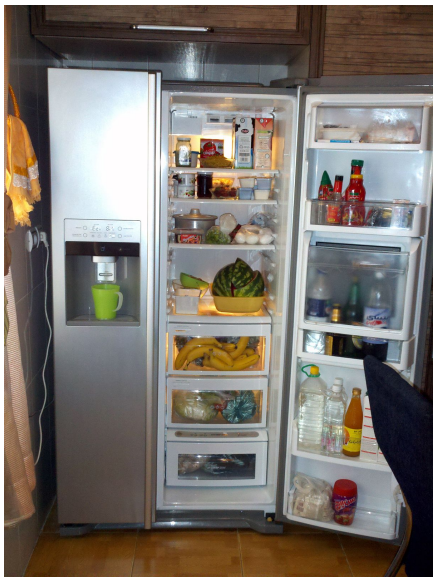
Refrigerator

A **refrigerator** (commonly referred to as a **fridge**) is a common household appliance that consists of a thermally insulated compartment and a heat pump (mechanical, electronic, or chemical) which transfers heat from the inside of the fridge to its external environment so that the inside of the fridge is cooled to a temperature below the ambient temperature of the room. Cooling is a popular food storage technique in developed countries and works by decreasing the reproduction rate of bacteria. The device is thus used to reduce the rate of spoilage of foodstuffs.

A refrigerator maintains a temperature a few degrees above the freezing point of water. Optimum temperature range for perishable food storage is 3 to 5 °C (37 to 41 °F).[1] A similar device which maintains a temperature below the freezing point of water is called a **freezer**.

The refrigerator is a relatively modern invention among kitchen appliances. It replaced the icebox, which had been a common household appliance for almost a century and a half prior. For this reason, a refrigerator is sometimes referred to as an **icebox**.



A side-by side refrigerator

A typical refrigerator with its door open

Freezer

Freezer units are used in households and in industry and commerce. Most freezers operate around 0 °F (−18 °C). Domestic freezers can be included as a separate compartment in a refrigerator, or can be a separate appliance. Domestic freezers are generally upright units resembling refrigerators, or chests (resembling upright units laid on their backs). Many upright modern freezers come with an ice dispenser built into their door.

Commercial and domestic refrigerators

Commercial fridge and freezer units, which go by many other names, were in use for almost 40 years prior to the common home models. They used toxic gas systems, which occasionally leaked, making them unsafe for home use. Practical household refrigerators were introduced in 1915 and gained wider acceptance in the United States in the 1930s as prices fell and non-toxic, non-flammable synthetic refrigerants such as Freon or R-12 were introduced. It is notable that while 60% of households in the US owned a refrigerator by the 1930s, it was not until 40 years later, in the 1970s, that the refrigerator achieved a similar level of penetration in the United Kingdom.[2]

Styles of refrigerators

Most households use the freezer on top and refrigerator on bottom style, which has been the basic style since the 1940s.

- Traditional style 1940s-present freezer top/refrigerator bottom (although most of the earlier models, some of the cheaper later models, and still some mini-fridges use the 'freezer chest,' or what is known as the 'freezer in the fridge'). A separate freezer compartment (e.g. *not* located within the larger refrigerator compartment) became the industry standard during the early- to mid-1960s.
- Side by side style – introduced by Amana in 1949 but not popular until 1965–present; left side is freezer and the right is refrigerator.
- Top refrigerator/bottom freezer style – mid-1950s – present.
- French door style – late 1990s-present. Two French doors for refrigerator and bottom freezer.

Frigidaire Imperial "Frost Proof" model FPI-16BC-63, top refrigerator/bottom freezer with brushed chrome door finish [3] made by General Motors Canada in 1963

In the early-1950s, most refrigerators were white, but from the mid-1950s through present day, designers and manufacturers put color into refrigerators. In the late-1950s/early-1960s, colors like turquoise and pink were popular, brushed chrome plating (similar to stainless finish) was available on some models from different brands. In the 1970s, common colors were Harvest Gold, Avocado Green and almond. In the 1980s, black colors were viewed as luxurious. In the late 1990s, stainless steel became stylish, and in 2009, one manufacturer introduced multi-color designs.[4]

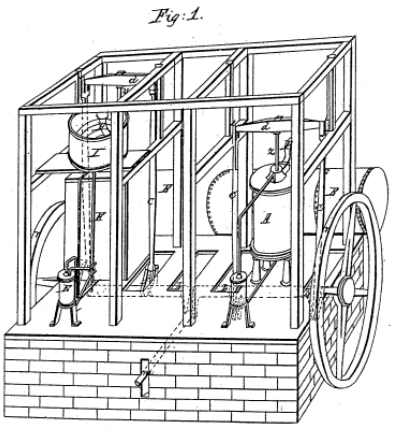
Many refrigerators can be blended into the cabinetry of the kitchen with panels that can slide over the doors for a built-in look.

Most home refrigerators weigh between 200 pounds (91 kg) and 450 pounds (200 kg), with some models weighing up to 875 pounds (397 kg).

History

Before the invention of the refrigerator, icehouses were used to provide cool storage for most of the year. Placed near freshwater lakes or packed with snow and ice during the winter, they were once very common. Natural means are still used to cool foods today. On mountainsides, runoff from melting snow is a convenient way to cool drinks, and during the winter one can keep milk fresh much longer just by keeping it outdoors.

In the 11th century, the Muslim physicist and chemist Ibn Sina (latinized name: Avicenna) invented the refrigerated coil, which condenses aromatic vapours.[5] [6] This was a breakthrough in distillation technology and he made use of it in his steam distillation process, which requires refrigerated tubing, to produce essential oils.[7]



Schematic of John Gorrie's 1841 ice machine.

