The Fluorocarbon-Free Option for the sake of the planet

Fluorocarbon-free product promotion pamphlet

Fluorocarbon-Free Refrigerators

Fluorocarbon-Free Thermal Insulation ~Rigid urethane foam~

Fluorocarbon-Free Air dusters

Natural Refrigerant-Based Refrigerators and Air-conditioners

nonフロン
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**Office of Fluorocarbons Control Policy, Global Environmental Issues Division,
Global Environment Bureau, Ministry of the Environment**
1-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100-8975
TEL+81-3-5521-8329 FAX +81-3-3581-3348 http://www.env.go.jp/en/

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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"

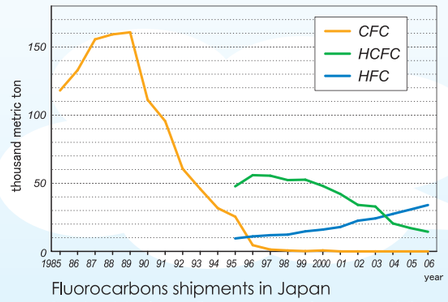
What are Fluorocarbons?

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.

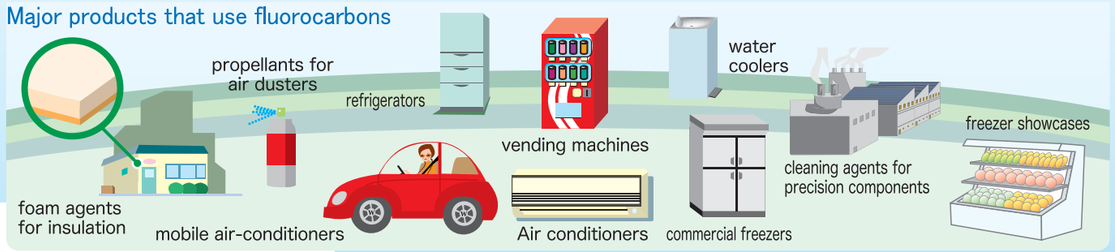
Types of Fluorocarbons

- **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

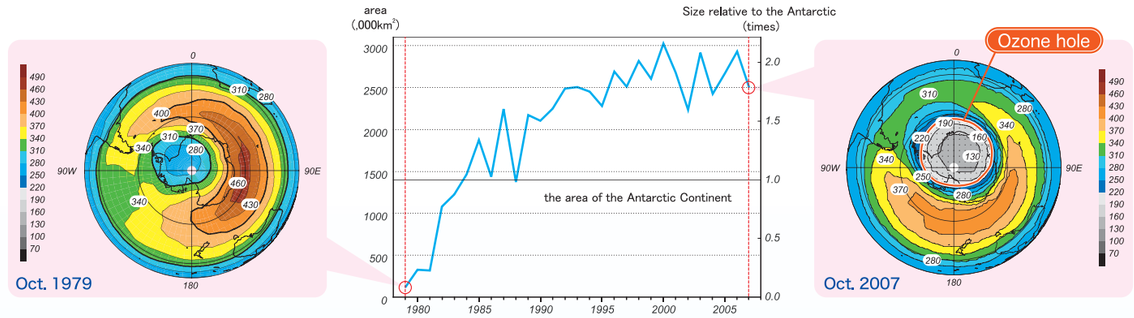


However, Freons are a cause of climate change and ozone layer depletion!!

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 CO_2

Currently, climate change caused by man-made emissions of CO_2 is becoming more and more serious. Climate change is not only caused by CO_2. 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 CO_2. For example, fluorocarbons used in air-conditioners and mobile air-conditioners are more than 1,000 times stronger greenhouse gases than CO_2. If 1 kg of fluorocarbons are emitted into the air accidentally, they will have the equivalent impact of more than 1 ton of CO_2.

