



Books & Reports

Sheet Membrane Spacesuit Water Membrane Evaporator

A document describes a sheet membrane spacesuit water membrane evaporator (SWME), which allows for the use of one common water tank that can supply cooling water to the astronaut and to the evaporator. Test data showed that heat rejection performance dropped only 6 percent after being subjected to highly contaminated water. It also exhibited robustness with respect to freezing and Martian atmospheric simulation testing. Water was allowed to freeze in the water channels during testing that simulated a water loop failure and vapor backpressure valve failure. Upon closing the backpressure valve and energizing the pump, the ice eventually thawed and water began to flow with no apparent damage to the sheet membrane.

The membrane evaporator also serves to de-gas the water loop from entrained gases, thereby eliminating the need for special degassing equipment such as is needed by the current spacesuit system.

As water flows through the three annular water channels, water evaporates with the vapor flowing across the hydrophobic, porous sheet membrane to the vacuum side of the membrane. The rate at which water evaporates, and therefore, the rate at which the flowing water is cooled, is a function of the difference between the water saturation pressure on the water side of the membrane, and the pressure on the vacuum side of the membrane. The primary theory is that the hydrophobic sheet membrane retains water, but permits vapor pass-through when the vapor side pressure is less than the water saturation pressure. This results in evaporative cooling of the remaining water.

This work was done by Grant Bue and Luis Trevino of Johnson Space Center; Felipe Zapata and Paul Dillion of ERC, Inc.; and Juan Castillo, Walter Vonau, Bob Wilkes, Matthew Vogel, and Curtis Frodge of Jacobs Technology. Further information is contained in a TSP (see page 1). MSC-24840-1

Advanced Materials and Manufacturing for Low-Cost, High-Performance Liquid Rocket Combustion Chambers

A document describes the low-cost manufacturing of C103 niobium alloy combustion chambers, and the use of a high-temperature, oxidation-resistant coating that is superior to the standard silicide coating. The manufacturing process involved low-temperature spray deposition of C103 on removable plastic mandrels produced by rapid prototyping. Thin, vapor-deposited platinum-indium coatings were shown to substantially improve oxidation resistance relative to the standard silicide coating.

Development of different low-cost plastic thrust chamber mandrel materials and prototyping processes (selective laser sintering and stereolithography) yielded mandrels with good dimensional accuracy (within a couple of mils) for this stage of development.

The feasibility of using the kinetic metallization cold-spray process for fabrication of free-standing C103 thrusters on removable plastic mandrels was also demonstrated. The ambient and elevated temperature mechanical properties of the material were shown to be reasonably good relative to conventionally processed C103, but the greatest potential benefit is that cold-sprayed chambers require minimal post-process machining, resulting in substantially lower machining and material costs.

The platinum-iridium coating was shown to provide greatly increased oxidation resistance over the silicide when evaluated through oxyacetylene torch testing to as high as 300 °F (≈ 150 °C). The iridium component minimizes reaction with the niobium alloy chamber at high temperatures, and provides the high-temperature oxidation resistance needed at the throat.

This work was done by Brian E. Williams and Victor M. Arrieta of Ultramet for Johnson

Space Center. Further information is contained in a TSP (see page 1). MSC-24495-1

Motor Qualification for Long-Duration Mars Missions

Qualification of motors for deep space under extreme thermal environments to be encountered during the Mars Science Laboratory (MSL) mission is required to verify the reliability and validate mission assurance requirements. The motor assembly must survive all ground operations, plus the nominal 670 Martian-day (or sol) mission that includes summer and winter seasons of the Mars environment. The motor assembly was tested and characterized under extreme temperature conditions with reference to hardware requirements. The motor assembly has been proved to be remarkably robust and displayed no sign of degradation due to the 3 \times (three times per JPL design principles) thermal environmental exposure to the punishing Mars surface operations cycles. The motor characteristics obtained before, during, and post-test comparisons for the surface operations cycles are within measurement error of one another.

The motors withstood/survived 2,010 extreme temperature cycles with a ΔT of 190 °C deep temperature cycles, representing three times the expected thermal cycling exposure during the MSL surface operations. The qualification test hardware elements (A200 motor assembly, encoders, and resolver) have not shown any signs of degradation due to the PQV (Package Qualification and Verification) testing. The test hardware has demonstrated sufficient life to survive the deep thermal cycles associated with MSL mission surface operations for three lives.

This work was done by Rajeshuni Ramesham, Michael R. Johnson, Darren T. Cooper, Warren S. Lau, Kobie T. Boykins, Jonathan D. Perret, and Richard A. Rainen of Caltech; and Andrea Greb of Orbital for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48760