

The Fluorocarbon-Free Option for the sake of the planet

Natural Refrigerant-Based Refrigerators and Air-conditioners



Ministry of the Environment



Ministry of the Environment
JAPAN

The Fluorocarbon-Free Option

The Fluorocarbon-Free Option - for the sake of the environment

Climate change has become a serious problem. To help solve this problem, we have the option to purchase products that do not use fluorocarbons, "Fluorocarbon-free products"

What are Fluorocarbons?

Various types of fluorocarbons are used in various applications

Fluorocarbons are composed of Fluorine and Carbon. Fluorocarbons have many advantages such as being hard to burn, chemically stable, easy to liquefy and safe to humans. Because of this, they have become used widely as refrigerants, which carry heat in air-conditioners, mobile air-conditioners, refrigerators, vending machines, drinks coolers, freezer showcases and water coolers. They are also used as foam agents for insulation, cleaning agents for semiconductors and precision components and propellants for aerosols such as air dusters. There are many types of fluorocarbons; the first type was CFCs, followed by HCFCs and then HFCs.

Types of Fluorocarbons

- CFCs (Chlorofluorocarbons)

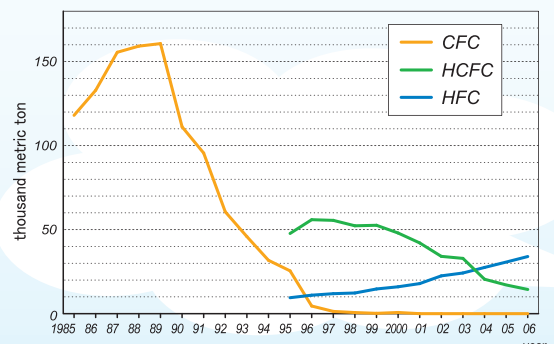
Compounds of Carbon, Fluorine and Chlorine

- HCFCs (Hydrochlorofluorocarbons)

Compounds of Carbon, Fluorine, Chlorine and Hydrogen

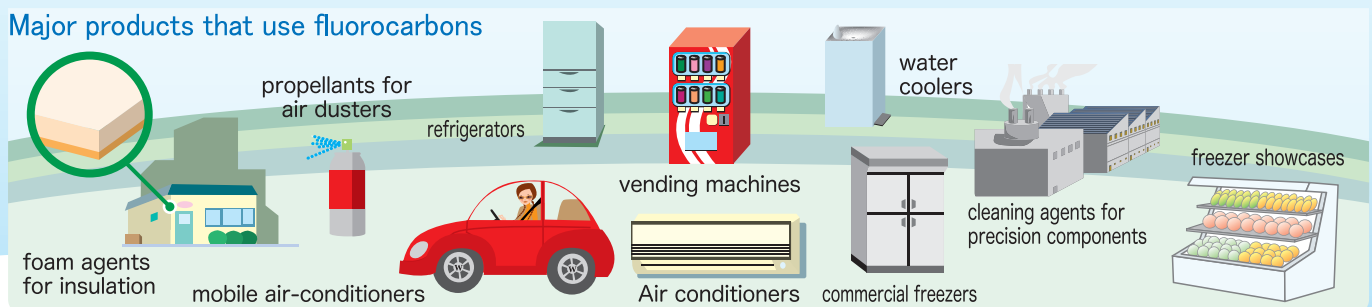
- HFCs (Hydrofluorocarbons)

Compounds of Carbon, Fluorine and Hydrogen



Fluorocarbons shipments in Japan
Based on data of Japan Fluorocarbon Manufacturers Association