Geographical pattern of surface warming

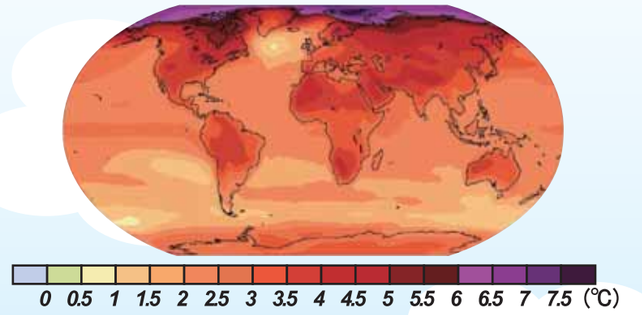
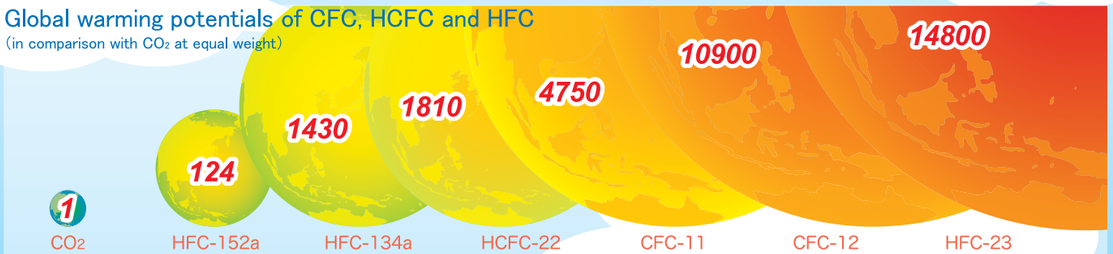


Figure : Projected surface temperature changes for the late 21st century (2090-2099). The map shows the multi-AOGCM average projection for the A1B SRES scenario. Temperatures are relative to the period 1980-1999.

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

Global warming potentials of CFC, HCFC and HFC
(in comparison with CO_2 at equal weight)



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

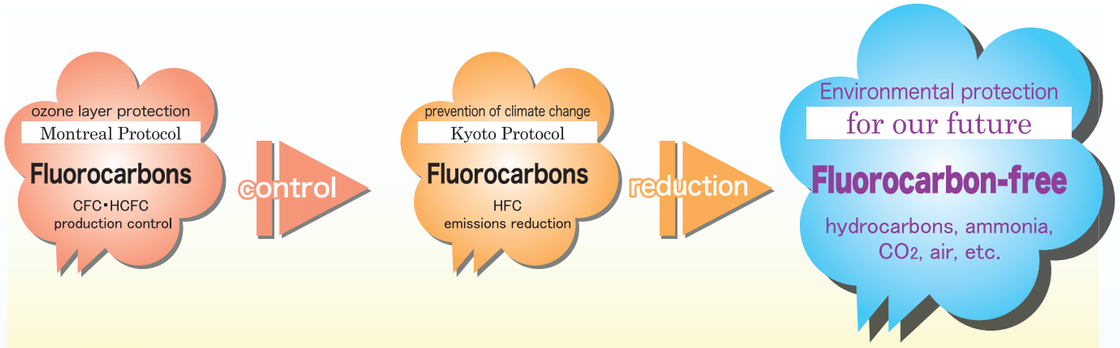
Global Developments in Action on Fluorocarbons

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.



Fluorocarbons are approximately 100 - 10,000 times stronger greenhouse gases than CO_2.

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 **Fluorocarbon-Free Refrigerators**, **Fluorocarbon-Free Thermal Insulation ～Rigid urethane foam ～**, **Fluorocarbon-Free Air Dusters**, **Natural Refrigerant-Based Refrigerators and Air-conditioners.** Please carefully consider whether you can choose a fluorocarbon-free product for the sake of the environment.

Label for Fluorocarbon-Free Products

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ハロー！環境技術

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

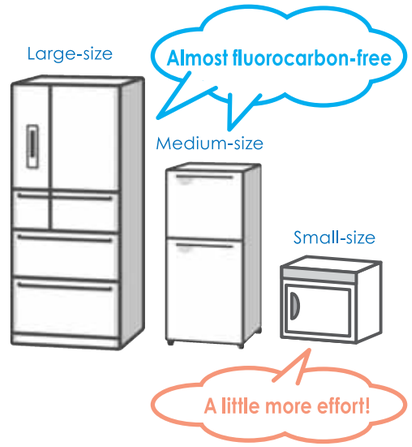
About Fluorocarbon-Free Refrigerators

What is a fluorocarbon-free refrigerator?

Refrigerators and freezers are indispensable in everyday life for conserving fresh food.

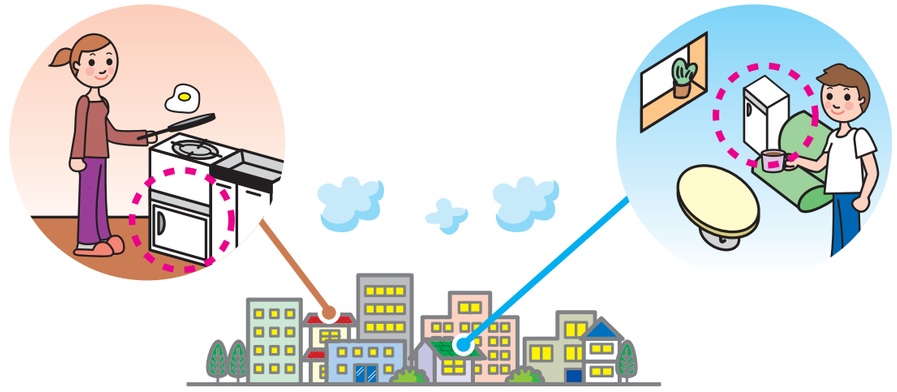
Chlorofluorocarbons (CFC), which are a variety of fluorocarbons, have traditionally been used as refrigerants to release heat from inside domestic refrigerators. When CFC production was restricted in order to protect the Earth's ozone layer, hydro-fluorocarbons (HFC) were replaced with CFC as refrigerants.

