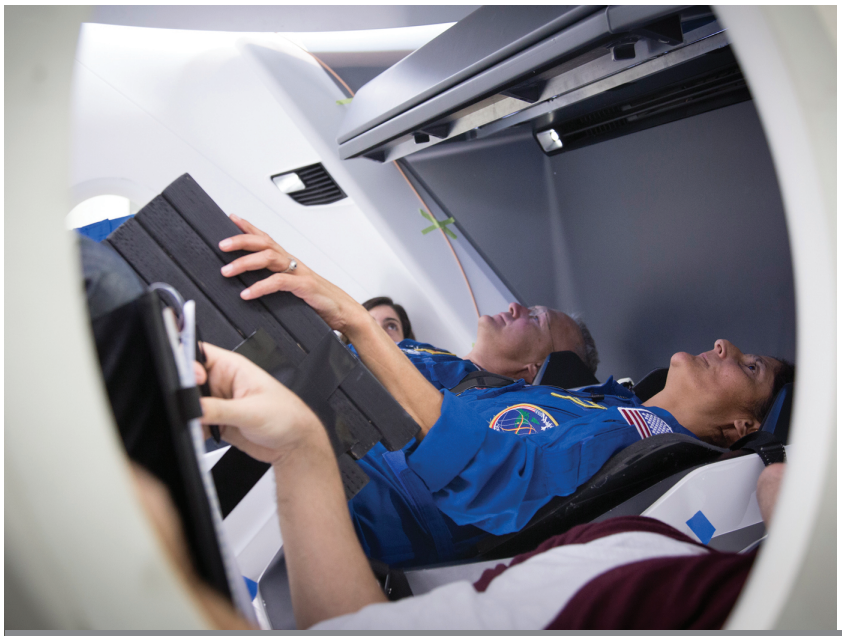


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Environment

Air Revitalization for Vacuum Environments

Sorbent-based Atmosphere Revitalization System for Crewed Vehicles

NASA has developed a lightweight atmosphere revitalization system to support short-duration human space flights. Air revitalization is a critical component of manned space flights since passenger-carrying vehicles require a way to control humidity and process metabolic carbon dioxide to sustain an environment that can support human life. For long-duration flights, metabolic water from respiration and evaporated sweat are typically treated and reclaimed, requiring extra equipment such as gas/liquid separators and condensing heat exchangers. To minimize equipment and reduce excess loads, NASA developed an adsorption-based carbon dioxide scrubber and water removal system for disposal in vacuum environments, ultimately reducing mass, power, and volume requirements. The lightweight, low-mass system is also regenerable, flexible, and can be arranged into different spatial configurations.

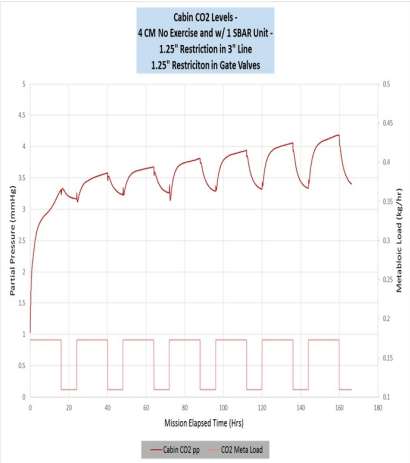
BENEFITS

- Lightweight
- Regenerable
- Reconfigurable
- Nonflammable

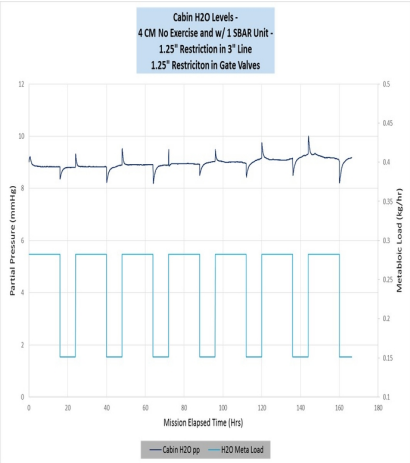
THE TECHNOLOGY

The NASA life support system uses a regenerable vacuum swing adsorption process, known as Sorbent-Based Air Revitalization (SBAR), to separate water and carbon dioxide for disposal. The SBAR system is an adsorbent-based swing bed system that has been optimized to provide both humidity and carbon dioxide control for a spacecraft cabin atmosphere.

The system comprises composite silica gel and zeolite-packed beds for adsorption and a bypass system for flow control. Under normal operating conditions, the disposal system would require a high-quality vacuum environment to operate. Improvements to the SBAR system include an enhanced inherent capacitance that extends the operation time within a non-vacuum environment for up to 4.5 hours. Flight time can be further expanded with multiple SBAR systems to allow for system regeneration. By scheduling periodic thermal regenerations—nominally during sleep periods—the SBAR technology may be suitable for missions of unlimited duration.



A single SBAR system maintains cabin CO2 pp at safe levels. Additional testing confirmed that using two SBAR systems jointly would further maintain a CO2 pp well below 4 mmHg.



The SBAR system removed > 99% of the water vapor passing through the system. Cabin H2O pp maintained at an expected level for test duration.

APPLICATIONS

The technology has several potential applications:

- Spacecrafts
- Submersible crafts
- Airtight chambers

PUBLICATIONS

Patent No: 9,802,149

Knox, J.C., H. Gauto, D. Trinh, D. Wingard, R. Gostowski, D. Watson, and K. Kittredge. Development of Carbon Dioxide Removal Systems for Advanced Exploration Systems 2012-2013. American Institute of Aeronautics and Astronautics. 2013.

Miller, L. and J.C. Knox. Development and Testing of a Sorbent-Based Atmospheric Revitalization System 2010/2011. American Institute of Aeronautics and Astronautics. 2011.

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

MFS-32997-1, MFS-TOPS-82

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NP-2017-09-2466-HQ