Center Innovation Fund: JSC CIF

Proving Water Production out of Mars Analog Soil

Completed Technology Project Unreleased Draft

Edited 12/21/2017

Project Introduction

This project addresses the sustainable aspect of NASA's Evolvable Mars Campaign (EMC), specifically using local resources on Mars to become as logistically independent of Earth as possible. Water is now a confirmed resource on the surface of Mars in various forms, but in order for it to be utilized it will need to extracted from the martian environment and purified. This project addresses Technology Area (TA) TA07, In-Situ Resource Utilization, specifically water extraction from regolith. The goal of this project was to study a method that could be used to separate water from other contaminating volatiles. This resulted in the development of a dedicated test stand and high fidelity Mars regolith simulant.

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Anticipated Benefits

This project establishes the capability for JSC scientists to produce a variety of special purpose, high-fidelity planetary soils simulants at a small scale for further ISRU testing (7.1.3 Processing and Production; 7.1.4 Manufacturing Products and Infrastructure Emplacement; 7.2.4 Food Production, Processing, and Preservation; 7.6.1 Particulate Contamination Prevention and Mitigation). These tests could be funded in the future by STMD and/or the AES ISRU Project. JSC's ISRU Mars soil processing test stand has also advanced in TRL, making it a better candidate system for further STMD funding (7.1.3 Processing and Production, 7.1.3.14 New Membranes for Gas Separation and Cleanup, 7.1.3.16 Freezers and Condensers).

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Project Closeout – Executive Summary

The Mars regoilth simulant developed for this project is based on the aeolian deposit known as 'Rocknest', which was analyzed by the Curiosiy rover in Gale Crater. Rocknest is representative of the windblown drifts that occur globally on Mars. Data from Curiosity confirmed the presence of several volatiles that are released simultaneously with water as martian regolith is heated. Mojave Mars Simulant (MMS), developed at the Jet Propulsion Laboratory (JPL), was used as the main component of the simulant (96 wt. %). Perchlorate (1 wt. %) and sulfate (3 wt. %) minerals were added in laboratory tests to mimic the water release profile of Rocknest and to produce contaminating volatiles (hyrdochloric and sulfuric acids, respectively).

Nafion is a commercially available material with the unique capability of allowing water to pass through while filtering other compounds, including those found on the surface of Mars. Nafion is a Teflon based material so its chemical robustness makes it a great candidate for long term water purification. We developed a test stand to demonstrate that nafion could be used to produce purified water extracted from Mars regolith. The test stand will also allow us to collect data on the rate of water extraction as a function of several variables such as membrane surface area and regolith temperature.

The individual components used in the test stand are well understood, however, the combination of a regolith dryer, vapor-phase cleanup and passive condenser has never been demonstrated. The combination of these components drives the overall pressure and rate of water extraction. Restricting dust particles is important for this application. However, the use of an inline filter was too restrictive, and would not allow for a sufficient pressure differential across the nafion membrane. Our test stand has been modified to allow for a much larger dust filter but that configuration has not yet been tested. Some pressure transducers may be susceptible to a steam environment, even if they are rated for the temperature and pressure. This was the case with the first pressure transducers we used in our testbed. Due to complications with the test stand, we don't have conclusive data at this time regarding water purity but this work will continue in FY18.