The first known artificial refrigeration was demonstrated by William Cullen at the University of Glasgow in 1748.[8] The American inventor Oliver Evans, acclaimed as the "father of refrigeration," invented the vapor-compression refrigeration machine in 1805. Heat would be removed from the environment by recycling vaporized refrigerant, where it would move through a compressor and condenser, where it would eventually revert back to a liquid form in order to repeat the refrigeration process over again. However, no such refrigeration unit was built by Evans.[9] In 1834, Jacob Perkins modified Evans' original design, building the world's first refrigerator and filing the first legal patent for refrigeration using vapor-compression.[10] John Gorrie, an American doctor from Florida, invented the first mechanical refrigeration unit in 1841, based on Evans' original invention to make ice in order to cool the air for yellow fever patients. Gorrie's mechanical refrigeration unit was issued a patent in 1851.[11] American professor Alexander C. Twining of Cleveland, Ohio patented an early vapor-compression refrigerator in 1853 that was fully capable of producing a ton of ice per day.[12]

In 1857, Australian James Harrison developed a practical ice making machine and refrigeration system, and it was used in the brewing and meat packing industries of Geelong, Victoria. Ferdinand Carré of France developed a somewhat more complex system in 1859. Unlike earlier compression-compression machines, which used air as a coolant, Carré's equipment contained rapidly expanding ammonia. In 1913, refrigerators for home and domestic use were invented by Fred W. Wolf of Fort Wayne, Indiana with models consisting of a unit that was mounted on top of an ice box.[13] A self-contained refrigerator, with a compressor on the bottom of the cabinet was invented by Alfred Mellowes in 1916. Mellowes produced this refrigerator commercially but was bought out by William C. Durant in 1918, who started the Frigidaire Company in order to begin the first mass-production of refrigerators.[14] The absorption refrigerator was invented by Baltzar von Platen and Carl Munters from Sweden in 1922, while they were still students at the Royal Institute of Technology in Stockholm. It became a worldwide success and was commercialized by Electrolux. Other pioneers included Charles Tellier, David Boyle, and Raoul Pictet. Carl von Linde was the first to patent and make a practical and compact refrigerator.

These home units usually required the installation of the mechanical parts, motor and compressor, in the basement or an adjacent room while the cold box was located in the kitchen. There was a 1922 model that consisted of a **wooden cold** box, water-cooled compressor, an ice cube tray and a 9-cubic-foot (0.25 m^3) compartment, and cost $714. (A 1922 Model-T Ford cost about $450.) In 1923 Frigidaire introduced the first self-contained unit. About this same time porcelain-covered metal cabinets began to appear. Ice cube trays were introduced more and more during the 1920s; up to this time freezing was not an auxiliary function of the modern refrigerator.

An Oldman's refrigerator, more like an icebox with its refrigerating mechanisms on top.

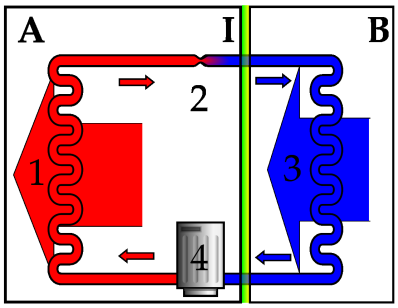
The first refrigerator to see widespread use was the General Electric "Monitor-Top" refrigerator introduced in 1927, so-called because of its resemblance to the gun turret on the ironclad warship USS *Monitor* of the 1860s. The compressor assembly, which emitted a great deal of heat, was placed above the cabinet, and surrounded with a decorative ring. Over a million units were produced. As the refrigerating medium, these refrigerators used either sulfur dioxide, which is corrosive to the eyes and may cause loss of vision, painful skin burns and lesions, or methyl formate, which is highly flammable, harmful to the eyes, and toxic if inhaled or ingested. Many of these units are still functional today. These cooling systems cannot legally be recharged with the hazardous original refrigerants if they leak or break down.

The introduction of Freon in the 1920s expanded the refrigerator market during the 1930s and provided a safer, low-toxicity alternative to previously used refrigerants. Separate freezers became common during the 1940s, the popular term at the time for the unit was a "deep freeze". These devices, or "appliances", did not go into mass production for use in the home until after World War II. The 1950s and 1960s saw technical advances like automatic defrosting and automatic ice making. More efficient refrigerators were developed in the 1970s and 1980s, even though environmental issues led to the banning of very effective (Freon) refrigerants. Early refrigerator models (from 1916) had a cold compartment for ice cube trays. From the late 1920s fresh vegetables were successfully processed through freezing by the Postum Company (the forerunner of General Foods), which had acquired the technology when it bought the rights to Clarence Birdseye's successful fresh freezing methods.

The first successful application of frozen foods occurred when General Foods heiress Marjorie Merriweather Post (then wife of Joseph E. Davies, United States Ambassador to the Soviet Union) deployed commercial-grade freezers in Spaso House, the US Embassy in Moscow, in advance of the Davies' arrival. Post, fearful of the USSR's food processing safety standards, fully stocked the freezers with products from General Foods' Birdseye unit. The frozen food stores allowed the Davies to entertain lavishly and serve fresh frozen foods that would otherwise be out of season. Upon returning from Moscow, Post (who resumed her maiden name after divorcing Davies) directed General Foods to market frozen product to upscale restaurants.

Home freezers as separate compartments (larger than necessary just for ice cubes), or as separate units, were introduced in the United States in 1940. Frozen foods, previously a luxury item, began to be commonplace.

General technical explanation



Vapor Compression Cycle – A: hot compartment (kitchen), B: cold compartment (refrigerator box), I: insulation, 1: Condenser, 2: Expansion valve, 3: Evaporator unit, 4: Compressor


An Embraco compressor and fan-assisted condenser coil

A vapor compression cycle is used in most household refrigerators, refrigerator–freezers and freezers. In this cycle, a circulating refrigerant such as R134a enters a compressor as low-pressure vapor at or slightly above the temperature of the refrigerator interior. The vapor is compressed and exits the compressor as high-pressure superheated vapor. The superheated vapor travels under pressure through coils or tubes comprising "the condenser", which are passively cooled by exposure to air in the room. The condenser cools the vapor, which liquefies. As the refrigerant leaves the condenser, it is still under pressure but is now only slightly above room temperature. This liquid refrigerant is forced through a metering or throttling device, also known as an expansion valve (essentially a pin-hole sized constriction in the tubing) to an area of much lower pressure. The sudden decrease in pressure results in explosive-like flash evaporation of a portion (typically about half) of the liquid. The latent heat absorbed by this flash evaporation is drawn mostly from adjacent still-liquid refrigerant, a phenomenon known as "auto-refrigeration". This cold and partially vaporized refrigerant continues through the coils or tubes of the evaporator unit. A fan blows air from the refrigerator or freezer compartment ("box air") across these coils or tubes and the refrigerant completely vaporizes, drawing further latent heat from the box air. This cooled air is returned to the refrigerator or freezer compartment, and so keeps the box air cold. Note that the cool air in the refrigerator or freezer is still warmer than the refrigerant in the evaporator. Refrigerant leaves the evaporator, now fully vaporized and slightly heated, and returns to the compressor inlet to continue the cycle.