However, HFC is a substance that has an effect on climate change one thousand times as strong as carbon-dioxide. For example, a large-sized domestic refrigerator contains about 150g of HFC134a. When this is released into the atmosphere, the impact on climate change is the same as the emission of 0.2t of carbon-dioxide (the equivalent of 20,000 soccer balls in volume). Since HFC is included in the list of restricted greenhouse gases under the Kyoto Protocol, its use must be reduced as much as possible, and research and development into new refrigerants has being undertaken. Refrigerators using isobutane, a hydrocarbon-type refrigerant, have already been put to practical use. At present, fluorocarbon-free refrigerators using isobutane as refrigerant are most commonly used for large- and medium-sizes.



Practical use of fluorocarbon-free refrigerators

On the other hand, in terms of small-sized refrigerators used mostly by students or unmarried people living on their own, products using either isobutane or HFC are both marketed. It is hoped that these small-sized refrigerators will also become fluorocarbon-free.



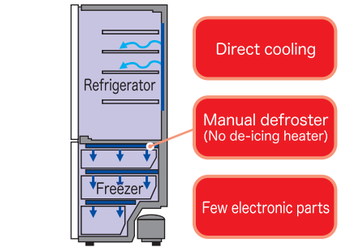
Small-sized refrigerators for which fluorocarbon-free is desirable
(Models used mostly by students and unmarried people living on their own)

Technological Development of Fluorocarbon-Free Products

Issues Concerning the Introduction of Fluorocarbon-Free Refrigerators in Japan

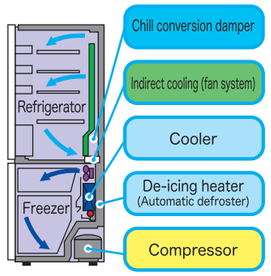
Since the hydrocarbon refrigerant isobutane is inflammable, the prevention of explosion in case of leaks was an issue regarding its use.

Most European domestic refrigerators operate upon the "direct cooling method", in which the inside is directly cooled by the chill from the cooler, and no defroster is installed inside. Therefore, there is no threat of ignition due to the heat from the defroster, even in the case of a gas leak. For this reason, the use of isobutane was accelerated in domestic refrigerators made in Europe.



Structure of European domestic refrigerators

However, in Japan, frost can build up inside the refrigerator due to high humidity. Therefore the "indirect cooling method", which forcibly circulates the chill from the cooler by using a fan was introduced, and de-icing heaters (automatic defrosters) were installed inside refrigerators. Refrigerators in Japan are mostly large- or medium-sized, the quantity of refrigerant filling tending to be large, and there are many wooden houses. For these reasons, extra care was required in the adoption of isobutane, in order to avoid fires.

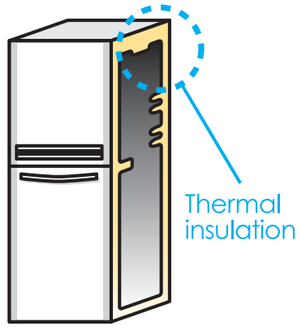


Structure of Japanese domestic refrigerators

Fluorocarbon-Free Technology

Domestic refrigerator manufacturers developed various technologies and made structural improvements in order to enable the use of fluorocarbon-free refrigerants.

In order to minimize the use of the inflammable isobutane and avoid refrigerant leaks, various measures were taken such as developing technologies for reducing the quantity of refrigerant filling, the use of ultrasonic welding for the outside of the refrigerator, structures with the minimum number of welds, technologies using electric parts which do not ignite the refrigerant in case of leaks, and explosion prevention structures. As a result, the use of isobutane refrigerants was achieved.



Thermal Insulation of Refrigerators

In the past, CFC and HCFC were used as foaming agents of thermal insulation for refrigerators. Fluorocarbons were excellent substances as foaming agents, but as they were recognized as environmentally unfriendly, foaming agents for refrigerators are becoming fluorocarbon-free. Today, hydrocarbons (cyclopentane) are used as foaming agents in most of the refrigerators made in Japan.

