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DESIGN AND SIMULATION OF AN ARTICULATED ON-BOARD CUBESAT PROPULSION SYSTEM

Abstract

The idea of on-board propulsion systems have revolutionized the domain of scientific research and applicability of CubeSats by minimizing the possibilities of orbit decay and lack of successful attempts to their nominal orbits. In case of an articulated CubeSat propulsion system proposed, in the first stage, an on-board laser system will be used to create laser sustained plasma to assist in the propulsion until the propellant gets exhausted and then, the second stage would bear gridded ion thrusters which will add more to the mission life. High impulse and long endurance are the key factors for devising any advanced space propulsion system. In this paper, an attempt has been made to simulate the stage II of the articulated propulsive unit for a 6U CubeSat involving a built-in laser-sustained plasma setup for stage I and a gridded-ion thruster (GIT) for stage II respectively. Initially, 2D simulations of Type B cathode orifice design for Stage II were found to be best fitting for Low Cathode Current boundary conditions and in this follow-up paper, a series of 3D magneto-hydrodynamic simulations have been performed. A comparison between 2D and 3D simulation outputs gives an overview of a better and realistic solution approach, whilst optimising the temperature distribution in the thruster. A range of mass flow rates from 0.025-2.5 kg/s, used for the simulations, has helped in the study and investigation of the variation in parameters like velocity, temperature, pressure, turbulent kinetic energy, through which the appropriate inlet mass flow rate can be determined. The 3D MHD simulations of the Stage II reveal how magnetic interactions affect the plasma and an optimised result from the simulations gives us clarity on how the thruster design can be improved to get maximum impulse. However, the future scope of this work includes optimisation of the pressure distribution, changes due to other parameters and implementation of a low power and high energy laser in the Stage I which can also serve as a multi-utility device for the satellite after jettisoning of the first stage and thus help in multifarious ways such as remote sensing, gravity waves detection, laser communication system, laser altimeter amongst other uses which is a part of future scope of work.