Major products that use fluorocarbons

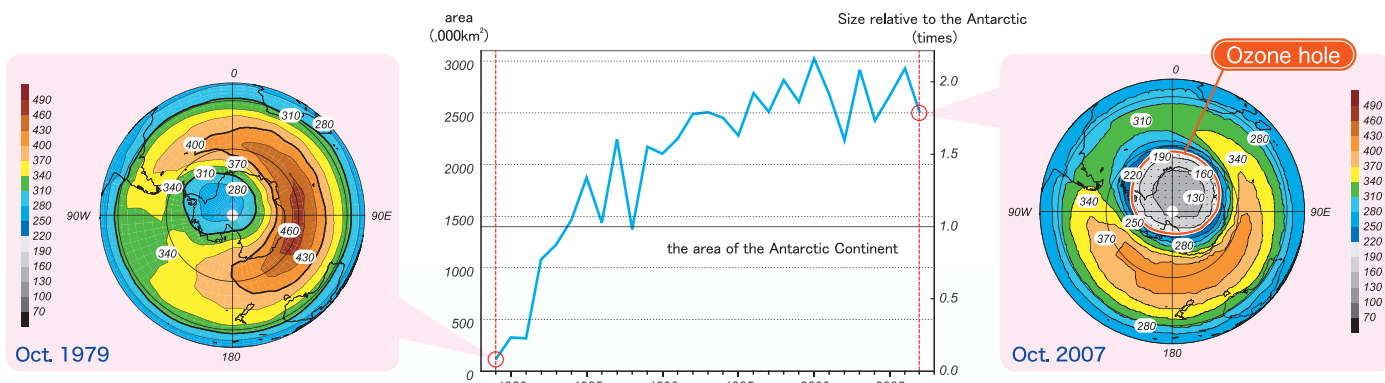


However, Freons are a cause of climate change and ozone layer depletion!!

Ozone Layer Depletion

Ozone layer depletion continues unabated

The Ozone Layer is 10-50km above the Earth's surface and absorbs harmful UV rays from the Sun. However, CFCs and HCFCs which are emitted into the air reach the ozone layer and decompose ozone by chemical reactions. The depletion of ozone above the Antarctic is so serious that in September - October each year the ozone density decreases drastically. This is called "Ozone Hole", because it looks like a hole in the sky. Still now, there is no clear sign of recovery of the Ozone Hole.



Chronological change of the size of the ozone hole and the distribution of the ozone above the Antarctic in October
Source: Japan Meteorological Agency Ozone Layer Observation Report 2007

Impact on Climate Change

Fluorocarbons are about 100-10,000 times stronger greenhouse gases than CO₂

Currently, climate change caused by man-made emissions of CO₂ is becoming more and more serious. Climate change is not only caused by CO₂. Fluorocarbons such as CFCs, HCFCs and HFCs also have strong greenhouse effects. Their impact on climate change is known to be extremely strong – ranging from a hundred times to over ten thousand times stronger than CO₂. For example, fluorocarbons used in air-conditioners and mobile air-conditioners are more than 1,000 times stronger greenhouse gases than CO₂. If 1 kg of fluorocarbons are emitted into the air accidentally, they will have the equivalent impact of more than 1 ton of CO₂.

Geographical pattern of surface warming

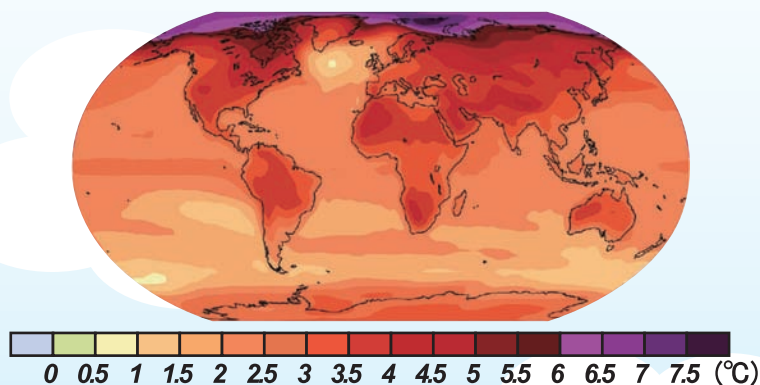


Figure : Projected surface temperature changes for the late 21st century (2090-2099). The map shows the multi-AOGCM average projection for the A1B SRES scenario. Temperatures are relative to the period 1980-1999.

Figures have been taken from IPCC third assessment report (2007)

Global warming potentials of CFC, HCFC and HFC (in comparison with CO₂ at equal weight)

1

CO₂

124

HFC-152a

1430

HFC-134a

1810

HCFC-22

4750

CFC-11

10900

CFC-12

14800

HFC-23

Figures have been taken from IPCC third assessment report (2007)

