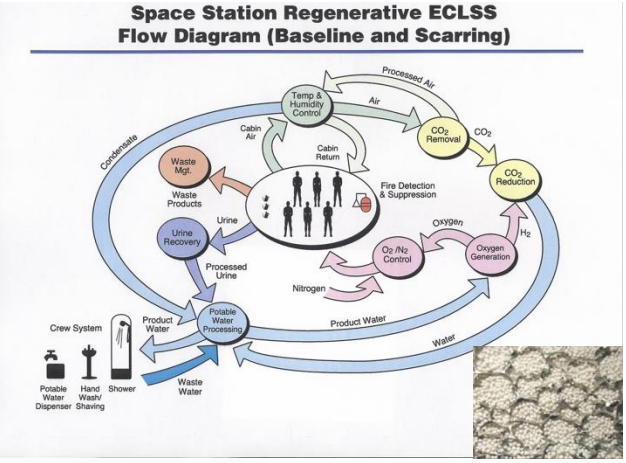
Life Support CO_2 Removal



Name of Technology:
High Reliable, Closed-loop-forward Carbon Dioxide Removal Systems

Participating NASA Centers:
JSC (Lead); ARC, GRC, JPL, KSC, MSFC

Technological Area:
T6.01Innovative Solutions to Carbon Dioxide Removal for Spacecraft, Surface Systems, and EVA Systems

Vision for the Technology:
For future exploration missions, NASA needs a highly reliable Carbon Dioxide (CO_2) removal system that is compatible with closed-loop life support, low maintenance, and can maintain cabin CO_2 at <3.0 mmHg.

Challenges:
The State-of-the-Art (SOA) Carbon Dioxide (CO_2) removal systems have required considerable maintenance, although recent improvements have decreased that to greater than 3 years between unplanned maintenance. Secondary CO_2 removal systems are required to operate during maintenance.

The International Space Station (ISS) Carbon Dioxide Removal Assembly (CDRA) provides CO_2 removal at the required levels and is compatible with closed-loop life support. However, the CDRA requires replacement of the adsorption beds (currently >3 years lifetime) and for the secondary CO_2 removal system to operate during those periods of down-time. The current CDRA technologies work for the large volume of ISS but will not work in smaller exploration spacecraft.

In addition to the current system challenges, ISS CDRA is not available due to obsolescence of the sorbent materials. New materials could be used but may result in reduced performance and/or high quantities of resupply to mitigate dust.

NASA Seeks to Meet the Following Specs:

Successful closure of this gap will be determined through (based on 4-person load):

1) Demonstration of CO_2 removal at:
   a. <2.5 mmHg-enabling
   b. <2.3 mmHg-enhancing (1 hour average)
2) Greater than 3 years maintenance
3) Minimal crew intervention/maintenance
4) Removal rate of 4.16 kg/day
5) System size ≤0.3 cubic meters
6) System power use ≤500 watts of power
7) System mass of ≤100 kilograms
8) Effectively separate out water vapor (less than 100 ppm water vapor in the CO_2 product is desired)
9) Effectively separate out oxygen and nitrogen (less than 1% O_2 and 2% N_2 by volume in the CO_2 product is desired)

Overview of Student Project:
NASA seeks innovative Carbon Dioxide (CO_2) removal technologies that can maintain cabin CO_2 meeting the desired goals including low power and maintenance, and work in a closed-loop life support system. Technologies need to collect and remove CO_2 from the spacecraft cabin. Technologies that can utilize the removed CO_2 for other beneficial usages are of interest to NASA as well.

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Innovative Areas Student Projects Can Address:

- Innovative Carbon Dioxide (CO_2) removal technologies
- Develop alternative technologies to accomplish NASAs goals

Project Phases

I. Conceptual and feasibility study with characteristics

II. Proof of Concept/Prototype in lab environment

Research Funded by NASA on this Topic:

Proposal Number: 02-II B3.01-7618
Carbon-Supported Amine Sorbent Monoliths for Carbon Dioxide Removal

Proposal Number: 11-1 X3.01-8150
Bio-Electrochemical Carbon Dioxide Removal for Air Revitalization in Exploration Life Support Systems

Proposal Number: 21-1- H3.05-1771
Additively-Manufactured, Net-Shape Adsorbent Beds for Carbon Dioxide Removal

Proposal Number: 22-1- H4.07-2816
MOF based Adsorbents for Carbon Dioxide Removal Assembly

Proposal Number: 12.01-2228
Removal of Carbon Dioxide from Spacecraft Atmosphere by Selective Membranes

References:

H3.08Challenges in Carbon Dioxide Removal and Reduction: Carbon Particulate and Thermal Management

T6.01Innovative Solutions to Carbon Dioxide Removal for Spacecraft, Surface Systems, and EVA Systems

H3.01Advancements in Carbon Dioxide Reduction: Critical Subsystems and Solid Carbon Repurposing

X3.01Spacecraft Cabin Atmospheric Resource Management and Particulate Matter Removal

International Space Station Carbon Dioxide Removal Assembly (CDRA)