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Life support Challenges for Human Space Exploration (10)
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MICROCHANNEL ARTIFICIAL PHOTOSYNTHESIS SYSTEM (MCAPS) FOR CLOSED LOOP ENVIRONMENTAL CONTROL AND LIFE SUPPORT

Abstract

Because of the high cost to transport mass to the Moon, Mars, a Near Earth Object (NEO), or other extraterrestrial bodies, the logistics of space missions will be a major cost driver that could make or break a sustainable space exploration program. Battelle is developing new technologies that can be applied to minimize the logistics requirements for long duration space missions. Specifically, Battelle is looking to combine its Photolytically Driven Electro-Chemistry (PDEC) technology with its microchannel chemical process technology to create the MicroChannel Air Revitalization System (MCARS), an ultra-efficient air revitalization and life support system that addresses space exploration needs. MCARS has the potential to revolutionize closed-loop life support, minimizing the logistics requirements for human spaceflight systems, including space vehicles, EVA suits, habitat modules, and manned rovers. Battelle's PDEC technology is bio-inspired by photosynthesis occurring in green plants but, unlike photosynthesis, uses robust industrial (non-biological) materials (e.g., metals, ceramics, and plastics) in a portable, rugged configuration suitable for use in harsh environments. PDEC is a platform technology that can couple O2 and H+ generation with energy conversion to chemical and electrical forms in a single device. Battelle's microchannel chemical process technology enables the manufacturing of very small and highly efficient components that provide process intensification through rapid heat and mass transfer. Microchannel-based components, which include heat exchangers, reactors, and separators, can be one to two orders of magnitude smaller than conventional components at comparable process rates, making them highly advantageous for use in space systems. Furthermore, microchannel devices offer inherent parallelism that enables and facilitates a modular architecture. Using light energy, MCARS will simultaneously generate oxygen while removing CO2 and water from the breathing atmosphere. MCARS will then utilize H2O and the expired CO2 as feedstocks for the creation of useable complex hydrocarbons, such as a food supplements. MCARS can close the mass balance on the respiration gas maintenance cycle and minimize logistics by conserving carbon, hydrogen, and oxygen throughout the mission. These elements are highly interrelated chemically as macronutrients, breathable air, and fuel. The technology's ability to drive a wide range of chemical reactions enables the integration of air maintenance, water management, and food/fuel production within a common, scalable modular platform. For long duration space missions, the logistics savings from MCARS will be significant in terms of both mass and volume.