View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by NASA Technical Reports Server

Green Design

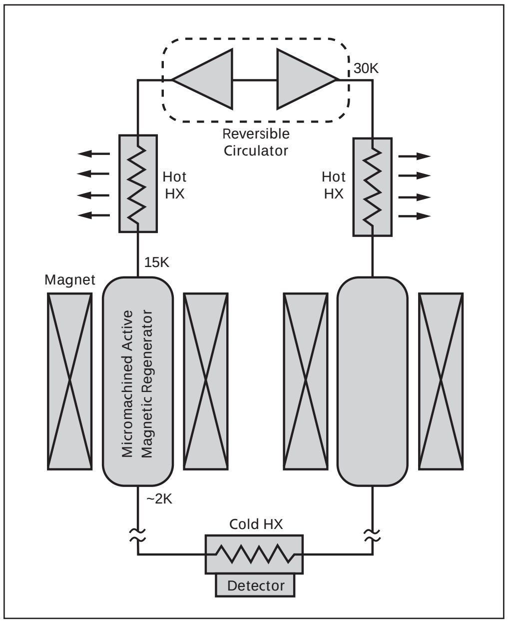
Lightweight Magnetic Cooler With a Reversible Circulator

This lightweight design features relatively high efficiency.

Goddard Space Flight Center, Greenbelt, Maryland

A design of a highly efficient and lightweight space magnetic cooler has been developed that can continuously provide remote/distributed cooling at temperatures in the range of 2 K with a heat sink at about 15 K. The innovative design uses a cryogenic circulator that enables the cooler to operate at a high cycle frequency to achieve a large cooling capacity. The ability to provide remote/distributed cooling not only allows flexible integration with a payload and spacecraft, but also reduces the mass of the magnetic shields needed.

The active magnetic regenerative refrigerator (AMRR) system is shown in the figure. This design mainly consists of two identical magnetic regenerators surrounded by their superconducting magnets and a reversible circulator. Each regenerator also has a heat exchanger at its warm end to reject the magnetization heat to the heat sink, and the two regenerators share a cold-end heat exchanger to absorb heat from a cooling target.



System Schematic of a Magnetic Cooler with a reversible circulator. (Note: HX is heat exchanger)

The circulator controls the flow direction, which cycles in concert with the magnetic fields, to facilitate heat transfer. Helium enters the hot end of the demagnetized column, is cooled by the refrigerant, and passes into the cold-end heat exchanger to absorb heat. The helium then enters the cold end of the magnetized column, absorbing heat from the refrigerant, and enters the hot-end heat exchanger to reject the magnetization heat. The efficient heat transfer in the AMRR allows the system to operate at a relatively short cycle period to achieve a large cooling power.

The key mechanical components in the magnetic cooler are the reversible circulator and the magnetic regenerators. The circulator uses non-contacting, self-acting gas bearings and clearance seals to achieve long life and vibration-free operation. There are no valves or mechanical wear in this circulator, so the reliability is predicted to be very high. The magnetic regenerator employs a structured bed configuration. The core consists of a stack of thin GGG disks alternating with thin polymer insulating films. The structured bed reduces flow resistance in the regenerator and therefore the pumping work by the cryogenic circulator.

This magnetic cooler will enable cryogenic detectors for sensing infrared, x-ray, gamma-ray, and submillimeter radiation in future science satellites, as well as the detector systems in the Constellation-X (Con-X) and the Single Aperture Far-Infrared observatory (SAFIR). Scientific applications for this innovation include cooling for x-ray microcalorimeter spectrometers used for microanalysis, cryogenic particle detectors, and superconducting tunnel junction detectors for biomolecule mass spectrometry. The cooler can be scaled to provide very large cooling capacities at very low temperatures, ideal for liquid helium and liquid hydrogen productions.

This work was done by Weibo Chen and John McCormick of Creare, Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15410-1

The Invasive Species Forecasting System

Applications built using the Invasive Species Forecasting System help natural resource managers model habitat suitability for non-native, invasive plants.

Goddard Space Flight Center, Greenbelt, Maryland

The Invasive Species Forecasting System (ISFS) provides computational support for the generic work processes found in many regional-scale ecosystem modeling applications. Decision support tools built using ISFS allow a user to load point occurrence field sample data for a plant species of interest and quickly generate habitat suitability maps for geographic regions of management concern, such as a national park, monument, forest, or refuge. This type of decision product helps resource managers plan invasive species protection, monitoring, and control strategies for the lands they manage. Until now, scientists and resource managers have lacked the data-assembly and computing capa-