NASA SBIR 2017 Phase I Solicitation

H3.03 Environmental Control and Life Support

Lead Center: JSC

Participating Center(s): ARC, GRC, MSFC

Technology Area: TA6 Human Health, Life Support and Habitation Systems

Spacecraft Cabin Carbon Dioxide Removal

NASA currently has CO_2 removal and capture systems that are compact and effective, but future missions may require CO_2 capture technology that control to lower levels, and operate with greater power efficiency. NASA is especially interested in systems with the following performance parameters:

- Removal rate of 4 kg/day.
- Operate in an environment with 1.5 mmHg ppCO_2.
- System size 0.3 cubic meters.
- System power use 500 watts of power.
- Effectively separate out water vapor (less than 100 ppm water vapor in the CO_2 product is desired).

Oxygen Separation from Air

NASA mission planners envision future mission scenarios that require oxygen separation from spacecraft cabin air. New technology developments show promise for reliable, low power performance. System safety, and the ability to easily verify oxygen product purity are especially important. Reliable operation without service or repair is key, but many R&D designs cannot report Mean Time Between Failure. If MTBF data is not available, an assessment of reliability should be provided. Although pressurization of product oxygen is not the intent of this call, future requirements for oxygen delivery pressure are variable, depending on mission scenario: some scenarios use ambient pressure (<5psig) oxygen, while other scenarios intend to store oxygen at pressures as high as 3600 psig. NASA is interested in systems with the following performance parameters:

- Production rate: 15 slpm.
- Power use: ?450 W (30 Watts/liter).
- Sound level: <45 dB.
- System size: 0.03 cubic meters (200 cc/liter).

Carbon Repurposing

Several oxygen recovery technologies currently under consideration for future long-duration missions involve production of solid carbon. For technologies whose goal is to maximize oxygen recovery by producing this carbon, approximately 1 kg of solid carbon must be disposed of or repurposed daily for a crew of four. Repurposing this carbon will reduce logistical challenges associated with disposal and will ultimately result in materials or processes advantageous to long-duration missions.

The carbon product includes nanofibers, microfibers, and amorphous carbon. It may contain quantities of metals including, but not limited to iron, nickel, and cobalt. Venting or disposal of this carbon to space will present considerable logistical challenges and will result in large volumes of space debris. Disposal of this carbon on a planetary surface may result in concerns for Planetary Protection or science. NASA is seeking technology and/or processes that repurpose solid carbon and its contaminants and that result in useful products for transit, deep space, or planetary surface missions.

Filtration of Particulate Carbon and Hydrocarbons from Process Gas Streams

Oxygen recovery technology options almost universally result in particulates in the form of solid carbon or solid hydrocarbons. Mitigation for these particulates will be essential to the success and maintainability of these systems during long duration missions.

Techniques and methods leading to compact, regenerable methods for removing residual particulate matter generated from Environmental Control and Life Support (ECLS) system process equipment such as carbon formation reactors and methane plasma pyrolysis reactors is desirable for long-duration manned life support. Filtration performance approaching HEPA rating is desired for ultrafine particulate matter with minimal pressure drop. The gas filter should be capable of operating for hours at high particle loading rates and then employ techniques and methods to restore its capacity back to nearly 100% of its original clean state through in-place and autonomous regeneration or self-cleaning operation. The device must minimize crew exposure to accumulated particulate matter and enable easy particulate matter disposal or chemical repurposing.

Solid State Microwave Generator for Environmental Control and Life Support

Many possible future technologies for human spaceflight may utilize microwave energy, including plasma pyrolysis of methane, incineration and solid waste drying, and ovens for food heating. Traditional microwave generating systems have significant inefficiencies resulting in a high mass, high volume power system. Solid state microwave generators have the potential to limit the total mass and volume of a microwave power system. However, limited advancement has been achieved at power levels of 1kW and higher.

NASA is seeking solid state microwave generators with the following capabilities:

- Microwaves generated and controlled at 2.38-2.54GHz (nominally 2.45GHz).
- Maximum output power level capability of 1-5kW.
- Variable power output over entire range (0-max kW).
- Input power of 120VDC.
- Efficiency greater than or equal to 50%.
- Method of measuring/monitoring output power.
- Method of measuring/monitoring reflected power.
- Method of dispersing/absorbing reflected power up to maximum output power.
- Utilizes non-air cooling method (e.g., liquid cooling).