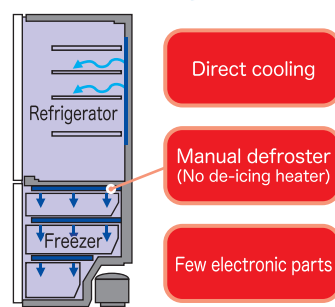


Technological Development of Fluorocarbon-Free Products

Issues Concerning the Introduction of Fluorocarbon-Free Refrigerators in Japan

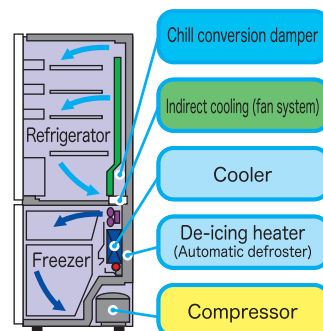
Since the hydrocarbon refrigerant isobutane is inflammable, the prevention of explosion in case of leaks was an issue regarding its use.

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.

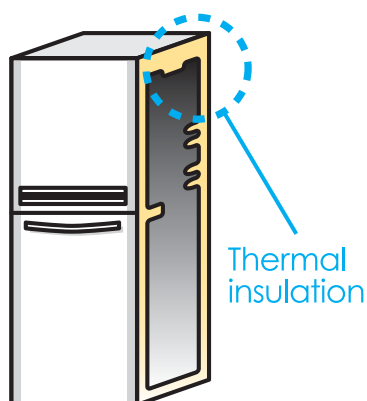


Structure of Japanese domestic refrigerators

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.