

Periodic graphics

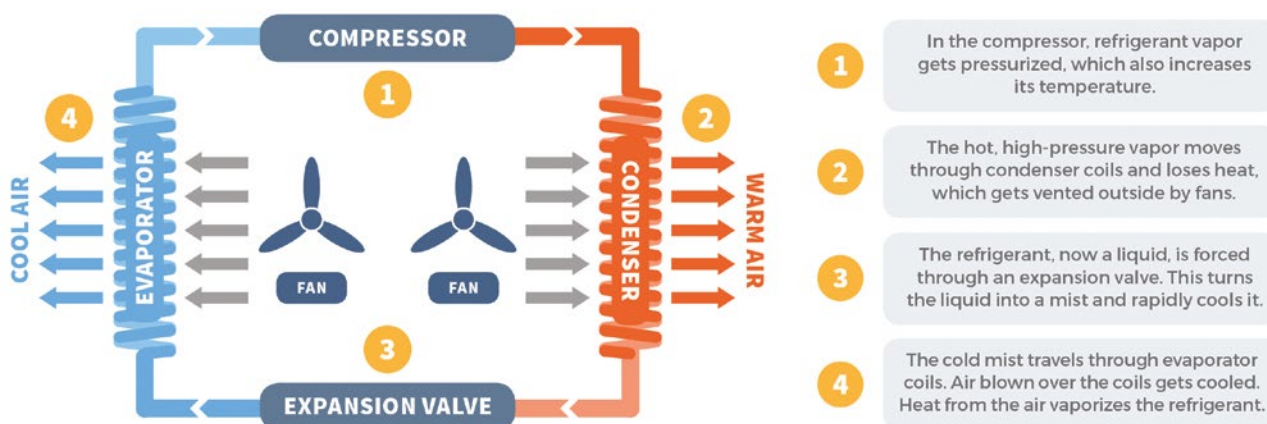
A collaboration between C&EN and
Andy Brunning, author of the popular
graphics blog **Compound Interest**

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Bunning's work, go to
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THE CHEMISTRY OF AIR-CONDITIONING

Air-conditioning units can help you beat the heat on a hot summer day. Here, we take a look at how these systems work and the changing refrigerant compounds that help the units blast cool air.



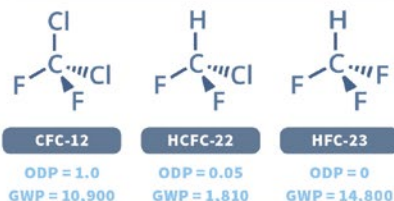
CURRENT REFRIGERANTS

Chlorofluorocarbons (CFCs) were discovered in 1928 and replaced more toxic refrigerants such as ammonia, methyl chloride, and propane.



In the upper atmosphere, ultraviolet radiation triggers reactions with CFCs that produce chlorine atoms, which destroy ozone. A 1987 international agreement, the Montreal protocol, required CFC production to stop. Hydrochlorofluorocarbons (HCFCs), used as CFC replacements, will be phased out in coming years.

Hydrofluorocarbons (HFCs) have replaced CFCs and HCFCs. These replacements do not contain chlorine atoms, so they pose no harm to the ozone layer.

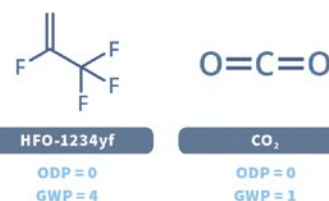


ODP = ozone depletion potential (scale 0–1.0)
GWP = global warming potential (CO₂ = 1)

HFCs have a higher global warming potential than CFCs and HCFCs. As a result, a 2016 amendment to the Montreal protocol plans a phaseout of HFCs.

THE NEXT GENERATION

Hydrofluoroolefin (HFO) refrigerants could replace HFCs. They have a lower global warming potential, but they are also more expensive.



Some car air-conditioning units use HFO-1234yf. But scientists are concerned that it is flammable, so some manufacturers are using carbon dioxide instead. Some experimental systems in development do not use any refrigerant gases to cool air.



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