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ELECTROLYSIS PROPULSION SYSTEMS FOR INTERPLANETARY CUBESAT MISSIONS

Abstract

CubeSats have revolutionized the way private organizations access space since their inception in the late 1990's. Research universities have taken the lead and developed satellites that are much more than just great educational projects. CubeSats today can perform very real and important science for a fraction of the cost of larger missions. So far, CubeSats have been confined to Earth orbit. In order to expand the benefits of CubeSat development to scientific targets beyond Earth, several important obstacles need to be overcome in communications architectures, power sources in the outer solar system and propulsion systems. Emerging technologies in the area of propulsion will allow CubeSats to be used in interplanetary missions without the need for dedicated interplanetary launches. This paper focuses on the challenges in the area of propulsion, and analyzes one of these enabling technologies—the electrolysis propulsion system. Since CubeSats launch as secondary payloads, a major issue with the development of suitable propulsion systems is ensuring the safety of the primary payload. This and other safety concerns need to be balanced with the need for a sufficiently powerful (high specific impulse) system. Electrolysis propulsion systems, specifically designed for CubeSat-scale spacecraft, are being developed at Cornell's Space Systems Design Studio as a solution to this challenge. These propulsion systems use water as their propellant, do not have explosives, toxic components, hypergolic propellants, or pressurized tanks at launch. Because they store energy in the electrolyzed gases, they do not require high power, batteries or capacitors, and can adapt to the power available. Since electrolysis propulsion systems use hydrogen and oxygen gases, their specific impulse is comparable to that of liquid hydrogen/liquid oxygen rockets. Thrust from these systems is impulsive, operating in quick bursts that can be timed at specific positions in the orbit to maximize the effect of ΔV. Total ΔV for a 3U CubeSat is estimated to be 1 km/s, making lunar missions a possibility from a GTO launch. This paper considers the scaling of ΔV produced by the propulsion system using 6U and 12U CubeSats, and presents several possible interplanetary missions that are made possible by using electrolysis propulsion.