Major National Policies

Many schemes are being put into place in order to encourage the use of fluorocarbon-free refrigerators.

1) Labeling Fluorocarbon-Free Appliances

Based on the "Rationalization in Energy Use Law", a "Standardized Energy Saving Label" is affixed to domestic appliances meeting energy-saving standards, providing easily to understand information on the energy-efficiency of the product to the consumer. A fluorocarbon-free mark is printed on this label along with energy-saving information (energy saving labeling system, multiple grade evaluation system, rough estimate of annual electricity charges, etc.,) enabling the consumer to distinguish fluorocarbon-free products from products that use flourocarbons.

Label for Fluorocarbon-Free Products

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2) Purchasing Initiative Taken by Governmental Entities

Based on the "Law Concerning the Promotion of Procurement of Eco-Friendly Goods by the States and Other Entities (Law on Promoting Green Purchasing)" requiring Government Entities to purchase environmentally friendly products, government entities have to follow the "Evaluation Criteria" listed below, when purchasing domestic refrigerators. " Factors for Consideration" are matters that are recommended for consideration but are not compulsory.

Evaluation Criteria and Factors for Consideration for Electric Refrigerators, etc., from the Law on Promoting Green Purchasing (extract)

Evaluation Criteria	① Omitted
	② No substance that depletes the ozone layer shall be used as a refrigerant or as an insulation foaming agent .
	③ No hydro-fluorocarbon (alternative fluorocarbon) shall be used as a refrigerant or as an insulation foaming agent.
	④ Omitted
Factors for Consideration	① Substances with the smallest possible impact on climate change should be used as refrigerants or insulation foaming agents . ②～⑤ Omitted

Source: Basic Policy on the Promotion of Procurement of Eco-friendly Goods (Partly revised by the Cabinet on 5th February 2008)

When purchasing a domestic refrigerator or freezer, it is important to make sure that it is fluorocarbon free and energy-efficiency in order to gain further climate benefit.

Fluorocarbon-Free Thermal Insulation

What is thermal insulation?

Recently, highly insulated houses that improve the efficiency of heating and cooling are getting popular. Improving the insulation performance of buildings is also desirable as a measure to prevent climate change.

There are many types of thermal insulation, and some foam plastic insulation uses fluorocarbons.

Fluorocarbons are harmless, odorless, and make fine bubbles in plastic, yielding high insulation performance, leading to the use of significant amount of fluorocarbons in this application.

However, fluorocarbons emitted from this insulation deplete the ozone layer and contribute to climate change. For this reason, today foam plastic insulation freeing itself from fluorocarbons and insulation such as extruded polystyrene, high expanded polyethylene and phenolic foam, which historically depend on fluorocarbons, are now almost fluorocarbon-free.

However, in the field of rigid urethane foam insulation, the use of fluorocarbon HCFC141b has been greatly reduced and replaced mainly with HFCs. In 2006, almost 6,000 tons (around 5.6 million tons of CO_2 equivalent) of HFCs were newly used, part of which was emitted during manufacturing and the rest of which will be gradually emitted over a long period of time. Most of the HFCs used are HFC245fa and HFC365mfc. Although these two types of HFCs are not targeted under the Kyoto Protocol, their use must be reduced to prevent climate change as they are still powerful greenhouse gases.

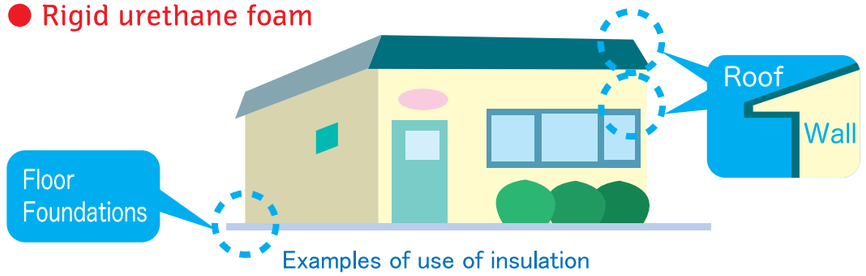
Major insulation types

Completely or almost fluorocarbon-free

- Non-foam-plastic insulation (Glass wool etc.)
- Extruded polystyrene foam
- Phenolic foam
- High expanded polyethylene foam
- Expanded polystyrene foam

Using fluorocarbons

- Rigid urethane foam



Examples of use of insulation

The focus of this pamphlet is rigid urethane foam insulation, for which it is particularly desirable to be fluorocarbon-free.

