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Atmosphere Resource Recovery and Environmental Monitoring

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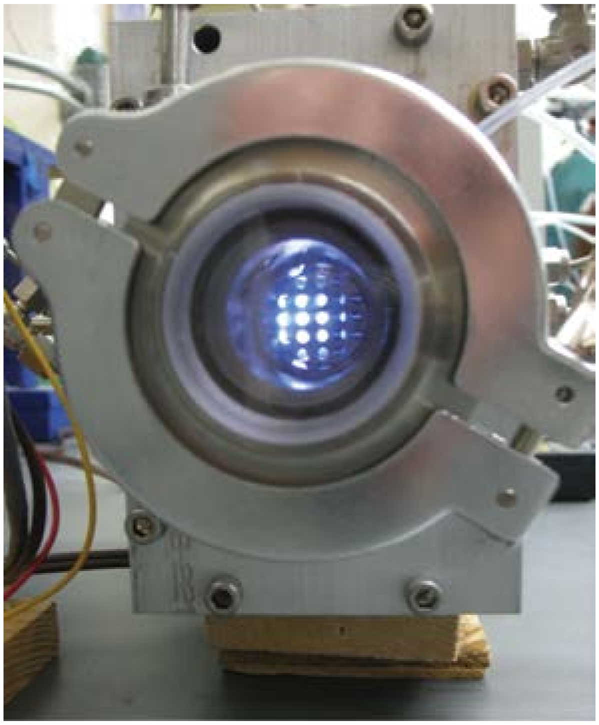
Sponsoring Program(s)

Human Exploration and Operations Mission Directorate
Advanced Exploration Systems

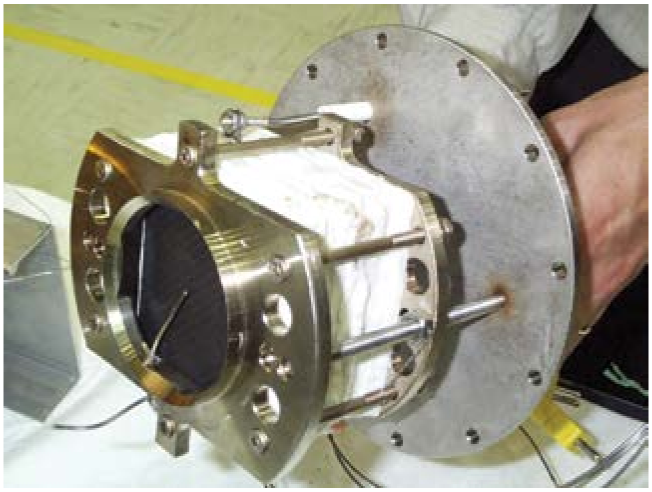
Project Description

Atmosphere Resource Recovery and Environmental Monitoring (ARREM) is a project focused on evolving existing and maturing emerging 'closed loop' atmosphere revitalization (AR) life support systems that produce clean, breathable air for crewmembers, and developing a suite of low mass, low power environmental monitors to detect and measure air- and water-borne constituents and contaminants. The objective is to improve reliability and efficiency, reduce mass and volume, and increase recovery of oxygen from carbon dioxide created by human metabolism from 43% to greater than 90%.

The technology developments under ARREM are vital to extending human space missions from low-Earth orbit like the International Space Station to destinations deeper into space such as Mars where dependency on Earth for resupply of maintenance items and critical life support elements such as water and oxygen is not possible. The primary goal of the ARREM project is to demonstrate that systems meet the more stringent performance parameters for deep space exploration and are compatible with other systems within closed loop life support through a series of integrated tests performed in an environmental test chamber capable of simulating human metabolic activities and measuring systems outputs.



Plasma pyrolysis assembly recovers hydrogen from the methane produced by the carbon dioxide reduction assembly/Sabatier, further enabling the recovery of oxygen from carbon dioxide.



Microlith® catalytic oxidizer is an ultracompact, lightweight, fast light-off catalytic reactor with resistive-heating capability for volatile organic compound trace contaminant control and other applications.

Integrated test chamber enables testing of AR technologies in an environment that simulates human metabolic activity integrated with functional AR hardware.

Anticipated Benefits

The benefit would be to improve ARREM systems, bringing them closer to meeting the figures of merit required to achieve long-duration human missions to destinations beyond low-Earth orbit such as Mars.

Potential Applications

This may potentially be used for deep space transport and orbiting habitats as well as nonterrestrial surface habitats.

Notable Accomplishments

The ARREM project completed multiple demonstration phases of integrated systems testing. The primary test objectives were to demonstrate the operation of the International Space Station-derived life support equipment in evolved configurations for the purpose of increasing reliability, reducing mass, and improving performance. The evolved configurations consisted of the oxygen generation assembly operating in an alternate configuration with improved reliability while considerably reducing mass. The carbon dioxide removal assembly operated in an alternate mode that demonstrated the capability of reducing cabin carbon dioxide levels by 40%. The trace contaminant control demonstrated an advanced configuration that used next generation catalyst configured to reduce ancillary equipment. The Trace Contamination Control system also incorporated a high flow carbon bed cartridge upstream of the condensing heat exchanger to reduce contaminant loading, including siloxanes, in water condensate to potentially relieve challenges to the water processor. The final phase of the test consisted of installing development environmental monitoring equipment developed for ARREM by the Jet Propulsion Laboratory into the E-chamber and exposing them to elevated levels of selected contaminates and comparing results to laboratory standard equipment. The monitors consisted of the tunable environmental laser spectrometer for detecting carbon monoxide, the rapid analysis self-calibrating for detecting trace gas contaminants, and the vehicle environmental monitor for detecting contaminants contained in the humidity condensate.

References

Perry, J.; Knox, J.; Parrish, K.; et al.: “Integrated Atmosphere Resource Recovery and Environmental Monitoring Technology Demonstration for Deep Space Exploration,” AIAA 2012–3585, AIAA 42nd International Conference on Environmental Systems, San Diego, CA, 2012.

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