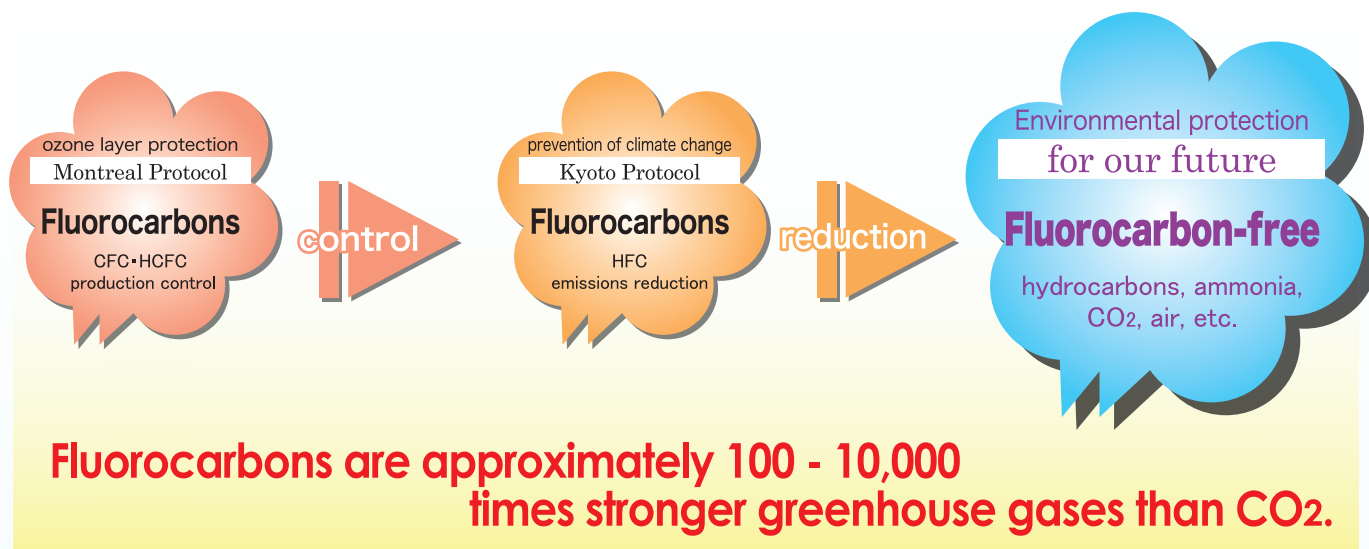
Global Developments in Action on Fluorocarbons

The world is moving forward to prevent climate change and protect the ozone layer

When ozone layer depletion was recognized as a global environmental problem caused by fluorocarbons, the "Montreal Protocol on Substances that Deplete the Ozone Layer" was adopted, under which production of CFCs has been completely phased out in developed countries including Japan. Global actions are also being taken for the phase-out of production of HCFCs, which were introduced as the alternatives to CFCs.

In addition, HFCs, the alternative to CFCs and HCFCs, are controlled under the "Kyoto Protocol" because they have a significant impact on climate change though they don't have any impact on ozone depletion.

In order to protect the ozone layer and prevent climate change, various measures are taken in Japan, including recovery and destruction of a fluorocarbons in equipment such as refrigerators and air-conditioners, and promotion of the use of alternative products.



Choose Fluorocarbon-Free Products

Our choices will change the future

Since fluorocarbons are a cause of climate change and ozone depletion, alternative technologies and products that do not use fluorocarbons are being developed. In Japan, to promote these products, government agencies are obliged to use fluorocarbon-free products in accordance with the "Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (Law on Promoting Green Purchasing)" and the government provides subsidies to encourage companies to adopt fluorocarbon-free products.

Fluorocarbon-free products are being developed and marketed in many areas. In this pamphlet, we will introduce **Natural Refrigerant-Based Refrigerators and Air-conditioners**. Please carefully consider whether you can choose a fluorocarbon-free product for the sake of the environment.

**Take a step towards combating climate change
by choosing fluorocarbon-free products.**

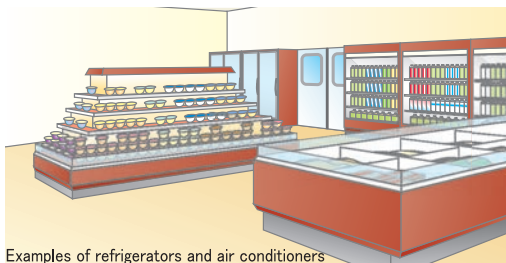


Label for
Fluorocarbon-Free
Products



Natural Refrigerant-Based Refrigerators and Air-conditioners

What are natural refrigerant-based refrigerators and air-conditioners?



Examples of refrigerators and air conditioners

In order to enjoy a comfortable indoor temperature and keep food fresh, we use air-conditioners, freezers and refrigerators. These machines move heat from inside the room or machine to outside to reduce the temperature. Substances that carry the heat are called the "refrigerant."

