



NASA SBIR 2009 Phase I Solicitation

X2.01 Spacecraft Cabin Atmosphere Revitalization and Particulate Management

Lead Center: MSFC

Participating Center(s): ARC, GRC, JSC, KSC

Cabin Atmosphere Revitalization

Atmosphere revitalization developmental activities target process technologies and equipment to condition and supply gaseous oxygen at pressures at or above 3,600 psia and achieve mass closure by recycling resources. As well, portable means for atmosphere revitalization that have synergy with extravehicular activity (EVA) equipment pertaining to trace contaminant control, carbon dioxide removal, humidity control are target technology areas. Durable, dust-tolerant fluid connections support the EVA and life support system infrastructure. Details on areas of emphasis are the following:

High Pressure Oxygen Gas Supply and Conditioning: Process technologies leading to an on-demand, in-flight renewable 3,600-psia oxygen supply are of interest. Process technologies and techniques must be capable of conditioning oxygen for temperature, pressure, and water content using oxygen from several sources. Source oxygen may originate directly from the cabin atmosphere or from gaseous storage, cryogenic storage, and/or on-demand production from water electrolysis or in-situ resource utilization processes.

There is specific interest in process technologies to remove water from saturated oxygen to provide a product having a dewpoint below -62°C .

Atmospheric Resource Recycling Techniques: Process technologies suitable for conditioning and converting gaseous products produced by the Sabatier CO_2 reduction reaction to useful products are of interest. Of particular interest are process technologies to recover moisture from a saturated stream of methane that contains residual CO_2 and hydrogen reactants, to convert methane to products such as low molecular weight alcohols or other compounds suitable for use in power co-generation via fuel cells or other means, and to produce a solid carbon product via a regenerative process based on the Bosch reaction or a variant of the Bosch reaction.

Particulate Matter Management

Particulate matter suspended in the habitable cabin atmosphere is a challenge for all phases of crewed lunar

surface exploration missions. Removing and disposing of particulate matter originating from sources internal to the habitable cabin and from lunar surface dust intrusion into the cabin environment is of interest. Staged techniques employing combinations of course media filtration (>50 micron size), inertial separation (2.5 micron size), and fine media filtration (

Atmosphere Revitalization for EVA

Synergy exists between cabin atmosphere revitalization and EVA suits. Common functions include trace contaminant control, CO₂ partial pressure control, and humidity control.

Trace Contaminant Control for EVA Suits: EVA suits designed for long durations with minimal maintenance will require new methods of trace contaminant control to maintain spacesuit environments below Spacecraft Maximum Allowable Concentrations for toxic or irritating chemicals. Historically this has used activated charcoal. In the case of ISS EVA, the charcoal is regenerable with heat. A need exists for a reduced power solution, such as vacuum regeneration of a sorbent, or another, innovative, low consumable solution. Consideration of on-back, real-time EVA regeneration as well as post EVA regeneration is acceptable.

Mars EVA CO₂ and Humidity Control: ISS EVA suits utilize heat regenerable CO₂ removal systems. These systems are heavy and require significant power for regeneration. Lunar EVA suits are planned to use a lightweight, vacuum regenerable amine system to remove CO₂ and humidity from the suit. It is envisioned this concept could be extensible to Mars suits with the addition of sweep gas to prevent intrusion of the Martian atmosphere. An innovative CO₂ and humidity removal system that could remove CO₂ and humidity while eliminating gas losses to the Martian atmosphere, remain lightweight, and utilize minimal power is desired. Consideration of on-back, real-time EVA regeneration as well as post EVA regeneration is acceptable.

Dust Tolerant Quick Disconnects for High and Low Pressure Fluids

Connections will need to be made between the EVA suits and lunar and Martian vehicles in environments where dust will be present. A lightweight QD that excludes dust during connections and disconnections is required.