The Impact of Using CFCs

What is the ozone layer?

The **ozone layer** is a portion of the stratosphere (upper atmosphere). It contains the gas ozone (O_3) which absorbs ultraviolet (UV) radiation emitted from the Sun.

There is strong evidence that UV radiation is harmful. Scientists believe that it causes skin cancer and cataracts, and can also damage plants and microorganisms.

In the late 1970s and early 1980s, scientists noticed that the ozone layer was being depleted.

How did scientists link CFCs to ozone depletion?

By the 1960s, CFCs were widely used in refrigerators, aerosol cans, cleaning products and in the manufacture of foam.
As non-toxic, unreactive chemicals, they were thought to pose no dangers.

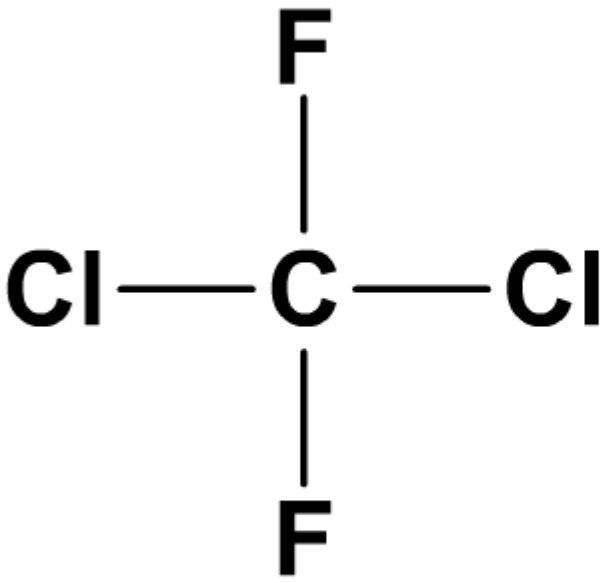
Click "**start**" to find out how scientific understanding of CFCs in the environment changed.

start

How do CFCs form free radicals?

CFCs contain strong covalent bonds. This means that they are usually very inert (unreactive).
But what happens when CFCs reach the upper atmosphere?

Click "**play**" to find out.



How do CFCs react with ozone?

The chlorine free radical is actually a chlorine atom. It is extremely reactive because it has seven outer electrons – one short of a full shell.

Chlorine free radicals react with ozone:

$$Cl\bullet + O_3 \rightarrow ClO\bullet + O_2$$

The reaction produces another free radical species: ClO•. This can also react with ozone:

$$ClO\bullet + O_3 \rightarrow Cl\bullet + 2O_2$$

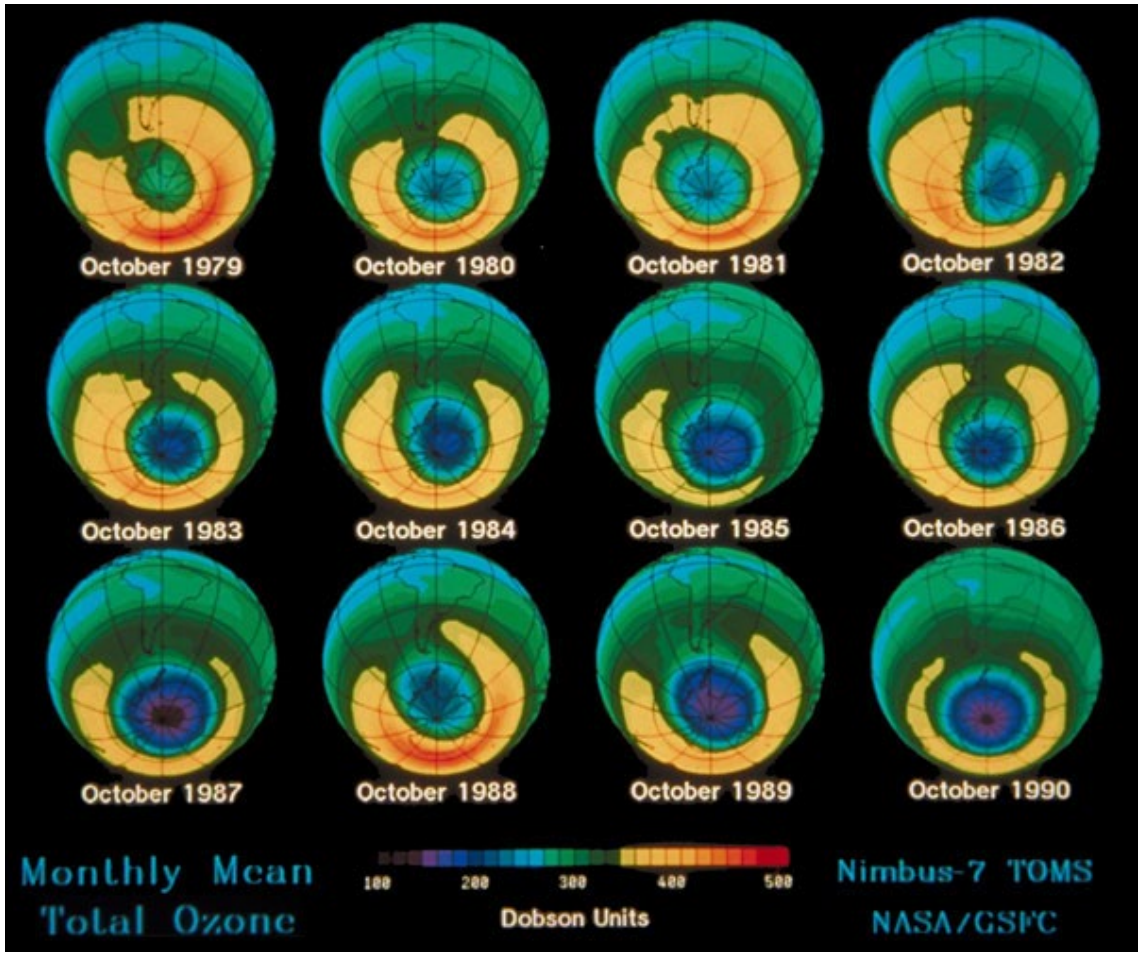
This process forms a **chain reaction**: chlorine free radicals are used up in the first step, but then reproduced in the second step.