Due to their excellent properties, "fluorocarbons," man-made fluorine compounds, were used as

refrigerants. However, since fluorocarbons deplete the ozone layer and contribute to climate change, substitutes with less impact on the environment are being developed and commercialized.

These refrigerants include ammonia (NH_3), carbon dioxide (CO_2), water (H_2O), air and hydrocarbons (HCs), which are called "natural refrigerants" since they all naturally exist in nature.

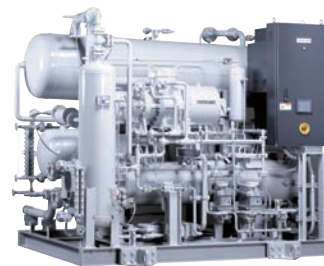
Features of Major Natural Refrigerants

Ammonia Refrigerant (NH_3)

Ammonia was used widely as a refrigerant before the dissemination of fluorocarbons. However, due to disadvantages such as "poor performance below -30°C ", "being toxic and odorous, dangerous to use in situations where there may be contact with people", fluorocarbons became the dominant refrigerant.

Recently these disadvantages have been overcome, and as fluorocarbons' impact on the environment has become recognized, ammonia refrigerant has been reevaluated as a superior refrigerant and ammonia-based products are being commercialized.

In the past, since ammonia refrigerant is toxic, the "indirect cooling method" was recommended, but the energy efficiency of this method was worse than the "direct cooling method" in some conditions. Today, with technology development, the efficiency has been improved by combining with CO_2 refrigerant for the indirect cooling method, while high safety has been achieved for the direct cooling method.



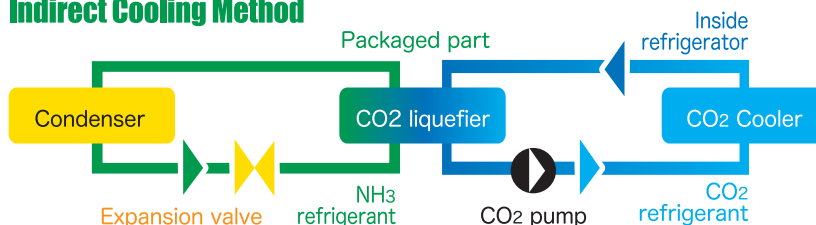
Ammonia Refrigerant Freezer

<Features of Ammonia Refrigerant>

- Requires small quantity of refrigerant (heat transfer coefficient is better than fluorocarbon refrigerants)
- Better COP* than fluorocarbon refrigerants in temperature range for freezers, refrigerators and air-conditioners.

<Usage Example> Commercial cold storage

Indirect Cooling Method



Example of System using Ammonia Refrigerant

*What is a Coefficient Of Performance (COP)?

Just as the "gas mileage", how many miles a car can travel on one gallon of gasoline, is important, the amount of cooling that a refrigerator can deliver from one kW of input energy is important. The amount of motive power and heat (input) consumed versus the refrigerating capacity (output) is known as the "COP": Coefficient of Performance. It is a measure of energy efficiency. The larger the COP value, the more energy-efficient the device is.

Carbon Dioxide Refrigerant (CO₂)

Although carbon dioxide is known as a major greenhouse gas, it is a promising refrigerant as one of alternatives to fluorocarbons since its Global Warming Potential (GWP) is significantly lower (GWP=1) than fluorocarbons and it is non-toxic and non-flammable.

When carbon dioxide is used as a refrigerant, it must operate at high pressure and this made it difficult to commercialize in compact appliances. Today more efficient and compact appliances have been developed by using a two-stage compression method.



Drinks showcase

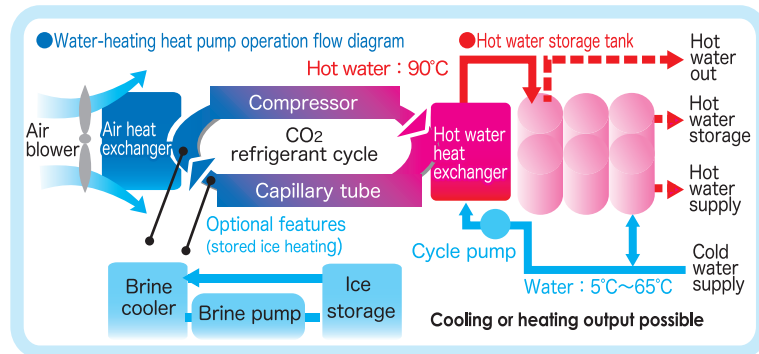
When used as a refrigerant in freezers, carbon dioxide has comparatively low efficiency, but it is suitable for heating equipment that transfers heat from outdoors to make hot water. For this application, carbon dioxide has become the most suitable and popular refrigerant in recent years.