Fluorocarbon-Free Rigid Urethane Foam Insulation

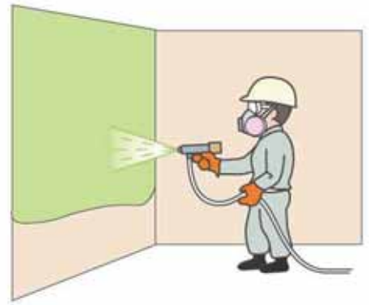
There are two types of rigid urethane foam: sprayed on site (Sprayed-Type) and formed in factories (Pre-formed). Fluorocarbon-free products are commercially available for both types.

Fluorocarbon-free sprayed-type rigid urethane foam

An insulation layer is formed and integrated with the building materials by using a blowing agent on site, taking advantage of the product's self-adherence properties.

Fluorocarbon-free sprayed type rigid urethane foam includes the method of spraying CO_2 directly as a blowing agent and the method of reacting chemical substances with water to produce CO_2 to create foam.

As a sprayed-type, the foam does not have joints, which are a cause of heat loss, and is quick and simple to install, this type represents a major part of rigid urethane foam insulation. However, fluorocarbon-free sprayed-type insulation represents around just 10% of the domestic market.



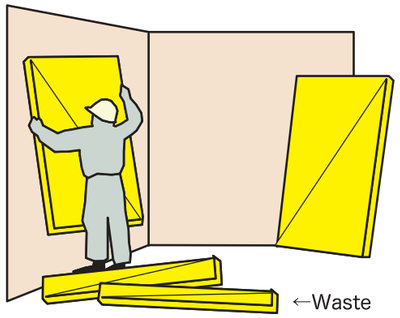
Application on site

＜Usage Example＞
Housing complexes and factories etc.

Fluorocarbon-free pre-formed rigid urethane foam

At the factory compounds such as cyclopentane are reacted with urethane to create foam. The shipment amount of pre-formed foam is less than that of site-applied foam, most of the factory-made foam has now been replaced with fluorocarbon-free alternatives.

＜Usage Example＞
Detached houses and vending machines etc.



Boards are attached to concrete walls

※For Sprayed-type rigid urethane foam, since fluorocarbon-free products have a lower insulation performance than fluorocarbon-based products, a thicker layer is required. Also, for both sprayed-type and pre-formed rigid urethane foam, special treatment and equipment is required in some cases, leading to relatively higher cost at present.

Major National Policies

Several Policies are Underway to Promote the Use of Fluorocarbon-Free Building Insulations

1) Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (Law on Promoting Green Purchasing)

In accordance with the Law on Promoting Green Purchasing, evaluation criteria and factors for consideration in procurement of specific products are specified in the "Basic Policy on the Promotion of Procurement of Eco-friendly Goods"
The evaluation criteria and factors for consideration for insulation for public works are shown in the table below. Government entities must fulfill the evaluation criteria and consider the factors for consideration when purchasing thermal insulation.

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Evaluation Criteria and Factors for Consideration for Thermal Insulation from the Law on Promoting Green Purchasing (extract)

Evaluation criteria	Materials that prevent loss of heat through the outer walls of buildings, and meet the criteria below.
	① May not use materials harmful to the ozone layer.
	② May not use hydro-fluorocarbons (replacement carbon).
	③~④ Omitted
Factors for consideration	Insulation materials made of plastic foam must maintain long term insulation performance, and use materials that have a global warming potential that is as small as possible.

Source: Basic Policy on the Promotion of Procurement of Eco-friendly Goods (Partly revised by the Cabinet on 5th February 2008)

2) Revision of Japanese Industrial Standards (JIS)

In 2006, JISs concerning sprayed-type rigid urethane foam for building insulation (JIS A 9526:2006R) and foam plastic insulation materials (JIS A 9511:2006R) were successively revised. This makes the type of blowing agent used easy to identify and the wider uptake of fluorocarbon-free products can be expected.

Type A: Products that use, as blowing agents, hydrocarbon and carbon dioxide (CO_2) etc., not fluorocarbons*
Type B: Products that use fluorocarbons as blowing agents

* In the case of JIS A 9526, carbon dioxide (CO_2) only

3) Revision of Public Works Standard Specifications

In February 2007, the "Public Works Standard Specifications" and "Public Works Standard Specifications for Repair Works" were revised. In accordance with the revision in JISs, it was clearly specified that, unless there are special circumstances, fluorocarbon-free (JIS Type A) products should be used in methods for placing insulation in reinforced concrete in interior construction and also methods for spraying foams in public works. It is expected that due to this revision the uptake of fluorocarbon-free insulation will be accelerated in public works.