An absorption refrigerator works differently from a compressor refrigerator, using a source of heat, such as combustion of liquefied petroleum gas, solar thermal energy or an electric heating element. These heat sources are much quieter than the compressor motor in a typical refrigerator. A fan or pump might be the only mechanical moving parts; reliance on convection is considered impractical.

The Peltier effect uses electricity to pump heat directly; this type of refrigerator is sometimes used for camping, or where noise is not acceptable. They can be totally silent (if they don't include a fan for air circulation) but are less energy-efficient than other methods.

Other uses of an absorption refrigerator (or "chiller") include large systems used in office buildings or complexes such as hospitals and universities. These large systems are used to chill a brine solution that is circulated through the building.

Many modern refrigerator/freezers have the freezer on top and the fridge on the bottom. Many ask the question "How does the fridge stay cold if the motor doesn't start when I turn the fridge knob?" This question is answered easily. Most fridge/freezers, with the exception of manual defrost models and/or cheaper models utilize what appears to be two thermostats. Only the freezer compartment is properly temperature controlled. When the freezer gets too warm, the thermostat starts the refrigeration process and a fan also starts. The air is circulated around the freezer. During this time, the fridge is also getting colder. The fridge temperature control knob is doing nothing to 'control' the temperature. This knob is only controlling the amount of air that actually flows into the fridge via a damper system. This means that the fridge may become too warm. However, because only enough air is partitioned off to the

fridge compartment, the freezer usually re-acquires the set temperature quickly, unless the door is opened. When a door is opened, either in the fridge or the freezer, the fan stops straight away to prevent excessive frost build up on the freezer's evaporator coil (because this coil is technically cooling two areas). When the freezer reaches temperature, the unit cycles off, no matter what temperature the fridge is at. Some people recommend setting the fridge to max and the freezer to a point where your fridge food won't freeze.

There are also many complaints about fridge/freezers being kept in garages. One very common complaint is that the freezer is defrosted, but the fridge is not. This occurs when the temperature becomes cool enough to cool the inside of the fridge. Because the fridge thinks the temperature is ok, it won't start unless warm beverages etc. are added. When this happens, the freezer thaws. It is therefore recommended to keep this type of fridge/freezer in a place where it won't get this cold. If the fridge compartment is the sole temperature controller, then, due to the design, the unit is likely to run for a longer amount of time, which will in turn keep the freezer very cold.

Modern, computerized refrigerators do not use the damper system. The computers manage fan speed for both compartments (although air is still pumped from the freezer).

Other alternatives to the vapor-compression cycle but not in current use include thermionic, vortex tube, air cycle, magnetic cooling, Stirling cycle, Malone refrigeration, acoustic cooling, pulse tube and water cycle systems.[15]

Features

Newer refrigerators may include:

- Automatic defrosting;
- A power failure warning, alerting the user by flashing a temperature display. The maximum temperature reached during the power failure may be displayed, along with information on whether the frozen food has defrosted or may contain harmful bacteria;
- Chilled water and ice available from an in-door station, so that the door need not be opened;

The inside of a home refrigerator containing a large variety of everyday food items.

Water and Ice Dispensing became available in the 1970s. Also some refrigerators have icemakers built-in so the user doesn't have to use ice trays. Some refrigerators have water chillers and water filtration systems.

- Cabinet rollers that allow the refrigerator to be easily rolled around for easier cleaning;
- Adjustable shelves and trays which can be repositioned to suit the user;
- A Status Indicator to notify the user when it is time to change the water filter;
- An in-door ice caddy, which relocates the ice-maker storage to the freezer door and saves approximately 60 litres (2 cu ft) of usable freezer space. It is also removable, and helps to prevent ice-maker clogging;
- A cooling zone in the refrigerator door shelves. Air from the freezer section is diverted to the refrigerator door, to cool milk or juice stored in the door shelf.

Early freezer units accumulated ice crystals around the freezing units. This was a result of humidity introduced into the units when the doors to the freezer were opened condensing on the cold parts, then freezing. This frost buildup required periodic thawing ("defrosting") of the units to maintain their efficiency. Manual Defrost (referred to as Cyclic) units are still available. Advances in automatic defrosting eliminating the thawing task were introduced in the 1950s, but are not universal, due to energy performance and cost. These units utilized a counter, that only defrosted the freezer compartment (Freezer Chest) when a specific number of door openings had been made. The units were just a small timer combined with an electrical heater wire which heated the freezer's walls for a short

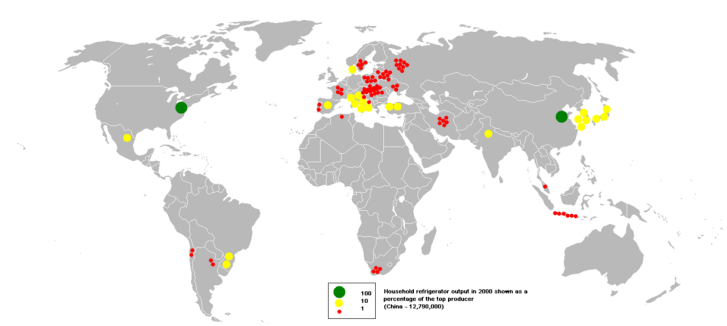
amount of time to remove all traces of frost/frosting. Also, early units featured freezer compartments located within the larger refrigerator, and accessed by opening the refrigerator door, and then the smaller internal freezer door; units featuring an entirely separate freezer compartment were introduced in the early 1960s, becoming the industry standard by the middle of that decade. These older freezer compartments were the main cooling body of the refrigerator, and only maintained a temperature of around -6°C, which is suitable for keeping food for a week.

