Advanced Thermal Technology Development

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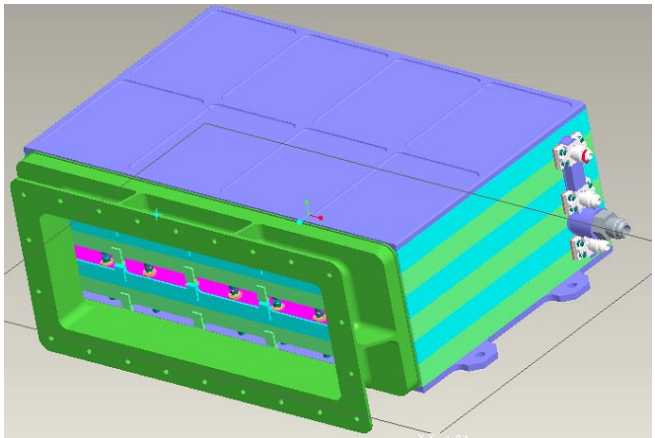
Active Thermal Controls Systems (ATCSs) are required to control vehicle temperatures and cabin humidity. The Advanced Thermal Team, within the Crew and Thermal Systems Division at Johnson Space Center (JSC), develops advanced ATCS technologies to support NASA's Exploration Systems Mission Directorate.

Steve Lee and George Tuan are leading an effort to design a condensing heat exchanger that uses porous media or membranes to recover humidity condensate and to control cabin air temperature and humidity. Current efforts consist of characterizing the heat and mass transfer performance of different membranes and porous media as well as evaluating methods to control microbial growth on the constantly wetted surfaces of the heat exchanger.

The Low Power Two Phase Active Thermal Control System (LPTPA) demonstrates innovative two-phase thermal control system architecture developed to provide power savings when compared to existing single-phase and two-phase systems. This system, which was scaled to represent the International Space Station Thermal Control System, consists of a pump (liquid-phase only), a metal bellows accumulator, five coldplates, a liquid-to-liquid evaporating heat exchanger, a regenerative heat exchanger, and a condensing heat exchanger. Testing, design, and analysis activities are currently aimed at providing steady temperature setpoint control. Dr. Eugene Ungar is the principal investigator for the LPTPA.

Heat pump technology will enable missions to lunar locations where warm environments exist. The vapor compression heat pump was designed for a 15-kW thermal load and a 50°C temperature lift. It was also designed to run off a power supply or directly from solar panels. Recent activities focused on building the heat pump system and supporting test facilities, which include the Building 29 solar array at JSC. Future activities will focus on testing this unit and evaluating specific components for microgravity performance. Mike Ewert is the principal investigator for the vapor compression heat pump, a collaborative effort between JSC and Glenn Research Center.

Charles Dingell and Clemente Quintana developed an advanced sublimator concept that uses a two-stage fluid distribution and control method that allows the ice formed in the



sublimator to sublimate from a large-pore aluminum foam. The larger pore size reduces the potential for sublimator clogging due to feed water contaminants, providing a more robust design. This sublimator was originally designed, fabricated, and tested as part of the X-38 Program. Current efforts are focused on reducing the unit mass through improved manufacturing techniques and heat transfer enhancements.