4) CASBEE: Comprehensive Assessment System for Building Environmental Efficiency

The CASBEE system is being developed and promoted by the Ministry of Land, Infrastructure and Transport to improve energy efficiency and reduce the environmental impact of houses and other buildings. CASBEE is a comprehensive system to assess the environmental performance of buildings. One of the assessment items is "avoidance of fluorocarbons and halons", in which fluorocarbon-free insulation is ranked at the highest level 5 for being an environmentally friendly product.

In building a house, while it is important to improve insulation performance, it is also important to choose fluorocarbon-free insulation to gain further climate benefit.

Fluorocarbon-Free Air Dusters

What is an air duster?

Air dusters, which emit a jet of high pressure gas, are used widely in maintenance of office appliances (computers, office automation equipment etc.) as well as precision equipment in factories and laboratories (electronic and optical equipment etc.), ATMs in banks and convenience stores, and automatic ticket gates etc. in stations, with the purpose of removing dust and static electricity and cooling the object. The demand for air dusters has grown strongly in parallel with the popularization of computers etc. and in recent years approximately 6 million cans are sold every year.

Up to now, fluorocarbons have been used as the propellant in air dusters. As air dusters function by emitting the gas, all of the fluorocarbons are emitted to the atmosphere through the use of air dusters. In 2006, some 800,000 tons of CO_2 equivalent were emitted through air dusters, and this is equivalent to the CO_2 emissions of 80,000 people under the assumption that a Japanese citizen be responsible for 10 tons.

The fluorocarbon propellants used in air dusters have changed from CFCs and HCFCs, the production of which is controlled under the Montreal Protocol, to HFCs which are one of the target gases of the Kyoto Protocol. Among various types of HFCs, there has been a shift of propellant from HFC134a with high GWP to HFC152a with lower GWP. Additionally, products using Dimethyl Ether (DME) or CO_2 as alternatives to fluorocarbons have recently begun to be marketed.

Comparison of Fluorocarbon-Based and Fluorocarbon-Free Products

	Name	Inflammability	Odor	GWP	Type	Pressure
fluorocarbon-based products	HFC134a	non-flammable	none	1430	aerosol can	low
	HFC152a	inflammable	none	124	aerosol can	low
	HFC152a/DME	inflammable	slight odor	<124	aerosol can	low
fluorocarbon-free products	DME/CO_2	inflammable	slight odor	<1	aerosol can	low
	CO_2	non-flammable	none	1	high-pressure gas cylinder	h igh

Types of Fluorocarbon-Free Air Dusters

The types of fluorocarbon-free air duster available can be categorized into 1) Aerosol cans with mix of Dimethyl Ether(DME) and Carbon Dioxide (CO_2) gas, and 2) High pressure gas cylinders with Carbon Dioxide (CO_2). The switch to fluorocarbon-free products was difficult due to the necessary measures addressing the inflammability, high pressure and explosibility, but recently these points have been improved, and fluorocarbon-free air dusters are proactively being introduced in accordance with policies such as the Green Purchasing Law.

The features of fluorocarbon-free air dusters are as following.

1) DME/CO_2 mix gas type

- Ozone Depleting Potential: 0, Global Warming Potential: <1
- Comparable price to previous products
- To reduce risk of inflammation, a special absorbent is used in the can to prevent the injection of liquefied gas, which mixes DME with the CO_2 when sprayed.

2) CO_2 Type (high pressure gas cylinder type)

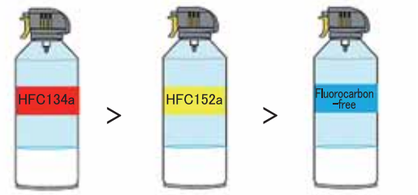
- Ozone Depleting Potential: 0, Global Warming Potential: 1
- No risk of inflammation
- Since the gas is at high pressure, a high pressure gas cylinder equipped with an automatic leakage device for high temperature situations is used
- Contents less than 100ml, which is exempted from the High Pressure Safety Law
- Gas cylinders can be replaced and reused

Gas	DME/CO_2 mix gas	CO_2	
Container type	Aerosol 2 piece can	High pressure gas cylinder	
		Cartridge style with replaceable cylinder	Used containers can be collected and reused
Contents	350ml	Less than 100ml (Exempted from the High Pressure Safety Law)	
Can weight (excluding gas)	200～250g	400～450g	250～300g
Measures against inflammation	Prevent inflammation by preventing injection of liquefied gas	No flammability, no risk of inflammation	
Measures against explosion, high pressure	Extra measures not necessary as the pressure is comparable to fluorocarbon products	High pressure, designed to allow automatic leakage from valve and cylinder at high temperatures. Have thick sides	
Sales price	Comparable price to fluorocarbon-based products	2-3 times price of fluorocarbon-based products	

※Fluorocarbon-free air dusters use inflammable and high pressure gases.
It is important to carefully read and follow the safety directions.