Later advances included automatic ice units and self compartmentalized freezing units.

An increasingly important environmental concern is the disposal of old refrigerators – initially because of the freon coolant damaging the ozone layer, but as the older generation of refrigerators disappears it is the destruction of CFC-bearing insulation which causes concern. Modern refrigerators usually use a refrigerant called HFC-134a (1,1,1,2-Tetrafluoroethane), which does not deplete the ozone layer, instead of freon. A R-134a is now becoming very uncommon in Europe. Instead, newer refrigerants are being used instead. The main refrigerant now used is R-600a, or Isobutane. This refrigerant is naturally occurring and therefore has a smaller effect on the atmosphere, if released. There have been some reports of refrigerators exploding, if the refrigerant leaks and comes into contact with a spark.

Disposal of discarded refrigerators is regulated, often mandating the removal of doors; children playing hide-and-seek have been asphyxiated while hiding inside discarded refrigerators, particularly older models with latching doors. Since August 2, 1956, under U.S. federal law, refrigerator doors are no longer permitted to lock from the inside.[16] More modern units use a magnetic door gasket which holds the door sealed but can be pushed open from the inside. This gasket was invented by Herman C. Ells Sr.[17]

Types of domestic refrigerators



Household refrigerator output in 2000

Domestic refrigerators and freezers for food storage are made in a range of sizes. Among the smallest is a 4 L Peltier fridge advertised as being able to hold 6 cans of beer. A large domestic fridge stands as tall as a person and may be about 1 m wide with a capacity of 600 L. Some models for small households fit under kitchen work surfaces, usually about 86 cm high. Fridges may be combined with freezers, either stacked with fridge or freezer above, below, or side by side. A fridge without a frozen food storage compartment may have a small section just to make ice cubes. Freezers may have drawers to store food in, or they may have no divisions (chest freezers).

Fridges and freezers may be free-standing, or built into a kitchen.

- Compressor refrigerators are by far the most common type; they make a noticeable noise.
- Absorption refrigerators or thermo-electric Peltier units are used where quiet running is required; Peltier coolers are used in the smallest refrigerators as they have no bulky mechanism.
- Compressor and Peltier refrigerators are powered by electricity; absorption units can be designed to be powered by any heat source. A noticeable difference between the two types is the absence of refrigerant with the Peltier coolers (these use a different method of cooling). But Peltier coolers use more electricity because they are thermodynamically inefficient.
- Oil, gas (natural gas or propane) and dual power gas/electricity units are also available (typically found in RV's).
- Solar refrigerators and Thermal mass refrigerators are designed to reduce electrical consumption. Solar refrigerators have the added advantage that they do not use refrigerants that are harmful to the environment or

flammable. Typical solar designs are absorption refrigerators that use ammonia as the working gas, and employ large mirrors to concentrate sufficient sunlight to reach the temperature required to free gaseous ammonia from the solvent.[18] [19] Most thermal mass refrigerators are designed to use electricity intermittently. As these units are heavily insulated, cooling load is limited primarily to heat introduced by new items to be refrigerated, and ambient air transfer when the unit is open. Very little power is therefore required if opened infrequently. Refrigeration units for commercial and industrial applications can be made in various size, shape or style to fit customer needs.

Other specialised cooling mechanisms may be used for cooling, but have not been applied to domestic refrigerators.

- Magnetic refrigerators are refrigerators that work on the magnetocaloric effect. The cooling effect is triggered by placing a metal alloy in a magnetic field.[20]
- Acoustic refrigerators are refrigerators that use resonant linear reciprocating motors/alternators to generate a sound which is then converted to heat and cold using compressed helium gas. The heat is descarded and the cold is routed to the refrigerator.[21]

Energy efficiency

Modern refrigerators

In the past, refrigerators consumed more energy than any other home appliance, but in the last twenty years progress has been made to design, manufacture, and encourage the sale of refrigerators with improved energy efficiency. In the early 1990s a competition was held among the major manufacturers to encourage energy efficiency. Current models that are Energy Star qualified use 50 percent less energy than the average models made in 1974.[22] The most energy-efficient unit made in the US consumes about half a kilowatt-hour per day.[23] But even ordinary units are quite efficient; some smaller units use less than 0.5 kilowatt-hour. Larger units, especially those with large freezers and icemakers, may use as much as 4 kW·h per day. The small, mini-fridge (or bar fridge), is an example of bad design. Because these fridges are so small and lacking in large amounts of capacity, when the door is opened a large amount of the cool air escapes, leaving a large amount of warm, moist air for the unit to cool down. This means, if the unit is cycled off when the door is opened, it is likely the unit will start almost as soon as the door is shut.

Among the different styles of refrigerators, top-freezer models are more efficient than bottom-freezer models of the same capacity, which are in turn more efficient than side-freezer models. Models with through-the-door ice units are less efficient than those without.[24] Dr. Tom Chalko in Australia has developed an external thermostat to convert any chest freezer into a chest fridge using only about 0.1kWh per day—the amount of energy used by a 100 watt light bulb in one hour.[25] A similar device is manufactured by Johnson Controls.[26] Scientists at Oxford University have reconstructed a refrigerator invented in 1930 by Leó Szilárd and Albert Einstein in their efforts to replace current technologies with energy efficient green technology. The Einstein refrigerator operates without electricity and uses no moving parts or greenhouse gases.[27]

Many refrigerators made in the 1930s and 1940s were far more efficient than most that were made later. This is partly attributable to the addition of new features, such as auto-defrost, that reduced efficiency. Additionally, post World War 2, refrigerator style became more important than efficiency. This was especially true in the 1970s, when side by side models with ice dispensers and water chillers became popular. However, the reduction in efficiency also

comes partly from cost cutting (less insulation). Due to the introduction of new energy requirements, refrigerators made today are much more efficient than those made in the 1930s; they consume the same amount of energy while being three times as large. [28] [29]

The efficiency of older refrigerators can be improved by defrosting (if the unit is manual defrost) and cleaning them regularly, replacing old and worn door seals with new ones, adjusting the thermostat to be appropriate to the actual contents (a fridge doesn't need to be colder than 4°C if it is storing drinks and non-perishable items only) and also replacing insulation, where applicable. Some sites recommend that you clean the condenser coils every month or so on units that have coils on the rear. It has been proved that this does very little for improving efficiency, however, the unit should be able to 'breathe' with adequate spaces around the front, back, sides and above the unit. If the refrigerator uses a fan to keep the condenser cool, then this must be cleaned, at the very least, yearly.

