Professional Association of Research for Space Engineering Concepts (PARSEC)

Atmospheric Electrochemical Transformation for Habitat and Environmental Regeneration

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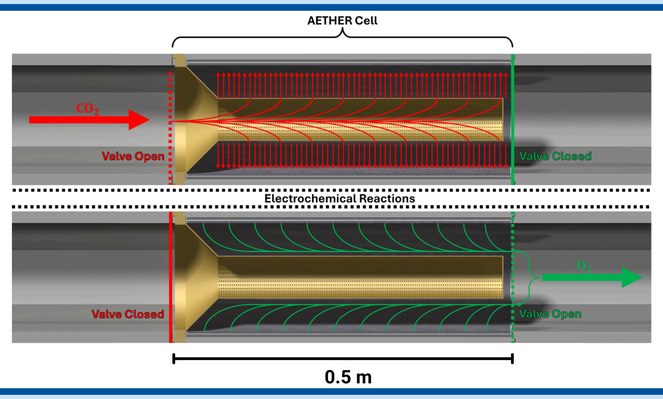
Mission Objective

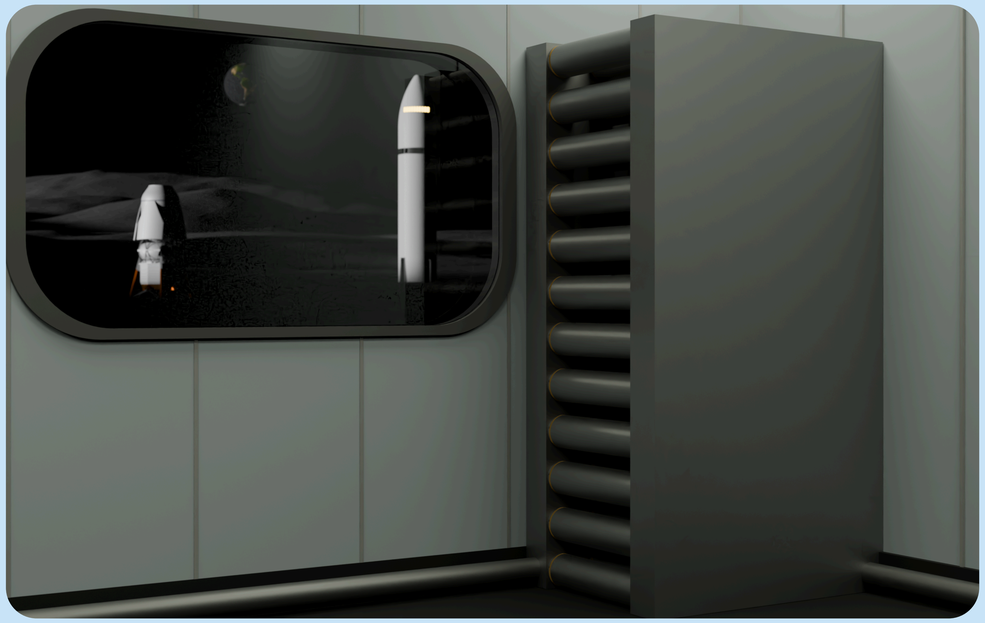
AETHER provides oxygen for long-duration lunar and martian missions through a series of room temperature electrochemical reactions. The system converts crew's exhaled CO_2 into O_2 while increasing efficiency and reducing mass compared to current systems. Additionally, AETHER can scale its output by adjusting the number of cells to meet crew demand.