Points to Consider When Choosing Fluorocarbon-Free Air Dusters

Fluorocarbon-free air dusters are labeled to show that they are fluorocarbon-free and contain CO_2 with Global Warming Potential of 1 or Dimethyl Ether (DME) with Global Warming Potential of less than 1. However, fluorocarbon (HFC)-based products also show "environmentally friendly"(because HFCs don' t damage the Ozone Layer), "Global Warming Potential one tenth" (the Global Warming Potential of HFC152a is 124, approximately one tenth of HFC134a),



None of the products harm the ozone layer, but their Global Warming Potential is markedly different

therefore it is important to confirm that a product is fluorocarbon-free when purchasing.

Major National Policies

Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (Law on Promoting Green Purchasing)

In accordance with the Law on Promoting Green Purchasing, evaluation criteria and factors for consideration in procurement of specific products are specified in the "Basic Policy on the Promotion of Procurement of Eco-Friendly Goods."

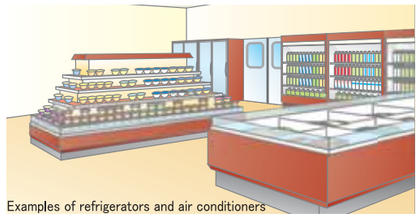
Previously, government entities were supposed to consider purchasing air dusters without HFCs; but in February 2008, the Cabinet decided that it should become an evaluation criteria to use fluorocarbon-free products. From April 2008, government entities must fulfill the evaluation criteria when purchasing air dusters.

However, since there is danger of sparks, this does not apply to the sectors which require safety consideration. In addition, given the time to clear the stocks of fluorocarbon-based products, this is a transitional measure until March 31st 2009. For these uses and in this period, products which neither contain ozone-depleting substances nor substances with a Global Warming Potential higher than 150 are to be used.

When we maintain our equipment, it is important to choose fluorocarbon-free air dusters where suitable, or take options other than air dusters, in the light of prevention of climate change.

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.

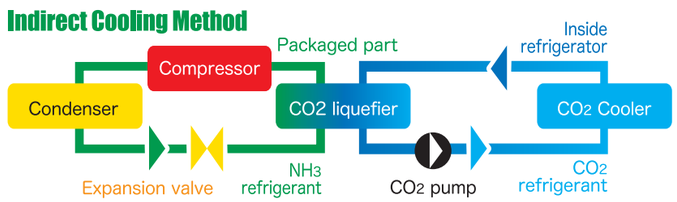
In the past, since ammonia refrigerant is toxic, the "indirect cooling method" was recommended, but the energy efficiency of this method was worse than the "direct cooling method" in some conditions. Today, with technology development, the efficiency has been improved by combining with CO_2 refrigerant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


Drinks showcase

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.

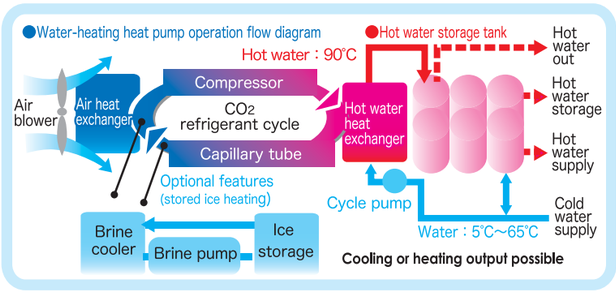
When carbon dioxide is used as a refrigerant, it must operate at high pressure and this made it difficult to commercialize in compact appliances. Today more efficient and compact appliances have been developed by using a two-stage compression method.

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 CO_2 refrigerant


Eco-Cute



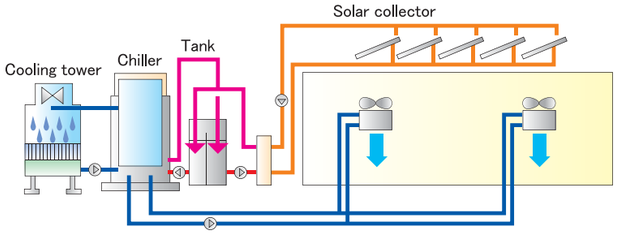
<Features of carbon dioxide refrigerant>
- non toxic, odorless
- non-flammable
- High COP for water-heating compared to fluorocarbon refrigerants

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

Water Refrigerant (H_2O)

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.

Fluorocarbon-Free vending machine

＜Features of hydrocarbon refrigerants＞
● odorless ● inflammable
● 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, freezers and air conditioning devices in distribution warehouses, large retailing stores, etc., are generally in use at all times, and require enormous amounts of energy.

