## Magnetic refrigerator

In the United States, Astronautics Corp. and Ames Laboratory have jointly demonstrated the world's first room-temperature, permanent-magnet refrigerator. Unlike conventional vapour-cycle fridges that use ozone-depleting refrigerants and energy-consuming compressors, the new equipment uses gadolinium metal that heats up when exposed to a magnetic field, then cools down when the magnetic field is removed. According to Ames Laboratory Senior Metallurgist Mr. Karl Gschneidner, previous successful demonstration fridges used large superconducting magnets, but this is the first to use a permanent magnet and operate at room temperature. Further tests have been scheduled to achieve larger temperature swings that would allow the technology to provide the cooling power required for specific markets such as home refrigerators, air-conditioning, electronics cooling and fluid chilling.

Based on a rotary design, the magnetic fridge consists of a wheel that contains segments of gadolinium powder and a high-powered, rare-earth permanent magnet. The wheel is arranged to pass through a gap in the magnet where the magnetic field is concentrated. As it passes through this field, the gadolinium in the wheel exhibits a large magnetocaloric effect, it heats up. After the gadolinium enters the field, water is circulated to draw the heat out of the metals. As the material leaves the magnetic field, the material cools further as a result of the magnetocaloric effect. A second stream of water is then cooled by the gadolinium. This water is then circulated through the refrigerator's cooling coils. The overall result is a compact unit that runs virtually silent and nearly vibration-free, without the use of ozone-depleting gases.

Additionally, two new developments at Ames Laboratory could lead to even greater advances on the magnetic refrigeration frontier. Scientists have developed a process for producing kilogram quantities of $Gd_5(Si_2Ge_2)$ alloy using commercial-grade gadolinium. $Gd_5(Si_2Ge_2)$ exhibits a giant magnetocaloric effect that promises to outperform gadolinium powders used in the current rotary refrigerator. The second breakthrough is the design for a permanent magnet configuration capable of producing a stronger magnetic field. The new magnet can produce a magnetic field nearly twice as powerful as that produced by the magnet used in the demonstration unit. (Website: www.external.ameslab.gov)