AETHER Overview

AETHER is a modular oxygen reclamation system that converts CO_2 into O_2 through a sequence of room-temperature electrochemical reactions. Three reaction cells (Co-Super P carbon cathode, lithium metal anode, and an aprotic electrolyte) are used to conduct these reactions. CO_2 is reduced at the cathode's surface to form intermediate lithium compounds, ultimately releasing O_2 at a theoretical yield of 94.7%.

$$3CO_2 + 4Li^+ + 4e^- \rightarrow 2Li_2CO_3 + C \quad (E^0 = 2.80\ V) \quad (1)$$
$$Li_2CO_3 + 4Li^+ + 4e^- \rightarrow 3Li_2O + C \quad (E^0 = 1.43\ V) \quad (2)$$
$$2Li_2O \rightarrow 4Li^+ + O_2 + 4e^- \quad (E^0 = 2.91\ V) \quad (3)$$



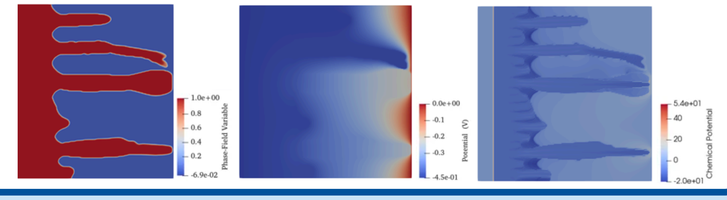
Full Scale Implementation

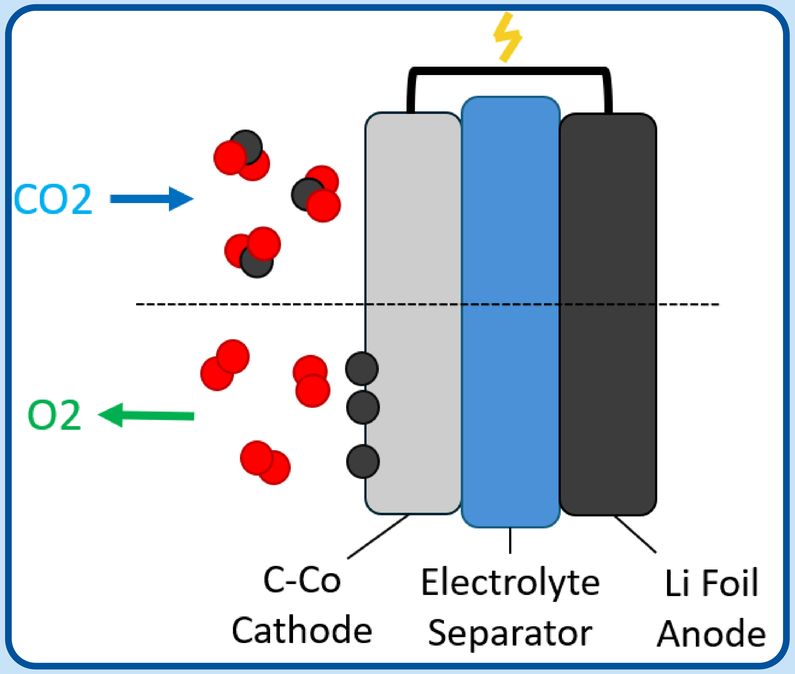
In a full scale application, AETHER would operate in a modular 72 cell array designed to fit within a standard ISS rack. As carbon builds up, surface area reduces, and cell efficiency decreases. Therefore, more cells are needed to produce the same level of oxygen. A array of 72 cells provide oxygen for a four person crew for 32 days, accounting for no carbon cleaning. Cells are designed to be easily removable in the event of cleaning and replacement. Additionally, AETHER can scale its output by adjusting the number of cells in it's array to meet crew demand. This scalability allows AETHER to not only meet mission requirements, but also in applications large scale on extraplanetary bases and small scale within human landing systems.

Nonrecurring Cost	Recurring Cost	Total Cost
$294.7 M	$21.2 M	$655M

Testing and Simulation

AETHER's validation methods consist of digital simulation and physical testing. Simulations identify, observe, and test mitigation methods for dendrite formation and carbon buildup, providing valuable data for mitigation and prevention methods. Physical testing was not completed in time for this forum to present applicable data. Future testing aims to validate the reaction's ability to produce oxygen in consecutive reactions, determine maximum lifespan, and test disk variation.





Timeline and Budget

Pre-Phase A	Phase A	Phase B	Phase C	Phase D	Phase E
Requirements & Trade Studies	Preliminary Design	Preliminary Testing	Final Design & Fabrication	Assembly & Launch	Operations & Sustainment