the global push to lower atmospheric air pollutants, incineration, although space conducive, also maintains its problems. All three forms of waste management have there problems. With the formation of better landfill design and site choice, landfills are becoming better managed and better contained. In the long term the only way to curb the production in solid wastes is to bring about a reduction of wastes produced. The use of composting is useful in the deposing of organic waste, however with regional composting you again run into the problem of site selection, due to public opposition. The problem of both land and sea persistent litter is also a problem in Newfoundland. A hazard to both aesthetics and marine animals (through entanglement and ingestion).

A reduction is garbage produced per person is ultimately the best way to solve the problem. The national Packaging Protocol calls for a reduction in packaging of 50%, over the 1988 levels, by the year 2000 (Maddocks, 1996). These are the kinds of reduction in produced waste that are beneficial to solid waste management. Total Carbon Dioxide (CO2) output is a combination of home burning of oil and wood for heating, the refining of the fossil fuels for the use in the heating and powering of gasoline engines, and the production of electrical power (Maddocks, 1996). Although Newfoundland power pushes people to use electricity for the use in heat, many people are still using oil in their homes. Surprisingly enough the oil fuelled furnace is more fuel efficient then the oil burning electrical power station supplying St. John’s with its electricity (Dawne, 1996).

In rural areas of Newfoundland many people are heating their homes with wood, this has a very high percentage of carbon dioxide for the relative heat in BTU’s. With the extreme need for a good fuel efficient source of heat during the long Newfoundland winter, it is evident other fuel sources must be explored. With fossil fuels being the cheapest form of heat, economics will play major role in the choices available. There is still room, however, for better fuel efficiency and reduced carbon dioxide emissions. The use of less polluting fuels, such as natural gas should be examined. The economic benefit of finding a cleaner, and cheaper source of heat is extremely important. The full range of environmental and economic impacts over its life cycle (extraction, refinement, and use) needs to be considered, whatever fuel is used.

Primary Natural Resource Processing can be split into two groups with Pulp and Paper Mills and Fish and Food Processing Plants, the Newfoundland Department of the Environment does not include Mining and Smelting in this group of polluters (Whelan, 1996). Pulp and Paper Mills are responsible for the discharge of effluents containing organic wastes and suspended solids to fresh and coastal waters. Effluents from the plants in Newfoundland produce a variety of toxic organo-chlorine compounds, including dioxins and furans. The formation of organic acids, due to the decomposition of wood, particulate matter also poses a problem. The volume of wood waste that is dumped into rivers and bays in Newfounland have caused the formation of toxic carcinogenic fish habitat enviroments (Whelan, 1996).

With new regulatory measures in place the environmental stress on the water ways will be reduced, however, even though sulphur dioxide air emissions have been reduced, noxious odours continue to be an aesthetic problem. The technology has come available in recent years for the use of a closed water system for pulp and paper plants. This system, however is not widely used because of the setup cost. Closed water systems would almost entirely eliminate the noxious odour problem and largely decrease the need to dump effluents into fresh and coastal waters.

The technology is available, once again the problem of the economics behind the production is the main concern. Fish Processing Plants operating in Newfoundland, however drastically reduced since 1992, primarily stress the environment by releasing high-strength oxygen- demanding wastes to the coastal environment. Harmful bacteria in plant effluents, and nuisance odours are also a potential concern. With the moratorium on the cod fishery in 1992, the closure of many fish plants was actually a multifaceted benefit to the environment, both to the areas surrounding the plants and to the cod fishery.

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Acknowledgments: General information and advice provided by the following agencies, in personal communication or from the world wide web are gratefully acknowledged: E. I. Du Pont de Nemours, Wilmington, DE Environment Canada Environmental Protection Service National Water Research Insitute Ontario Ministry of Environment and Energy Global Resources, Union of Concerned Scientists Health Canada Health Protection Branch. National Aeronautics and Space Administration (NASA) Greenbelt, Maryland, USA National Oceanic and Atmospheric Administration (NOAA) Climate Monitoring and Diagnostics Laboratory Boulder, Colorado, USA United Nations Environment Programme World Meteorological Organization Worldwatch Institute Washington, D. C., USA