Green Design

Spacecraft Radiator Freeze Protection Using a Regenerative Heat Exchanger

Heat load is reduced by more than half.

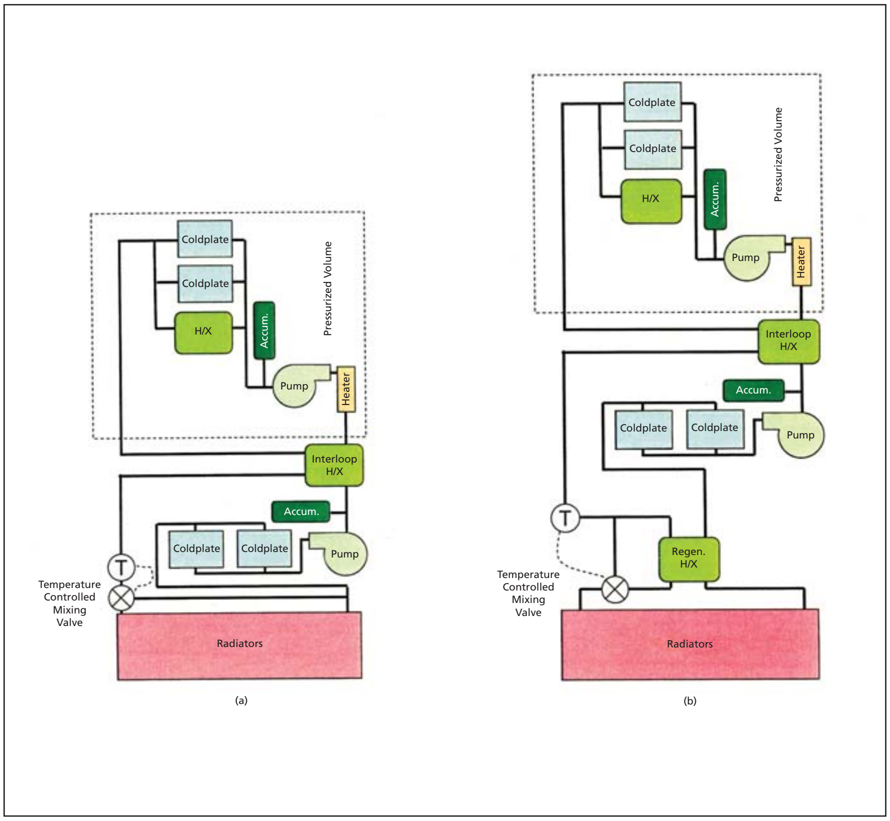
Lyndon B. Johnson Space Center, Houston, Texas

An active thermal control system architecture has been modified to include a regenerative heat exchanger (regenerator) inboard of the radiator. Rather than using a radiator bypass valve, as illustrated in (a), a regenerative heat exchanger is placed inboard of the radiators as shown in (b). A regenerator cold side bypass valve is used to set the return temperature.

During operation, the regenerator bypass flow is varied, mixing cold radiator return fluid and warm regenerator outlet fluid to maintain the system setpoint. At the lowest heat load for stable operation, the bypass flow is closed off, sending all of the flow through the regenerator. This lowers the radiator inlet temperature well below the system setpoint while maintaining full flow through the radiators.

By using a regenerator bypass flow control to maintain system setpoint, the required minimum heat load to avoid radiator freezing can be reduced by more than half compared to a radiator bypass system.

This work was done by Eugene K. Ungar and Richard G. Schunk of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-24423-1



(a) **Active Thermal Control System** with radiator bypass; (b) **Active Thermal Control System Design** with regenerator bypass.

Multi-Mission Power Analysis Tool

NASA's Jet Propulsion Laboratory, Pasadena, California

Multi-Mission Power Analysis Tool (MMPAT) Version 2 simulates spacecraft power generation, use, and storage in order to support spacecraft design, mission planning, and spacecraft operations. It can simulate all major aspects of a spacecraft power subsystem. It is parametrically driven to reduce or eliminate the need for a programmer. A user-friendly GUI (graphical user interface) makes it easy to use. Multiple deployments allow use on the desktop, in batch mode, or as a callable library. It includes detailed models of solar arrays, radioisotope thermoelectric generators, nickel-hydrogen and lithium-ion batteries, and various load types. There is built-in flexibility through user-designed state models and table-driven parameters.

MMPAT simulates a spacecraft power subsystem including the power source (solar array and/or radioisotope thermoelectric generator), bus-voltage control, secondary battery (lithium-ion or nickel-hydrogen), thermostatic heaters, and power-consuming equipment. It handles multiple mission types including heliocentric orbiters, planetary orbiters, and surface operations. Being parametrically driven, along with its user-programmable features, MMPAT can reduce or even eliminate any need for software modifications when configuring it for a particular spacecraft. It provides multiple levels of fidelity, thereby fulfilling the vast majority of a project's power simulation needs throughout the life cycle. It can operate in a standalone mode with