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ANALYSIS OF VASIMR AIR-BREATHING THRUSTER

Abstract

Space missions that fly in Very Low Earth Orbit (VLEO), less than 300 km altitude, where the atmospheric density is still relatively significant for spaceflight, require continuous drag compensation. Electric propulsion is the currently preferred option because of its high specific impulse and low fuel requirement. However, the mission lifetime is limited by the amount of fuel able to be carried on-board. Using air-breathing electric propulsion offers the advantage that no on-board propellant is required to compensate drag. In the literature we can find studies that demonstrate the feasibility Hall effect air-breathing thrusters [1]. Under this scenario, the limitation comes from the engine durability, and Hall effect thrusters suffer from electrode erosion. In this paper, we examine how a VASIMR engine could be modified to operate in an air-breathing mode. VASIMR engines offer increased durability and thrust over Hall effect thrusters. This then can extend the mission lifetime of VLEO missions and also significantly lower the operational altitude (¡100 km). The required lengths of the thruster chamber, the magnetic fields, the thrust, and other parameters of an ideal thruster are calculated as a function of the flying altitude of the vehicle. Special attention is paid to the RF ionization techniques. Finally, it is shown that VASIMR air-breathing thrusters are capable of providing the necessary thrust for sustained flight below 100 km altitude.

[1] L. Pekker and M. Keidar, Analysis of Air Breathing Hall Effect Thruster, 42nd AIAA Plasmadynamics and Laser Conference, held in Honolulu, HI, 27-30 June 2011.