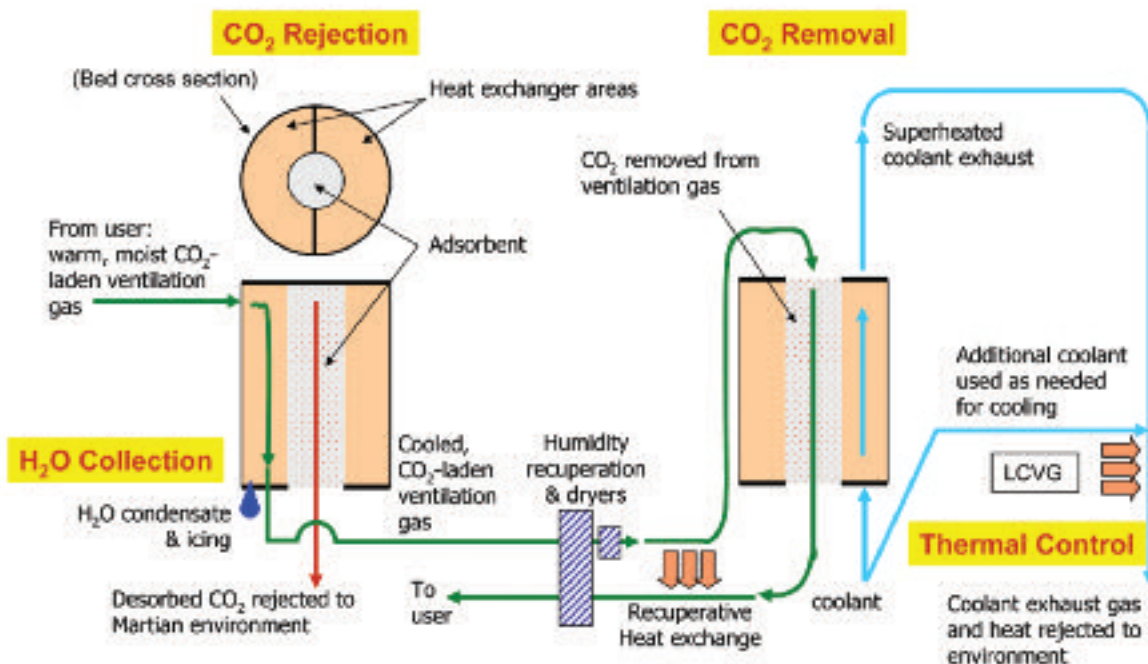


Metabolic Heat Regenerated Temperature Swing Adsorption

Paragon is developing Metabolic heat regenerated Temperature Swing Adsorption (MTSA) technology, for use with Portable Life Support Systems (PLSS) to remove and reject heat and carbon dioxide (CO₂) produced by an astronaut during extra vehicular activity (EVA), as well as to collect and recycle humidity in the ventilation loop. Employing MTSA increases mission flexibility because it is regenerable during the EVA, relies on less consumables delivered from Earth than the current baseline lunar and Martian PLSS technologies, and can use multiple coolants including non-cryogenic fluids. For Mars applications, MTSA technology is operationally sound because it can use room temperature liquid CO₂ for coolant. This means it does not have to expend expensive, life-critical water for heat rejection, does not compromise scientific investigations by contaminating the area around the astronaut, works in a CO₂ (LCO₂) environment as is found on Mars, and allows for easy storage of extra coolant on the surface of Mars for use in an emergency. (LCO₂ is non-cryogenic and it will not boil-off.)



Schematic demonstrating MTSA system in a PLSS



Hardware demonstrating full functionality of MTSA concept

MTSA uses CO₂-selective sorbent that is cycled between below freezing to ~280 K. When cold, the sorbent removes CO₂ from the astronaut's ventilation gas. Metabolic heat from the astronaut is then used to warm the sorbent and subsequently reject the CO₂ to the outside environment. Paragon has performed testing at Mars and MTSA operating conditions to identify a sorbent suitable for this unique cold temperature swing and to demonstrate the overall system concept. A detailed conceptual design was performed of the sorbent bed, the sublimation heat exchanger (for cooling) and the condensing ice heat exchanger (for warming and water collection). This drove manufacturing tests and demonstration of sorbent packaging for reduced sorbent bed pressure drop and mass. Analytical models of the channels in the condensing ice heat exchanger were developed, and tests were conducted to understand design drivers. LCO₂ sublimation experiments were conducted to quantify overall heat transfer coefficients. Paragon is now developing a prototype for lunar applications under a Phase 2 Small Business Innovative Research (SBIR) contract.