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Editorial

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Impact of Chlorofluorocarbons on Environment and Climate Change

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Abstract

Hydrochlorofluorocarbons (HCFCs) and chlorofluorocarbons (CFCs) are fully or partially halogenated hydrocarbons that are produced as volatile derivatives of propane, ethane, and methane. They contain carbon (C), hydrogen (H), chlorine (Cl), and fluorine (F). Additionally, the DuPont brand name Freon is a common name for them. Dichlorodifluoromethane, also known as R-12 or Freon-12, is the most typical example. Numerous CFCs have been utilized extensively as solvents, propellants (for aerosol applications), and refrigerants. Under the Montreal Protocol, the production of CFCs has been phased out and is being replaced by other products like hydrofluorocarbons because they contribute to ozone depletion in the upper atmosphere. The tetrahedral symmetry of the carbon bonds in CFCs is similar to that of simpler alkanes.

Keywords: Hydrochlorofluorocarbons; Chlorofluorocarbons

Introduction

The methane-derived CFCs deviate from perfect tetrahedral symmetry because the fluorine and chlorine atoms differ greatly in size and effective charge from hydrogen and from one another. Changing the number and identity of the halogen atoms can alter the physical properties of CFCs and HCFCs. They are volatile in general, but less so than their parent alkanes. The halides' molecular polarity, which causes intermolecular interactions, is responsible for the decreased volatility. As a result, while fluoromethanes boil between 51.7 (CF2H2) and 128°C (CF4), methane boils at 161°C. Because chloride is even more polarizable than fluoride, CFCs have even higher boiling points. The CFCs are useful solvents due to their polarity, and their boiling points make them suitable for use as refrigerants. Because they contain fewer C-H bonds and, in the case of chlorides and bromides, the released halides quench the free radicals that sustain flames, CFCs are significantly less flammable than methane. CFCs have densities that are higher than those of their alkane counterparts. In most cases, the number of chlorides and the density of these compounds are inversely correlated. Due to their low toxicity, reactivity, and flammability, CFCs and HCFCs are utilized in numerous applications. The majority of permutations of hydrogen, chlorine, and fluorine based on methane and ethane have been commercialized. In addition, numerous examples are known to contain bromine-containing related compounds and a greater number of carbon atoms. Refrigerants, blowing agents, aerosol propellants for medical applications, and solvents for degreasing are some of the uses. As a precursor to tetrafluoroethylene, the monomer that is transformed into Teflon, billions of kilograms of chlorodifluoromethane are produced annually.

CFCs' effects on the atmosphere go beyond their role as ozone-depleting chemicals. The earth's atmosphere is kept warm at that wavelength by infrared absorption bands. CFCs and other unreactive fluorine-containing gases like perfluorocarbons, HFCs, HCFCs, bromofluorocarbons, SF6, and NF3 create a "super" greenhouse effect because of the strength of CFC absorption bands and the unique susceptibility of the atmosphere at wavelengths where CFCs (indeed all covalent fluorine compounds) absorb radiation [1-5].

Discussion

This "atmospheric window" absorption is intensified by In contrast, the low concentration of CFCs allows their effects to increase linearly with mass, so chlorofluorocarbons are greenhouse gases with a much higher potential to enhance the greenhouse effect than CO_2. Because CO_2 is close to saturation with high concentrations and few infrared absorption bands, the radiation budget and consequently the greenhouse effect have low sensitivity to changes in CO_2 concentration; the increase in temperature is roughly logarithmic. To lessen their impact on the environment, organizations are actively disposing of old CFCs.

Due to their damaging effects on the ozone layer, the use of CFCs has been tightly regulated since the late 1970s. James Lovelock was the first to detect the widespread presence of CFCs in the air after developing his electron capture detector. He discovered a mole fraction of 60 ppt of CFC-11 over Ireland. Lovelock continued his self-funded research expedition in 1973 and measured CFC-11 in the Arctic and Antarctic. He found the gas in each of the fifty air samples he collected and concluded that CFCs are not harmful to the environment. However, the experiment yielded the first useful information regarding the presence of CFCs in the atmosphere. Sherry Rowland and Mario Molina discovered the damage caused by CFCs after hearing a lecture on Lovelock's work and starting research, which led to the first publication in 1974 suggesting a connection. It turns out that one of the most appealing characteristics of CFCs-their low reactivity-is the key to their most harmful effects. Because of their lack of reactivity, CFCs have a lifespan that can exceed 100 years, which gives them time to diffuse into the upper stratosphere. Once in the stratosphere, the sun's ultraviolet radiation is strong enough to break the C-Cl bond homolytically. CFCs and aerosol propellants were outlawed by the EPA in 1976 as part of the Toxic Substances Control Act. To address stratospheric ozone depletion, broader regulations enacted by the EPA under the Clean Air Act replaced this later. By 1987, diplomats in Montreal had drafted the Montreal Protocol, which called for a drastic reduction in the production of CFCs, in response to a significant seasonal depletion

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of the ozone layer over Antarctica. By the end of the century, 12 nations of the European Community had agreed to prohibit the production of all CFCs. When diplomats met in London in 1990, they decided to call for the complete elimination of CFCs by the year 2000, which would significantly strengthen the Montreal Protocol. CFCs ought to have been completely eliminated from developing nations as well by 2010.

Prices for CFCs have skyrocketed as a result of the fact that recycling is the only source available to countries that have signed the treaty. The smuggling of this material should also come to an end if production is stopped worldwide. However, the United Nations Environmental Programme (UNEP) identified current CFC smuggling issues in a 2006 report titled "Illegal Trade in Ozone Depleting Substances." Between 16,000 and 38,000 tonnes of CFCs, according to UNEP estimates, were traded on the black market in the middle of the 1990s. According to the report, between 7,000 and 14,000 tonnes of CFCs are smuggled into developing nations annually [6-9].

Conclusions

The countries in Asia that engage in the most smuggling are Seventy percent of the world's CFC production was found to come from China, India, and South Korea as of 2007. South Korea later outlawed CFC production in 2010. Other possibilities for why CFCs were still being smuggled were looked at as well: According to the report, many products that produce banned CFCs have long lifespans and continue to function. Sometimes, replacing these appliances with ones that are better for the ozone is less expensive than buying new ones. Furthermore, because CFC smuggling is not regarded as a significant problem, the perceived penalties for smuggling are low. Since about 2012, an unknown location in east Asia has been producing an estimated 13,000 metric tons of CFCs annually in violation of the protocol. Although the eventual phaseout of CFCs is likely, efforts are being made to stop these current non-compliance issues.

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