Environment Canada
Environmental Protection Service

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Service de protection de l'environnement

Chlorofluorocarbons

What are cholorofluorocarbons?

Chlorofluorocarbons (CFCs) are a group of chemicals composed of chlorine, fluorine, carbon and, in some cases, hydrogen. These were the gases used at one time in aerosol spray cans. Their use for this purpose is now largely prohibited, but CFCs continue to be used in industry.

The compounds most widely used in Canada are known as CFC-11, CFC-12, CFC-22, CFC-113, CFC-114 and CFC-115. Others may be used in small quantities for highly specialized purposes. At normal temperatures and pressures, some chlorofluorocarbons are liquids and some are gases. They are useful to industry because in general they are inert — that is they do not in normal circumstances, when mixed with other substances, react and form fresh compounds. Thus they are nonflammable, nonexplosive and nontoxic.

Another valuable characteristic is that in their gaseous state they conduct heat very slowly — CFC-11, for instance, is three times as good an insulator as air.

What are they used for?

The useful properties of chlorofluorocarbons have led to a steady increase in their commercial and industrial uses. Their most familiar use in the early seventies was in the ordinary aerosol spray can. The CFCs (usually a mixture of CFC-11, CFC-12 and CFC-114) are added to the compound to be applied, such as deodorant or insecticide, and stored under pressure. The CFCs supply the propellant force to drive the contents out of the can.

The most common aerosol uses of CFCs in the mid-seventies were as propellants for deodorants, antiperspirants and hairsprays, but they were also used to apply insecticides, oven cleaners, some drug products, paint and non-stick coatings for cookware. In 1974, the peak year for production of CFCs, aerosols accounted for about half of CFC use. Since then the use of CFCs in aerosols has declined, but the non-aerosol use of CFCs has grown steadily.

The most rapidly growing industrial use of CFCs is in the manufacture of polyurethane foams. It is CFC-11, captured in the cells, that contributes to the insulation value of the product. CFCs are also used in certain polystyrenes and, to a lesser extent, in other types of foams. In refrigeration, ammonia has largely been replaced by CFCs, which are safer. CFC-113 is useful as a solvent and cleaner.

Minor uses of CFCs include fast-freezing, sterilization and fire extinguishing.

In 1974, world production of the principal chlorofluorocarbons, CFC-11 and CFC-12, was 812 000 tonnes. By 1978, production had decreased to 655 000 tonnes. Nearly 90 percent of production was released into the environment the same year.

How do they react with the environment?

Initially, it had seemed that CFCs were the ideal, environmentally safe gas. But in 1973, scientists began to question this. Laboratory tests showed what happens.

On release, the CFCs rise through the atmosphere until reaching the stratosphere. In this zone, 10 to 50 kilometres above the earth's surface, air pressure is low, sunlight is strong and the hitherto inert CFCs break down and form new compounds with other gases. Research has shown that 100 to 120 different chemical reactions take place. The chlorine from the CFCs interacts with the ozone, and the net result is a partial depletion of the stratospheric ozone layer.

There have been a number of studies of the problem; the scientific consensus is that if CFCs continue to be released at the mid-seventies rate, ozone in the stratosphere will continue to be depleted until it stabilizes at 83.5 to 87 percent of its otherwise natural strength, early in the next century. This depletion would occur throughout the stratosphere; it would not, for instance, be localized over those areas where CFCs are released.

A reduction in stratospheric ozone would lead to an increase in damaging ultraviolet (DUV) rays from the sun that reach the surface of the earth. At present DUV rays are largely screened out by the ozone layer in the stratosphere. A 16 percent reduction of ozone would produce about a 44 percent increase in DUV rays at ground level in southern Canada.

What dangers do they pose?

Ultraviolet rays can damage deoxyribonucleic acid (DNA), the genetic material in living cells. An increase in DUV rays would threaten human health, plants and marine life.

Popular opinion notwithstanding, sunbathing confers no physical benefit on human beings other than an increase in bodily vitamin D, which can more conveniently be ingested in the diet. On the other hand, there is a strong association between sunbathing and skin cancer. Skin cancer is common among light-skinned people, and it is becoming more so. Medical scientists believe that the DUV rays in sunlight are the dangerous factor.

At least one in 15 Canadians will suffer during his or her lifetime from some form of skin cancer. Most forms of skin cancer are not dangerous if treated medically, although in certain cases it is disfiguring and expensive to treat. Malignant melanoma, however, is a form of skin cancer that can be fatal, and indeed deaths from this cause have doubled between 1950 and 1975 with the trends towards sunbathing and lighter clothing.

According to a scientific assessment, by the U.S. National Academy of Science, a 44 percent increase in DUV rays that reach the ground is expected to produce a 64 percent increase in skin cancer. There were 331 deaths from malignant melanoma in Canada in 1978, although it is not known how many of these resulted from ultraviolet radiation.

Many small creatures that live in the top layers of oceans and lakes are known to be susceptible to any increase in ultraviolet radiation. These species provide food for larger fish and animals; the effect on the marine ecosystem of increased ultraviolet rays is not fully understood.

About 20 percent of plant life seems susceptible to ultraviolet radiation, and an increase would reduce yields of some crops, unless resistant strains could be bred.

There is some evidence that release of CFC-11 and CFC-12 reinforces the so-called greenhouse effect caused primarily by higher concentrations of carbon dioxide (CO_2) in the environment that result from burning oil and coal. The CO_2 permits the sun's rays to strike earth, but traps some infrared radiation that naturally would escape earth. This infrared energy remains as heat, slightly increasing the temperature of the atmosphere.

What needs to be done?

The environmental build up of CFCs is a world-wide problem, to which this country contributes only two percent. Nevertheless, in 1976 the Canadian aerosol industry agreed to reduce its use of CFCs by half; in fact this objective was surpassed, partly because consumers learned of the problem and turned to alternatives.

On May 1, 1980, regulations came into effect banning the use of chlorofluorocarbons as propellants in antiperspirant, deodorant or hairspray aerosols. A socio-economic analysis by Environment Canada found that this action would have a moderate effect on industry and little if any cost increase to the consumer and society at large, inasmuch as alternative propellant gases are actually cheaper. The main drawback to the alternatives is that they are flammable; hairspray lacquer is flammable anyway, but the change does introduce an extra hazard into the home.

Environment Canada in 1979 began a study of non-aerosol uses of CFCs, which should be completed in 1981. It will then be possible to devise ways of further reducing the release of CFCs.

Chlorofluorocarbons do not pose an immediate environmental threat, but the right action today will prevent them from becoming a danger to future generations of all earth's inhabitants.