Frost Free refrigerators and/or freezers utilize electric fans to cool the appropriate compartment. This could be referred to as a 'Fan Forced' refrigerator, whereas manual defrost units rely on colder air lying at the bottom, versus the warm air at the top to achieve adequate cooling. The air is drawn in through an inlet duct and passed through the evaporator where it is cooled, the air is then circulated through-out the cabinet via a series of ducts and vents. Because the air passing the evaporator is supposedly warm and moist, frost begins to form on the evaporator (especially on a freezer's evaporator). In cheaper and/or older models, a defrost cycle was controlled via a mechanical timer. This timer was set to shut off the compressor and fan and energize a heating element located at the base of the evaporate for up to 30 minutes. This melted any frost or ice build up and allowed the refrigerator to work normally once more. It is believed that frost free units have a lower tolerance for frost, due to their air-conditioner like evaporator coils. Therefore, if a door is left open accidentally (especially the freezer), the defrost system may not remove all frost, in this case, the freezer (or fridge) must be defrosted.

If the defrosting system melts all the ice before the timed defrosting period ends, then a small device (called a Defrost Terminator) acts like a thermostat and shuts off the heating element to prevent too large a temperature fluctuation, it also prevents hot blasts of air when the system starts again, should it finish defrosting early. When the 30 minutes or so defrost is completed, the compressor and fan are allowed to cycle back on if necessary.

Single frost free fridge units that are frost free generally don't shut off their fans whilst defrosting. This allows consumers to leave food in the main fridge compartment uncovered, and also helps keep any vegetables some-what moist. This method also helps reduce energy consumption, because a fridge is above freeze point, the warmer than freezing air can be passed through the evaporator to aid the defrosting cycle. The less time the electric heater element is left on, the lower the energy consumption.

Regarding total life-cycle costs, many governments offer incentives to encourage recycling of old refrigerators. One example is the Phoenix fridge program launched in Australia. This government incentive picked up old refrigerators, paying their owners for 'donating' the fridge. The fridge was then refurbished, with new door seals, a thorough cleaning and the removal of items, such as the cover that is strapped to the back of many older units. The resulting fridges, now over 10% more efficient, were then distributed to low income families.

Effect on lifestyle

The refrigerator allows the modern family to keep food fresh for much longer than before. This, along with the modern supermarket, allows most families, without a sizable garden in which to grow vegetables and raise animals, a vastly more varied diet and improved health resulting from improved nutrition. Dairy products, meats, fish, poultry and vegetables can be kept refrigerated in the same space within the kitchen (although raw meat should be kept separate from other foodstuffs for reasons of hygiene).

The refrigerator lets people eat more salads, fresh fruits and vegetables, without having to own a garden or an orchard. Exotic foodstuffs from far-off countries that have been imported by means of refrigeration can be enjoyed in the home because of domestic refrigeration.

While allowing more healthy foods to be stored for longer times, more refrigerators and freezers are stocked with processed, quick-cook foods that are less healthy. Studies connecting the correlation between frozen (microwaved) foods and obesity have proven that access to easy meals has led to a general decline in overall health.[30]

Freezers allow households to buy food in bulk: it can be eaten at leisure, and bulk purchase saves money. Ice cream, a popular commodity of the 20th century, could previously only be obtained by traveling long distances to where the product was made fresh, and had to be eaten on the spot. Now it is a common food item. Ice on demand not only adds to the enjoyment of cold drinks, but is useful for first-aid, and for cold packs that can be kept frozen for picnics or in case of emergency.

Temperature zones and ratings

Some refrigerators are now divided into four zones to store different types of food:

- −18 °C (−0 °F) (freezer)
- 0 °C (32 °F) (meats)
- 5 °C (41 °F) (refrigerator)
- 10 °C (50 °F) (vegetables)

The capacity of a refrigerator is measured in either litres or cubic feet. Typically the volume of a combined fridge-freezer is split to 100 litres (3.53 cubic feet) for the freezer and 140 litres (4.94 cubic feet) for the refrigerator, although these values are highly variable.

Temperature settings for refrigerator and freezer compartments are often given arbitrary numbers by manufacturers (for example, 1 through 9, warmest to coldest), but generally 3 to 5 °C (37 to 41 °F)[1] is ideal for the refrigerator compartment and −18 °C (−0 °F) for the freezer. Some refrigerators are required to be within certain external temperature parameters to run properly. This can be an issue when placing units in an unfinished area such as a garage.

European freezers, and refrigerators with a freezer compartment, have a four star rating system to grade freezers.

- [*] : min temperature = −6 °C (21 °F). Maximum storage time for (pre-frozen) food is 1 week
- [**] : min temperature = −12 °C (10 °F). Maximum storage time for (pre-frozen) food is 1 month
- [***] : min temperature = −18 °C (−0 °F). Maximum storage time for (pre-frozen) food is between 3 and 12 months depending on type (meat, vegetables, fish, etc)
- [□[***] : min temperature = −18 °C (−0 °F). Maximum storage time for pre-frozen or frozen-from-fresh food is between 3 and 12 months

Although both the three and four star ratings specify the same storage times and same minimum temperature of -18°C, only a four star freezer is intended to be used for freezing fresh food, and may include a "fast freeze" function (runs the compressor continually, down to as low as -26'C) to facilitate this. Three (or fewer) stars are used for frozen food compartments which are only suitable for storing frozen food; introducing fresh food into such a compartment is likely to result in unacceptable temperature rises. This difference in categorisation is shown in the design of the 4-star logo, where the "standard" three stars are displayed in a box using "positive" colours, denoting the same normal operation as a 3-star freezer, and the fourth star showing the additional fresh food/fast freeze function is prefixed to the box in "negative" colours or with other distinct formatting.

Most European refrigerators include a moist cold fridge section (which does require (automatic) defrosting at irregular intervals) and a (rarely frost free) freezer section.

