NASAfacts

Space Technology
Game Changing Development
The Mars Oxygen ISRU Experiment (MOXIE)

NASA scientists are advancing technologies that can one day take humans to Mars. But what technologies are necessary to actually inhabit this planet, one with an atmosphere lacking oxygen, the critical element necessary for humans to breathe?

The Mars Oxygen ISRU Experiment (MOXIE) plans to substantiate the feasibility of producing oxygen during NASA's Mars 2020 mission. MOXIE's technology demonstration, under planning with the Game Changing Development Program, is a critical first step toward the development of a sustained human presence on another planetary body.

Because the atmosphere of Mars is predominantly carbon dioxide, MOXIE scientists want to demonstrate the in situ production of oxygen on the planet's surface. The Martian atmosphere can be processed to extract valuable oxygen to support the crew's breathing needs, a commodity that can also be used as the fuel oxidizer for a Mars ascent vehicle.

3D-printed model of the preliminary MOXIE payload. Image credit: NASA's Jet Propulsion Laboratory.

MOXIE uses a solid oxide electrolysis (SOXE) stack developed by Ceramatec, Inc. for converting CO_2 to O_2. Its working elements are stacked scandia-stabilized zirconia (ScSZ) electrolyte-supported cells with thin screen-printed electrodes that are coated with a catalytic cathode on one side and an anode on the other. These are separated by expansion matched interconnects that direct the source, exhaust, and product gases to and from their respective manifolds.

When CO_2 flows over the catalyzed cathode surface under an applied electrical potential, a reaction occurs and it is electrolyzed. The CO is exhausted and the oxygen ion electrochemically driven through the SOXE to an anode where it is oxidized. The O atoms combine to produce the gaseous O_2, which is then released from the anode cavity at a proportional rate. The reaction chemistry uniquely determines both the minimum electrical current and the minimum CO_2 flow required to produce O_2 at a given rate.

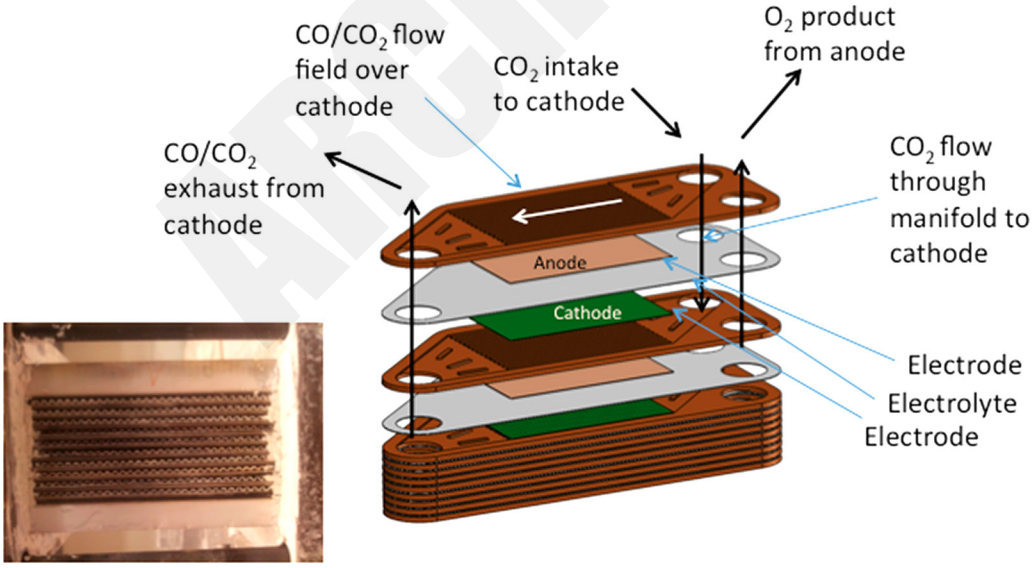
MOXIE is a 1-percent scale model of an oxygen processing plant capable of producing consumable grade (99.6 percent) oxygen at a rate of 20 grams per hour. The experiment will be conducted throughout several seasons over the course of a Martian year, demonstrating resilience with respect to dust and other environmental challenges.

As part of the Mars 2020 payload, MOXIE is significant to analyzing and determining if a specialized reverse fuel cell that consumes electricity to produce oxygen is a viable system. A system like this is also a crucial, necessary precursor to larger scale oxygen production plants on Mars.

An important challenge in space exploration is the production or acquisition of valuable commodities in situ, meaning space travelers and planetary colonists will fulfill needs from resources available on location. By applying this capability to Mars or other missions, expeditions become more affordable and more sustainable, and Earth-launch mass and mission cryogenic storage burden is significantly reduced.

The Game Changing Development (GCD) Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit http://gameon.nasa.gov/



SOXE design and sample stack. The side view of an actual stack is shown at left. Image credit: MIT.

National Aeronautics and Space Administration

Jet Propulsion Laboratory
Pasadena, CA 91109

www.nasa.gov

FS-2014-08-248-LaRC