SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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MARS ASCENT VEHICLE - OPTIMIZATION OF PROPULSION WITH IN-SITU PROPELLANT PRODUCTION

Abstract

In any analysis of human exploration of Mars, the role of In-Situ Propellant Production (ISPP) has been consider by many of the Mars architecture studies because the Earth launch vehicle payload requirements are reduced by trading the mass of required Mars ascent vehicle propellant with the mass of a system that produces propellant at Mars. The ISPP provides the opportunity for significant reductions in total gross mass to the Martian surface, as the total mass of the ISPP plant (including feedstock and power source) is often significantly less than the mass of propellant needed for Mars ascent.

A model for analyzing a methane/liquid oxygen Sabatier-based ISPP plant is presented that allows for trades of secondary oxygen generation technology, propellant demanded, and duration of stay, and outputs system mass, power, and hydrogen feed stock required.

Results indicating the utility of ISPP for Mars missions are presented. Further, the question of the optimum oxidizer-to-fuel (O/F) ratio of the combined ISSP-Mars ascent vehicle propulsion system is considered. A lower O/F ratio implies a less massive ISPP plant because the plant operates at an O/F ratio of 2, whereas the Mars ascent vehicle operates at an ideal O/F ratio of 3.5. The ISPP model data is combined with propulsion data (Isp and engine mass) generated from an engine sizing tool and a Mars ascent vehicle sizing tool to evaluate the total net mass to the Martian surface. Uncertainties due to estimates of the sizing of plant and mission components are also considered. For the ideal propulsion O/F ratio of 3.5, results show that the ISPP leads to mass savings in the realm of 50