CFCs and chain reactions

Chlorine free radicals are regenerated in the second step of the chain reaction, therefore a single chlorine radical can destroy 100,000 ozone molecules.

This image shows the amount of ozone over Antarctica. Dark blues and purples indicate low levels of ozone.

How has the ozone layer changed?

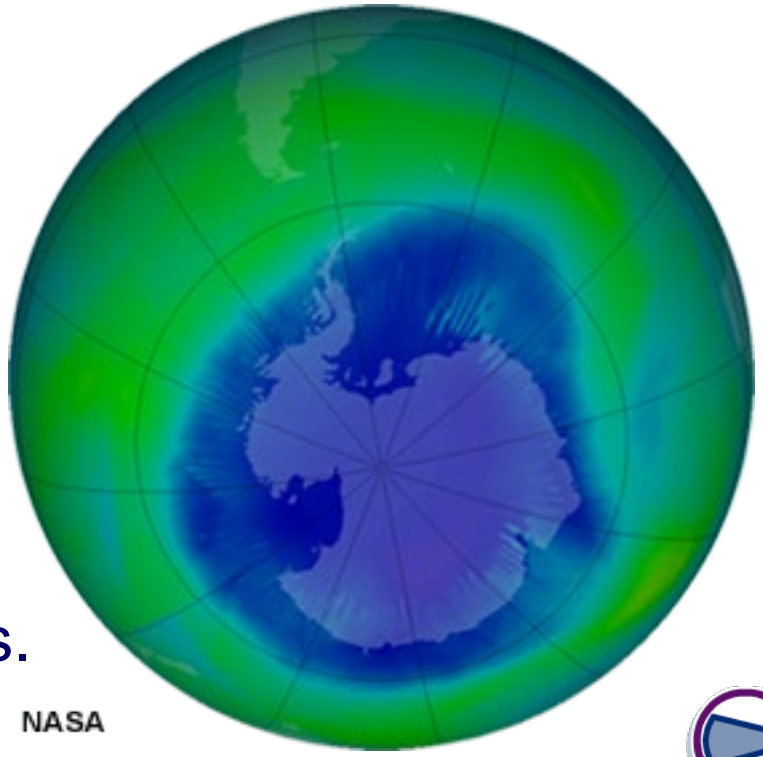


Is ozone depletion slowing?

In the 1980s, scientists discovered that ozone was being destroyed by the chlorofluorocarbons (CFCs) widely used in aerosols and refrigerators. CFCs can stay in the environment for 50 years, destroying ozone long after they are produced.

However, international regulations to reduce CFC emissions may be helping to repair the ozone layer.

Studies in 2006 showed that the hole in the ozone layer is not getting bigger. It is possible that if CFCs remain banned, the ozone layer could return to previous levels.



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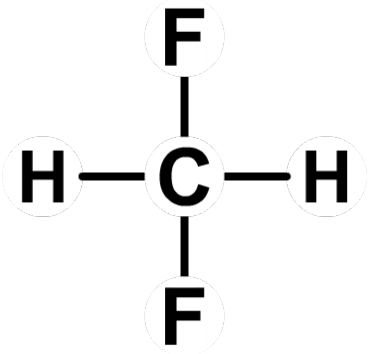
What are the alternatives to CFCs?

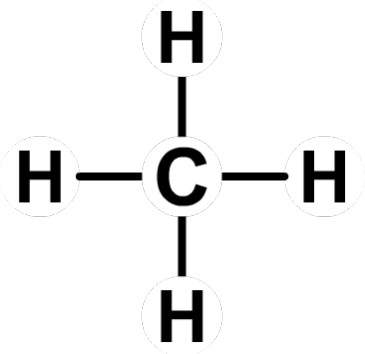
Two families of compounds are now used in place of CFCs:

- hydrofluorocarbons (HFCs)
- alkanes.

These compounds do not contain chlorine atoms, so cannot release chlorine free radicals into the atmosphere.



difluoromethane



methane

However, both these families of compounds are powerful greenhouse gases.

Voting activity: replacing CFCs

Should CFCs be replaced with HFCs and alkanes?

Over the course of 100 years, a single alkane molecule has the same effect on the atmosphere as 10 CO_2 molecules. Each HFC molecule has the same effect as 1000 CO_2 molecules.

0 yes

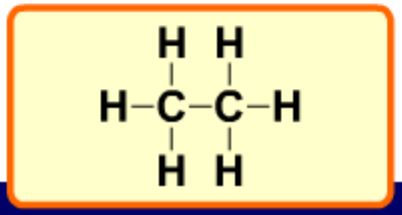
0 no

0 unsure

CFC, alkane or HFC?

Are these molecules CFCs, alkanes or HFCs?

CFC	alkane	HFC



solve

CFCs: true or false