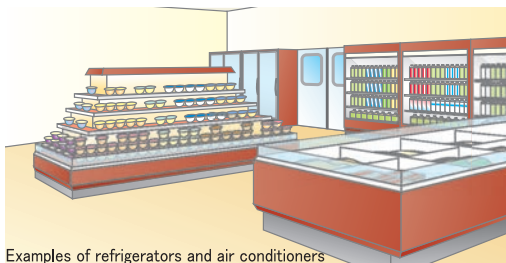


# Natural Refrigerant-Based Refrigerators and Air-conditioners

## 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 ( $\text{NH}_3$ ), carbon dioxide ( $\text{CO}_2$ ), water ( $\text{H}_2\text{O}$ ), air and hydrocarbons (HCs), which are called "natural refrigerants" since they all naturally exist in nature.

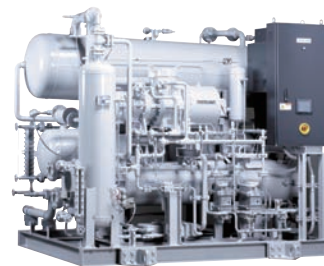
## Features of Major Natural Refrigerants

### Ammonia Refrigerant ( $\text{NH}_3$ )

Ammonia was used widely as a refrigerant before the dissemination of fluorocarbons. However, due to disadvantages such as "poor performance below  $-30^\circ\text{C}$ ", "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  $\text{CO}_2$  refrigerant for the indirect cooling method, while high safety has been achieved for the direct cooling method.



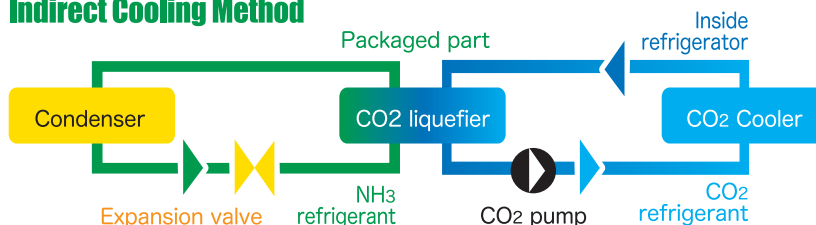
Ammonia Refrigerant Freezer

#### <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.