Recycling

Old refrigerators have been adapted to create low cost passive solar water heating systems.[31] Also, many refrigerators have been refurbished for low-income families in eastern Australia via the Phoenix fridge program (see energy efficiency)

In Mexico the Federal Government has created the program CAMBIA TU VIEJO POR UNO NUEVO (change your old fridge by a new one). This program consists on changing an old fridge for a new one. The old fridges are recycled to recover its components: refrigerant gas, copper, glass, iron, etc. [32]

Notes and references

[1] http://www.bbc.co.uk/bloom/actions/fridgefreezertips.shtml

[2] Jstor.org: Household appliances and the use of time: the United States and Britain since the 1920s (http://links.jstor.org/sici?sici=0013-0117(199411)2:47:4<725:HAATUO>2.0.CO;2-X)

[3] http://farm3.static.flickr.com/2737/4151458467_58ff5e8523_b.jpg

[4] Jaime Derringer, "Amana Color" (http://design-milk.com/amana-color/), *Design Milk* (website), March 3, 2009

[5] Pitman, Vicki (2004). *Aromatherapy: A Practical Approach*. Nelson Thornes. p. xi. ISBN 0748773460.

[6] Myers, Richard (2003). *The Basics of Chemistry*. Greenwood Publishing Group. p. 14. ISBN 0313316643.

[7] Marlene Ericksen (2000), *Healing with Aromatherapy*, p. 9, McGraw-Hill, ISBN 0658003828

[8] *How It Works: Science and Technology* (http://books.google.com/books?id=tGB0zbNtsEMC&pg=PA1945&dq=William+Cullen+demonstration+of+refrigeration&hl=en&ei=Lc5CTr2aEsy1twfasdyoCQ&sa=X&oi=book_result&ct=result&resnum=1&ved=0CC4Q6AEwAA#v=onepage&q&f=false). Marshall Cavendish. .

[9] *Encyclopedia of 20th-century technology, Volume 2* (http://books.google.com/books?id=0wkIlnNjDWcC&pg=PA672&dq=Oliver+Evans+and+refrigeration&hl=en&ei=bNNCTszqBYX30gGqt_y1Ag&sa=X&oi=book_result&ct=result&resnum=2&ved=0CC8Q6AEwAQ#v=onepage&q&f=false). Taylor & Francis. .

[10] *Modern Engineering Thermodynamic* (http://books.google.com/books?id=VC-RuN6moREC&pg=PA543&dq=Jacob+Perkins+refrigeration&hl=en&ei=iNBCTqKdIqTX0QH5ofW1CQ&sa=X&oi=book_result&ct=result&resnum=6&ved=0CEQQ6AEwBQ#v=onepage&q&f=false). Academic Press. .

[11] "Gorrie's Fridge" (http://www.phys.ufl.edu/~ihas/gorrie/fridge.htm). John Gorrie State Museum. .

[12] *Refrigeration Systems and Applications* (http://books.google.com/books?id=HSgmAJ3fxlkC&pg=PA106&dq=Alexander+Twining+refrigeration&hl=en&ei=0NFCTtH-IdGltwfs79C0CQ&sa=X&oi=book_result&ct=result&resnum=1&ved=0CCoQ6AEwAA#v=onepage&q&f=false). Jon Wiley and Sons. .

[13] "Barfly Fridge History" (http://www.barfly.ca/english/history.html). Barfly. .

[14] "Frigidaire Parts" (http://www.applianceservice.com/frigidaire.php). Appliance Service. .

[15] IIFIIR.org (http://www.iifiir.org/en/doc/1051.pdf)

[16] http://law.justia.com/cfr/title16/16-2.0.1.6.79.html

[17] Adams, Cecil (2005). "Is it impossible to open a refrigerator door from the inside?" (http://www.straightdope.com/columns/050304.html). . Retrieved 2006-08-31.

[18] Thermal mass refrigerators (http://blog.thegreenv.com/?p=191)

[19] Solar refrigerators for developing world (http://news.cnet.com/Hawaiian-firm-shrinks-solar-thermal-power/2100-11392_3-6207877.html)

[20] Magnetic refrigerators (http://www.physorg.com/news64851465.html)

[21] Q-Drive acoustic refrigerator (http://www.qdrive.com/UI/ProductsListing.aspx?mcid=111&pcid=111&ccid=111)

[22] "Refrigerators & Freezers" (http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators). Energy Star. .

[23] Humboldt.edu (http://www.humboldt.edu/~ccat/energyconservation/sunfrost/kosukiSP2002/index.html#runs)

[24] "What's more energy efficient, a refrigerator with a top-mounted freezers, bottom-mounted freezer, or a side-by-side?" (http://energystar.custhelp.com/cgi-bin/energystar.cfg/php/enduser/std_adp.php?p_faqid=4912). Energy Star. .

[25] "A fridge that takes only 0.1 kWh a day?" (http://mtbest.net/chest_fridge.pdf). MTbest.net. .

[26] Kegman.net (http://kegman.net/9025.html)

[27] "Albert Einstein Refrigerator" (http://www.inventor-strategies.com/albert-einstein-invention.html)

[28] "Successes of Energy Efficiency: The United States and California National Trust" (http://www.energy.ca.gov/2007publications/CEC-999-2007-023/CEC-999-2007-023.PDF). .

[29] "Out With the Old, In With the New" (http://www.nrdc.org/air/energy/appliance/app1.pdf). .

[30] . http://disease.disease.com/Diseases/Teen-Obesity.html.

[31] "More ways to recycle old refrigerators into low cost solar water heaters" (http://www.motherearthnews.com/Do-It-Yourself/1978-01-01/More-Ways-to-Recycle-Old-Refrigerators-into-Low-Cost-Solar-Water-Heaters.aspx). *Mother Earth News*. 1978 January. . Retrieved 2009-10-13.

[32] "Fridges recycling in Mexico" (http://www.ecofrigo.com.mx). *Ecofrigo*. . Retrieved 16 August 2011.

