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THERMODYNAMIC MODEL OF MARS OXYGEN ISRU EXPERIMENT (MOXIE)

Abstract

As humankind expands its footprint in the solar system, it is increasingly important to make use of the resources already in our solar system to make these missions economically feasible and sustainable. In-Situ Resource Utilization (ISRU), the science of using resources at a destination to support exploration missions, unlocks potential destinations by significantly reducing the amount of resources that need to be launched from Earth. Carbon dioxide is an example of an in-situ resource that comprises 96% of the Martian atmosphere and can be used as a source of oxygen for propellant and life support systems. The Mars Oxygen ISRU Experiment (MOXIE) is a payload being developed for NASA's upcoming Mars 2020 rover. MOXIE will produce oxygen from the Martian atmosphere using solid oxide electrolysis (SOXE). MOXIE is a 1% scale model of an oxygen processing plant that might enable a human expedition to Mars in the 2030's through the production of the oxygen needed for the propellant of a Mars ascent vehicle. MOXIE will produce 22 g/hr of O_2 on Mars with greater than 99.6% purity during 50 sols. MOXIE is essentially an energy conversion system that draws energy from the Mars 2020 rover's radioisotope thermoelectric generator and ultimately converts it to stored energy in oxygen and carbon monoxide molecules. A thermodynamic model of this novel system is used to understand this process in order to derive operating parameters for the experiment. Models developed of the MOXIE system include CO_2 acquisition and collection, the conversion of CO_2 to O_2 and CO by a SOXE stack, and the storage and release of the products. Assumptions and idealizations are addressed, and the system efficiency is derived.