National Aeronautics and Space Administration

LOx/LCH$_4$: A Unifying Technology for Future Exploration

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OVERVIEW

- For every *pound* of payload landed on Mars, *226 pounds* are required on Earth to get it there. Due to this enormous mass gear-ratio, increasing commonality between lander subsystems, such as power, propulsion, and life support, results in tremendous launch mass and cost savings.
- Human-Mars architectures point to an oxygen-methane economy, utilizing common commodities scavenged from the planetary atmosphere and soil via In-Situ Resource Utilization (ISRU) and common commodity tankage across sub-systems.

INNOVATION

- This work represents the first integrated power & propulsion testing and lays the foundations for the first in-space ignition of a LOx/LCH$_4$ rocket engine, the key commodity combination needed to help make Human exploration of Mars possible within our lifetime.

Furthering LOx/LCH$_4$ through integrated testing transforms promising technologies into Exploration solutions.

INFUSION

- In addition to space applications, solid oxide fuel cells (SOFC) are being used for stationary distributed power generation on Earth.

PARTNERSHIPS & COLLABORATIONS

- JSC has signed a non-disclosure agreement (NDA) with Delphi which allows us to work closer on co-development of SOFC technologies.

JSC-owned Delphi Solid Oxide Fuel Cell

LOx/LCH$_4$ Engine Testing at Stennis Space Center

NASA TECHNOLOGY AREA ROADMAP

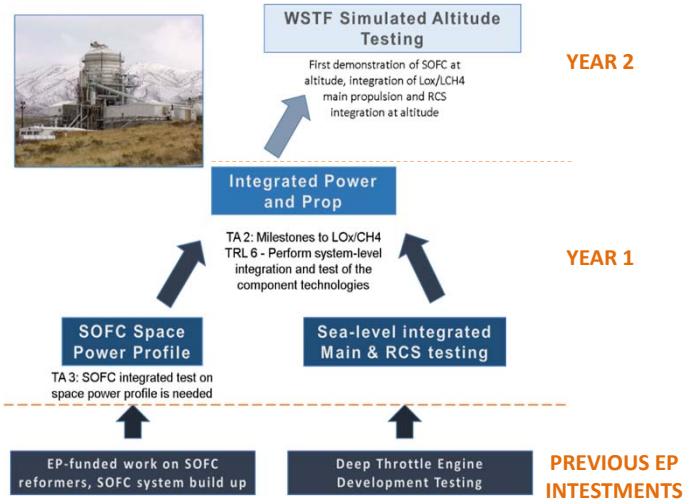
2.1.2 – LOx/LCH$_4$ Cryogenic Propulsion Systems & LOx/LCH$_4$ RCS Engines

2.1.1 – Non-Toxic RCS Engines

3.1.2 & 3.2.3 – Regenerative Fuel Cells, Fuel Cells & Electrolyzers

NASA TECHNOLOGY READINESS LEVEL: 4

PROJECT DEVELOPMENT FLOW



OBJECTIVE

- First integrated power and propulsion testing utilizing common commodity tanks. (Year 1)
- Development of integrated main engine / RCS propulsion system (Year 1)
- First Solid Oxide Fuel Cell (SOFC) testing in a space-power profile. (Year 1)
- First integrated main engine/RCS testing in a space-environment. (Year 2)

OUTCOME

- Understand fuel cell reactant conditioning requirements from a cryogenic source and thermal interactions between cryogenic commodity tanks and high temperature fuel cell.
- Full instrumentation (beyond what was done for Morpheus) allows for greater insight into Main/RCS fluid interaction.
- Better understanding of SOFC ability to meet space power profile requirements aids in future fuel cell design efforts and overall vehicle power system architecture design.
- Acts as spring-board to first in-space LOx/LCH$_4$ rocket engine ignition. (future work)