Trade Study for 9 kW Water Membrane Evaporator

Grant Bue, Gene Ungar, and Ryan Stephan

Sublimators have been proposed and used in spacecraft for heat rejection. Sublimators are desirable heat rejection devices for short duration use because they can transfer large amounts of heat using little mass and are self-regulating devices. Sublimators reject heat into space by freezing water inside a porous substrate, allowing it to sublimate into vapor, and finally venting it into space. The state of the art thermal control system in orbiting spacecraft is a two loop, two fluid system. The external coolant loop typically uses a toxic single phase fluid that acquires heat from the spacecraft and rejects most of it via a radiator. The sublimator functions as a transient topper for orbiting spacecraft during day pass periods when radiator efficiency decreases. The sublimator interfaces with the internal loop through a built in heat exchanger. The internal loop fluid is non-toxic and is typically a propylene glycol and water solution with inhibitors to prevent corrosion with aluminum fins of the heat exchangers. Feedwater is supplied from a separate line to the sublimator to maintain temperature control of the cabin and vehicle hardware. Water membrane evaporators have been developed for spacecraft and spacesuits. They function similar to a sublimator but require a backpressure valve which could be actuated for this application with a simple fully open or fully closed modes. This technology would be applied to orbital thermal control (lunar or planetary). This paper details a trade study showing that evaporators would greatly reduce the consumable that is used, effectively wasted, by sublimators during start up and shut down during the topping phases of each orbit. State of the art for 9 kW sublimators reject about 870 W per kilogram of mass and 1150 W per liter of volume. If water with corrosion inhibitors is used the evaporators would be about 80% of the mass and volume of the equivalent system. The size and mass increases to about 110% if the internal fluid is 50% propylene glycol/50% water. The true benefit comes from the backpressure valve, that prevents the cyclical shutdown/startup loss of the sublimator and amounts to as much as 0.85 kg per orbit.

Dr. Your Name; email – your.name@nasa.gov; phone - 281-792-xxxx (work)