External links

- Refrigeration History (http://www.rogersrefrig.com/history.html)
- The History of the Refrigerator and Freezers (http://inventors.about.com/library/inventors/blrefrigerator.htm)
- How does a gas-powered fridge actually work (without compressor – using heater to power the heat transfer cycle) (http://web.archive.org/web/20040417020411/http://www.cam.net.uk/home/StKilda/electrolux.html) Archived Page
- Elert, Glenn. "Refrigerators" (http://hypertextbook.com/physics/thermal/refrigerators/). *The Physics Hypertextbook*.
- How Refrigerators Work (http://home.howstuffworks.com/refrigerator.htm) Article by HowStuffWorks
- Refrigerators (http://www.sciencetech.technomuses.ca/English/schoolzone/Domestic_Technology2.cfm#fridge), Canada Science and Technology Museum
- How Refrigerators Work and What goes wrong with them (http://www.apwagner.com/index.php?main_page=page&id=19) Article by Apwagner.com

Article Sources and Contributors

Refrigerator *Source*: http://en.wikipedia.org/w/index.php?oldid=445170040 *Contributors*: ...---...SOS, .:Ajvol:., 16@r, 4k7a2, A Softer Answer, A. B., AHRtbA==, Aarnev, AbdulRahiem, Academic Challenger, Adam850, Adambro, Aemiliano, Afluent Rider, After Midnight, Ahmed-shaqlawa, Ahoerstemeier, Alansohn, Albylion, Ale jrb, AlexDenney, Ali, Allstarecho, Almazi, Alsandro, Alvis, Amaraiel, Amazinrick, Andonic, Andres.felipe.ordonez, Andrewpmk, Andrewrp, Andy Dingley, Andycjp, Anna Frodesiak, Antandrus, Anwar saadat, Arafel6, Atlant, Aude, Averell23, B-D, BBnet3000, BFritzen, Baa, Bagpipes1, Baraderphead, Barek, Bartle1, Bastin, BenKovitz, Bender235, Bestbets1, Betterusername, Bigfella1221, Bilky asko, Bill82, Biscuittin, Blawk me, Bobblehead, Bobblewik, Bobo192, Bongwarrior, BorgQueen, BrainInstigator, BrentWii, Brian0918, Brusegadi, BuBZ, Burstroc, Bus stop, CSW1986, Caltas, CambridgeBayWeather, Can't sleep, clown will eat me, CanOfWorms, CanisRufus, Canyouhearmenow, Capricorn42, Casdious, Casey56, Catgut, Cathalwoods, Catslash, Cbustapeck, Cenarium, Chasingsol, Chendy, Chris the speller, ChrisHodgesUK, Christian75, Civil Engineer III, Ckatz, Clawed, Clement Cherlin, Closedmouth, Cmdrjameson, Code65536, Colanderman, Concernedresident's butler, Corti, Courcelles, Craptree, Crystallina, D0762, D4ni3l 26, DARTH SIDIOUS 2, DMahalko, Dabuddy, DaiTengu, DanielCD, Darrelljon, Davewild, DavidLevinson, Davidbod, Davidgend, Dekimasu, Delirium, Demott, Dennis Brown, DerHexer, Dgies, Doniago, DragonFury, Dragoon0106, Dslamngu, Dulciana, Dust Filter, Dustimagic, E23, Earlypsychosis, Ed Poor, EdGl, Eggman3, Ehrenkater, Elert, Eli lilly, Emdx, Emersoni, Enviroboy, Epbr123, EscapingLife, Ewlyahoocom, Ewulp, Falcon8765, Fbriere, Fede.Campana, Feesgo, Feinoha, Fiilott, FireSalamander, Fito, Flyguy649, Fomthebomb, Franny Wentzel, FreplySpang, Fresheneesz, Funandtrvl, Furrykef, Gadfium, Gail, Gaius Cornelius, GeeJo, Giftlite, Gimboid13, Gioto, Girdi, Gogo Dodo, GoingBatty, Golbez, Goodnightmush, Grafen, Groogle, Groogokk, Gwernol, HJ Mitchell, Hall Monitor, HamburgerRadio, Hanacy, Harvey994, Hdt83, HenryLi, Heron, Hetar, Hogibear, Hohum, Homer Landskirty, Hooperbloob, Horse583, Hot water heater, Hu12, Hut 8.5, Hydrargyrum, I dream of horses, IRP, Ibn Battuta, Icseaturtles, Ilikefroot, Indiana Edison, Infrogmation, Iridescent, IronGargoyle, Irule90, Isnow, JNW, JaGa, Jagged 85, Japa, Javert, Jeff Muscato, Jennavecia, Jimp, Jkstark, Jll, Jmanp11, Jmax-, Jmh123, Jmlk17, Joel gerhardt, John Kaduwanema, Johnkenyon, JohnnyB256, Johntheadams, Jose77, Joyous!, Juliancolton, KVDP, Karthik6129, Kayba, KelleyCook, Keno, Kes16rangers, KevinCuddeback, Kikos, Kilgar, KillerChihuahua, Kingadrock, Kingfish, Kingpin13, Kjkolb, Klingoncowboy4, KnowledgeOfSelf, Kollibris, Konradlk, Koolman2, Kornerkick29, Krillion, Kristoferb, Krrish23, L Kensington, LAX, Leon7, Lewis fat, Liehann, Liftarn, Lindenburg, Linnell, Logan, LonelyMarble, Lotje, Luk, Lumos3, Luna Santin, Luprecal, MADCOW6, MCB, MTT1981, MZMcBride, Magi Media, Mais oui!, Makemi, Marek69, Margana, Markome, Markt3, Martin451, Martpol, MarvintheParanoidAndroid, Mason117, Mattbrundage, Matthew Yeager, Max Naylor, Mbennett555, Mdw0, Meco, Melsaran, Mentifisto, Merope, MetricUSA, Mgiganteus1, Mhking, Michal Nebyla, Mikaey, Mike Selinker, Mikro2nd, Milad Mosapoor, Mild Bill Hiccup, Milkpowder, Minna Sora no Shita, Miraculousrandomness, Moe Epsilon, Mohsenkazempur, MoneyAdviceExpert, Monkeyman, Moonriddengirl, Moonroe, Mrwriter12345, Mwalimu59, Myscrnnm, N2e, NHJG, Nakon, Namazu-tron, Natitude, NatureA16, NawlinWiki, Neelix, NellieBly, Netjeff, NewEnglandYankee, Nihiltres, Nollid0331, Nopetro, Noq, Northamerica1000, Nsaa, Octahedron80, Odie5533, Ohnoitsjamie, Oli Filth, Omegatron, Omgtotzlawl, Orange Suede Sofa, Orthologist, Oxymoron83, PMDrive1061, Passapeg, Pauli133, Paxsimius, Peruvianllama, Peter Horn, Peter gk, Petiatil, Phaicles, Phil racicot, Phoenix-forgotten, Piano non troppo, Pietaster, Pinkadelica, Pol098, Pookity, Ppk01, Prolog, QVanillaQ, Quadibloc, Quaeler, Quintote, R'n'B, RadioActive, Ramajois, Random updater, Raul654, Raymondwinn, Rbarreira, Rcellsjr, RexNL, Rico402, Riki, Rivertorch, RjCan, Rmhermen, RobinHood70, Robinh, Rockintovanhalen, Ronewolf, Ronhjones, RoyBoy, Royalguard11, Roybadami, Rui Silva, SPUI, Sable232, Sallicio, Salvio giuliano, Samtheboy, Sanchopanza65, Saopaulo1, Science3456, ScottDavis, Sean 2015, Sean Whitton, Seaphoto, Seasonsgreetings, SebastianHelm, Sebleblanc, Seraphimblade, Seraphita, Sesshomaru, Shai-kun, Shawnc, Shinpah1, Shoeofdeath, Shultz IV, SigmaEpsilon, Sir Stig, Sknaht158, Sky Attacker, Skyezx, SlavaRybalka, Slither 18, Sluggy, Slysplace, Smalljim, Smartse, Sneakernets, Snowolf, Soccerisawesome, Sohelpme, Somebody in the WWW, SpaceFlight89, Speedevil, Spiesr, Spud Gun, SpyMagician, Squidraider, Srikarna, St.daniel, SteBee, Stephenb, Stevertigo, Strabismus, Stumanusa, SunDragon34, Supaluminal, SusanB123, SweetNeo85, Sydor Kovpak, Symane, TDS, Talkstosocks, Tcncv, Techy2674, Teh Teck Geek, Tgeairn, The RedBurn, The Thing That Should Not Be, The Wild Falcon, Thehelpfulone, Theroachman, Thollyness, Thumperward, Tiddly Tom, Tide rolls, Timrollpickering, Tinton5, Tiptoety, Tjmayerinsf, TjoeC, Tktktk, Tobby72, Tom harrison, Tommy2010, TrackFan, Trekphiler, Trisar, Triwbe, Truthkeeper88, Ttiotsw, Turnipface, Twinsday, Twostaricebox, UninvitedCompany, User A1, Utcursch, Vala M, VanBurenen, Vancouver Outlaw, Velella, Verne Equinox, Vinsci, Violetriga, Voodoom, Voortle, Vsmith, W guice, Waks-123, Wavelength, Wavemaster447, Wayne Slam, Weedwhacker128, Wellinever, WellsSt, WhisperToMe, Wiki-Man, Wikibofh, WikidSmaht, Wilderness Tech, Williamwade, Wimt, Winged-stone, Wj32, Wknight94, Wtmitchell, Xaosflux, Xionbox, Yak99, Yamamoto Ichiro, Yidisheryid, Yoganate79, Yonatan, Yvwv, Zedla, Zigger, Zzuuzz, Âme Errante, Ὁ οἶστρος, 每日飞龙, 1113 anonymous edits