Recently, "Energy-Efficient Natural Refrigerant-Freezers" are being developed using natural refrigerants (substances such as ammonia that exist in the natural world) which have a smaller impact on the environment, and are more energy-efficient than current products,. These devices not only reduce carbon-dioxide (CO_2) emissions, but also prevent the emission of fluorocarbons which have a greater impact on the greenhouse effect than CO_2. However, their initial cost, which is higher than current devices using fluorocarbons as refrigerant, is currently a barrier to their wider use.

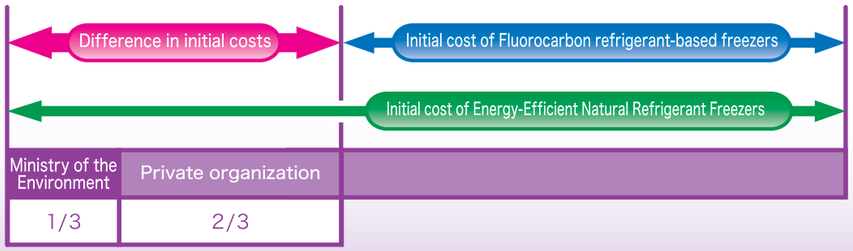
For this reason, the Ministry of the Environment is providing a subsidy of one third of the difference between the initial cost of "Energy-Efficient Natural Refrigerant-Freezers" and that of Fluorocarbon refrigerant-based devices to businesses that introduce them, in order to encourage their broader use. (subsidy schedule: 2008~2012).

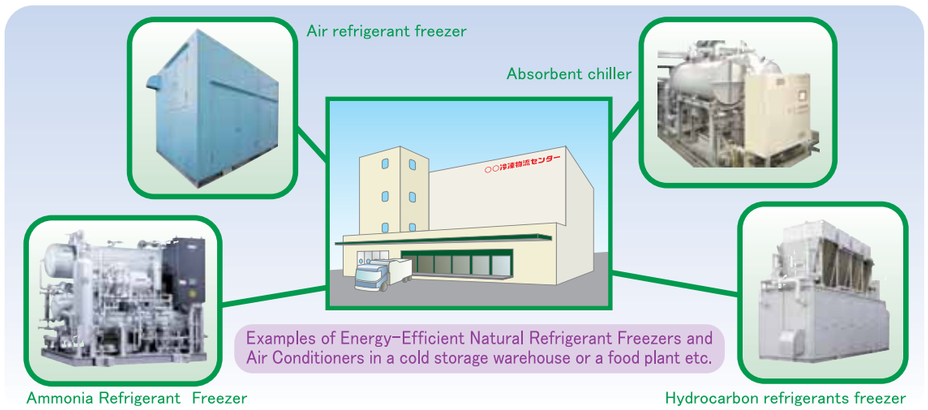
Reference URL: http://www.env.go.jp/earth/ondanka/biz_local.html

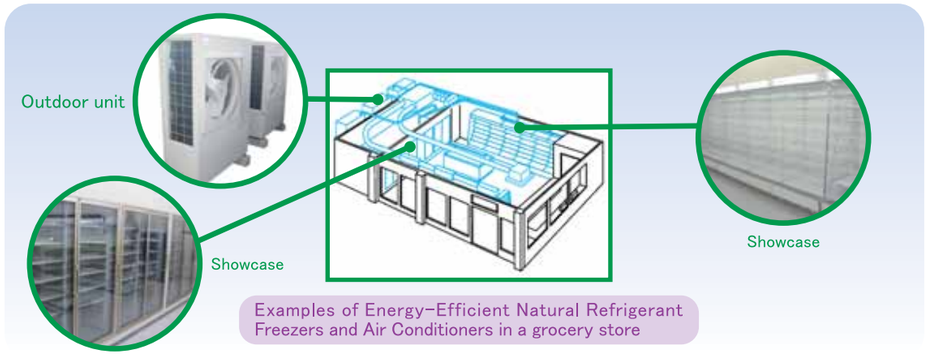
(For further details, please refer to the "FY 2008 Subsidies for Carbon-Dioxide Emission Control Business, etc., Energy-Efficient Natural Refrigerant-Freezer Promotion Business" on this web page in Japanese.)

Subsidy details

1. Subsidy target	Private businesses, etc.
2. Subsidy target facilities and businesses	Businesses introducing Energy-Efficient Natural Refrigerant Freezers when replacing the current freezers or newly establishing the facility
3. Proportion of subsidy	One third (1/3) of the difference between the initial cost of the Energy-Efficient Natural Refrigerant Freezer and the Fluorocarbon refrigerant-based device







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.