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Adiabatic Demagnetization Refrigerator
for the
ASTRO-E Project
Final Report

Grant Number NAG5-7101

Overview

The University of Wisconsin Space Science and Engineering Center fabricated, assembled, and tested a Salt Pill, P/N 1300-0006 S/N-002, for use in an Adiabatic Demagnetization Refrigerator (ADR) system for the Astro-E mission. The S/N-002 salt pill was built as a flight spare prior to the ASTRO-E launch.

The S/N-001 and S/N-002 salt pills incorporated several design changes that improved reliability and thermal performance. The design provided the following features:

- Equivalent or better thermal performance as compared to previous design performances: Functional performance testing of the salt pill at Goddard Space Flight Center (GSFC) showed the salt pill to have greater cooling capacity and a shorter recycle time than previous salt pills. The measured parasitic heat load, heat capacity, and eddy current heating values were at or better than design standards.
- Improved reliability, specifically the inclusion of a hermetically sealed container to prevent the degradation of the Ferric Ammonium Alum (FAA): To achieve improved reliability, the design eliminated the use of epoxy seals. This required the utilization of stainless steel, gold, and stycast epoxy. These materials are impervious to FAA. The thermal bus consisted of sixteen hundred 0.008 inch diameter gold wires strung between two grid plates. The wires were bundled into groups of 200. Each bundle was terminated into one the four copper Front End Assembly (FEA) bus bars or into one the four studs on the copper Heat Switch Base Mount (HSBM). The bus assembly is mounted into a stainless steel tube that is hermetically sealed with a Tungsten Inert Gas (TIG) weld. The FAA salt was grown in the tube through a port on end. The port was sealed off with a plug TIG welded in place. The gold wire terminations into the copper were sealed off from the FAA with stycast epoxy.
- Prevention of thermal shorting of the gas gap heat switch: The gas gap heat switch thermally connects to the salt pill via mounting surfaces on the Heat Switch Base Mount (HSBM). The HSBM has twelve small pads each with a #2-56 Keensert. The surface of each pad was plated with 300 ± 50 microns of soft gold. This presents a soft, malleable surface to provide an effective thermal connection between the heat switch and the salt pill.
- Compatible with GSFC ADR interfaces: The salt pill design provided mounting holes and surfaces on each end for the installation of GSFC brackets for configuring the salt pill in the suspension system. The length and outside diameter fit within the ASTRO-E cryostat envelope.

Schedule

The following summarizes the flow of activities from January to October 1998.

January	Fabrication of parts
April	Complete part machining Prepare bundles and silver braze into FEA bus bars Silver braze the insulation ring & Heat Switch Base Mount (poor brazing, parts remachined and brazed together)

- May New HSBM and insulation ring complete
 Silver brazed HSBM and insulation ring together, forms "copper plug"
 Silver brazed gold wire bundles into the copper plug
 Perform conductivity test on FEA bus bars and copper plug
 Parts helium leak tested
- June FEA rods and copper plugs gold plated
 Welded center cup with sleeves to the insulation ring on the copper plug.
 Assembled grid plates and spacers
 Strung the 1,600 gold wires between the grid plates
 Annealed gold wires
 Applied stycast epoxy to the bottom end grid plate and trimmed wires
- July Installed fixturing hardware for welding
 Welded the FEA bus bar sleeves to the Top Plug Ring and then the Top Plug Ring
 to the center cup
 Helium leak tested the assembly
 Installed dams and applied stycast epoxy to the gold wire bundles
- August Welded the tube to the Top Plug Ring
 Welded the bottom cap to the tube
 Helium leak tested the assembly
 Pressure tested
 Helium leak tested the assembly
- September Masked the salt pill exterior
 Copper plated exterior
 Remove masked and cleaned-up excess copper plating
 Gold plated the exterior
 Tapped the HSBM and installed Keenserts
 Grew FAA
- October Dye penetrant inspected
 Drilled & tapped FEA bus bars for keenserts
 Cryogenic temperature cycled
 Final helium leak test

Delivery

The salt pill was shipped to GSFC on Monday October 26, 1998 via Midwest Express Airlines.
 Dr. Scott Porter of GSFC took receipt of the salt pill at Reagan National Airport.