

# Testing and Results of Vacuum Swing Adsorption Units for Spacesuit Carbon Dioxide and Humidity Control

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A principal concern for extravehicular activity (EVA) space suits is the capability to control carbon dioxide (CO<sub>2</sub>) and humidity (H<sub>2</sub>O) for the crewmember. The release of CO<sub>2</sub> in a confined or unventilated area is dangerous for human health and leads to asphyxiation; therefore, CO<sub>2</sub> and H<sub>2</sub>O become leading factors in the design and development of the spacesuit. An amine-based CO<sub>2</sub> and H<sub>2</sub>O vapor sorbent for use in pressure-swing re-generable beds has been developed by Hamilton Sundstrand. The application of solid-amine materials with vacuum swing adsorption technology has shown the capacity to concurrently manage CO<sub>2</sub> and H<sub>2</sub>O levels through a fully regenerative cycle eliminating mission constraints imposed with non-regenerative technologies.

Two prototype solid amine-based systems, known as rapid cycle amine (RCA), were designed to continuously remove CO<sub>2</sub> and H<sub>2</sub>O vapor from a flowing ventilation stream through the use of a two-bed amine based, vacuum-swing adsorption system. The Engineering and Science Contract Group (ESCG) RCA is the first RCA unit implementing radial flow paths, whereas the Hamilton Sundstrand RCA was designed with linear flow paths. Testing was performed in a sea-level pressure environment and a reduced-pressure environment with simulated human metabolic loads in a closed-loop configuration.

This paper presents the experimental results of laboratory testing for a full-size and a sub-scale test article. The testing described here characterized and evaluated the performance of each RCA unit at the required Portable Life Support Subsystem (PLSS) operating conditions. The test points simulated a range of crewmember metabolic rates. The experimental results demonstrate the ability of each RCA unit to sufficiently remove CO<sub>2</sub> and H<sub>2</sub>O from a closed loop ambient or sub-ambient atmosphere.

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