For example, it is used in "Eco-cute" water heaters, which make use of cheaper nighttime electricity to heat water for use in our daily life.

Example of system using CO₂ refrigerant



Eco-Cute



<Features of carbon dioxide refrigerant>

- non toxic, odorless
- non-flammable

- High COP for water-heating compared to fluorocarbon refrigerants

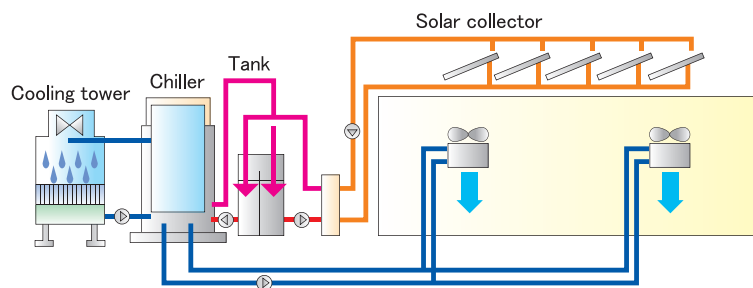
<Usage Example> water-heating in domestic houses, hospitals, hotels, and spas.
Cooling in vending machines and drinks showcases.

Water Refrigerant (H₂O)

Water is a safe refrigerant with no toxicity and flammability. It can be used as a refrigerant by combining with other substances. Absorbent cooling systems combined with a solid absorbent (Silica gel) and absorption freezers and refrigerators combined with lithium bromide etc. have been commercialized. These types of equipment are not relatively energy-efficient, but water is non-toxic and non-flammable and can make use of solar heat and waste heat from factories. In these cases, these systems are very energy-efficient.



Absorbent chiller



Example of water chiller system using solar heat

<Features of water refrigerant>

- non-toxic, odorless
- Main drive mechanism is a pump: compressor is not required
- non-flammable
- Solar heat or waste heat can be used to produce chilled water

<Usage Example> Cooling equipment using waste heat from Industrial reactors or engines, or natural energy etc.

Air Refrigerant

Air absorbs or releases heat as it is compressed or expanded and can therefore be used directly as a refrigerant to cool air. Today, air refrigerant can be used at extremely low temperature ranges of around -60°C. It is expected that air refrigerant will become more widely used because fluorocarbon refrigerants such as HCFC22 and HFC23 with high ODP and GWP were used in this temperature range.



Air refrigerant freezer

<Features of air refrigerant>

- non-toxic, odorless
- non-flammable
- Simple structure without coolers or ducts is possible by cooling air directly.

<Usage Example> Very low temperature freezers, rapid freezing devices

Hydrocarbon Refrigerants (HC)

Hydrocarbons such as propane and isobutane are known as flammable refrigerants. Since these refrigerants do not deplete the ozone layer, have a lower Global Warming Potential and have high energy efficiency, they are rapidly becoming popular in highly-sealed equipment such as domestic refrigerators. Recently, their safety has been improved and they are being commercialized in commercial applications.



Hydrocarbon refrigerants freezer

<Features of hydrocarbon refrigerants>

- odorless
- inflammable
- greater water-heating efficiency than carbon dioxide refrigerant
- Rapidly becoming popular for domestic refrigerators due to their high efficiency

<Usage Example> domestic refrigerators, commercial air-conditioners, vending machines

Major National Policies • • • • •

Project for Promotion of Introduction of Refrigeration Equipment with Natural Refrigerants and High Energy Efficiency

Refrigerators and air-conditioners which use natural refrigerants such as Ammonia and CO₂ face difficulties in deployment because of their high capital cost.

To promote such equipment, Ministry of the Environment subsidizes companies that introduce Refrigeration Equipment with Natural Refrigerants and High Energy Efficiency with one third of the difference in capital costs between such equipment and fluorocarbon based equipment with the equivalent capacity. (Period : FY2008-FY2012)

Reference URL: http://www.env.go.jp/earth/ondanka/biz_local/20_03/index.html

In introducing refrigerators and air-conditioners, it is essential to choose a product, taking into account the refrigerant used, as well as the energy-efficiency, in the light of prevention of climate change.



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