Image Sources, Licenses and Contributors

file:2011-05-09 14-56-45 407.jpg *Source*: http://en.wikipedia.org/w/index.php?title=File:2011-05-09_14-56-45_407.jpg *License*: Creative Commons Attribution-Sharealike 3.0 *Contributors*: Milad Mosapoor (talk) FACEBOOK PAGE

Image:Juliesfridge.jpg *Source*: http://en.wikipedia.org/w/index.php?title=File:Juliesfridge.jpg *License*: Public Domain *Contributors*: Original uploader was LaraLove at en.wikipedia

File:1963 Refrigerator.jpg *Source*: http://en.wikipedia.org/w/index.php?title=File:1963_Refrigerator.jpg *License*: Public Domain *Contributors*: Phil Racicot

File:Gorrie Ice Machine.png *Source*: http://en.wikipedia.org/w/index.php?title=File:Gorrie_Ice_Machine.png *License*: Public Domain *Contributors*: Original uploader was JW1805 at en.wikipedia

File:Monitor refer.jpg *Source*: http://en.wikipedia.org/w/index.php?title=File:Monitor_refer.jpg *License*: GNU Free Documentation License *Contributors*: Big Bird, Gurch, Infrogmation, Magi Media, 2 anonymous edits

File:Refrigerator-cycle.svg *Source*: http://en.wikipedia.org/w/index.php?title=File:Refrigerator-cycle.svg *License*: GNU Free Documentation License *Contributors*: Original source file: User:Ilmari Karonen Original uploader was Keno at en.wikipedia. Later version(s) were uploaded by Homer Landskirty at en.wikipedia.

File:Refrigeration comp and coil.jpg *Source*: http://en.wikipedia.org/w/index.php?title=File:Refrigeration_comp_and_coil.jpg *License*: Creative Commons Attribution-Sharealike 3.0 *Contributors*: User:Kristoferb

File:Fridgeinterior.jpg *Source*: http://en.wikipedia.org/w/index.php?title=File:Fridgeinterior.jpg *License*: Public Domain *Contributors*: Original uploader was Seasonsgreetings at en.wikipedia

File:2000refrigerator (household).PNG *Source*: http://en.wikipedia.org/w/index.php?title=File:2000refrigerator_(household).PNG *License*: Creative Commons Attribution-Sharealike 3.0 *Contributors*: User:Anwar_saadat/bubble_maps_(FAQ)

File:ExpensiveRefrigerators.JPG *Source*: http://en.wikipedia.org/w/index.php?title=File:ExpensiveRefrigerators.JPG *License*: Public Domain *Contributors*: Id1337x

License