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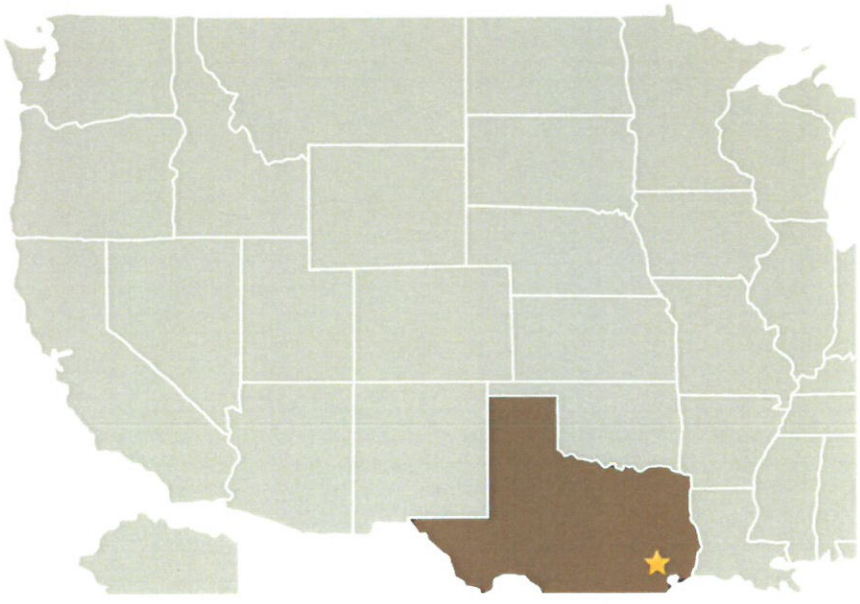
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Johnson Space Center (JSC)	Lead Organization	NASA Center	Houston, TX
Johnson Space Center (JSC)	Supporting Organization	NASA Center	Houston, TX

Co-Funding Partners	Type	Location
Space Technology Mission Directorate (STMD)	NASA Mission Directorate	

Primary U.S. Work Locations

Texas

Project Library

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Innovation Fund: JSC CIF

Project Management

Program Director:
John M Falker

Project Manager:
John E Gruener

Principal Investigator:
John E Gruener

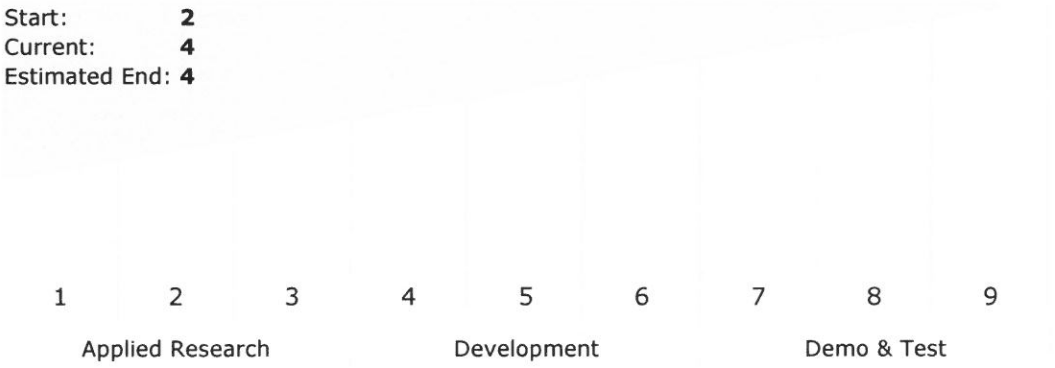
Co-Investigator:
Aaron Paz

Project Duration

Start: Oct 2016 **End:** Sep 2017

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TA 7 Human Exploration Destination Systems

Target Destination

Mars

Supported Mission Type

Projected Mission (Pull)

NASA Internal

Information in this section is visible only within NASA

Project Budget

Fiscal Year	Full-Time Equivalent $	Work-Year Equivalent $	Procurement $ (Non-Work-Year Equivalent $)	Total Fiscal Year Budget $
2017	$84,844	$62,875	$37,125	$184,844
Totals:	**$84,844**	**$62,875**	**$37,125**	**$184,844**

Project Closeout – Final Report

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181.5 KB Final Report PDF

Scientific and Technical Information Document Availability Authorization (STI-DAA)

The STI-DAA Form 1676 is used to authorize NASA scientific and technical information for public release.

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Responsible NASA Official: Tracy Bierman