Paper ID: 65866
oral
student

IAF SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (1) (5)

Author: Mr. Conor Kennedy
The University of Sydney, Australia, conor.kennedy1003@gmail.com

MINIATURIZED CO2-FED PROPULSION SYSTEM FOR MICRO-SATELLITES IN VERY LOW MARS ORBITS

Abstract

CubeSats are invaluable platforms for performing high-risk and experimental applications due to their low mass and development costs, which makes them ideal for interplanetary missions such as Mars observation. To mitigate the payload constraints placed by their smaller dimensions and power capacity, CubeSats can be placed in a very low orbit to maximize their effectiveness. At such low altitudes, Martian atmospheric drag will cause rapid orbital decay which can be counteracted by an electric propulsion system. While the satellite is skimming the upper atmosphere it is feasible to collect and compress these molecules for use as a propellant, and as Mars' atmosphere is approximately 95% carbon dioxide (CO_2) the developed propulsion system will be designed to use CO_2 as a propellant. The molecules collected will be used to supplement existing propellant stores onboard.

This paper will address the design, construction, and testing of a miniaturized CO_2-fed electric propulsion system that can maintain the orbit of a micro-satellite in a very low Martian orbit. The propulsion system proposed is a small-scale Hall Effect thruster designed to meet the standard power, mass, and volume limitations available in a micro-satellite. There are two key challenges addressed in this paper. The first is mitigating the decrease in efficiency of the Hall Effect thruster as it is decreased in scale. The second is successfully implementing gaseous CO_2 as a propellant for a Hall Effect thruster without significant losses in efficiency when compared to more conventional propellants.

This paper develops a kinematic model of a micro-satellite in a very low Martian orbit, which is used to calculate the average and peak thrust required to be generated by the propulsion system to maintain the desired orbit. Once designed and constructed, the miniaturized system is tested in a high-altitude vacuum chamber and on an air bearing table. During these tests, performance information such as thrust, specific impulse, propellant exit velocity, and power consumption are recorded and analyzed to determine the feasibility of this propulsion system for very low orbital maintenance.