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RF HELICON-BASED PLASMA THRUSTER DEVELOPMENT FOR VERY-LOW EARTH ORBIT PLATFORMS: PROGRESS AT IRS

Abstract

Orbiting at very-low Earth orbit (VLEO) altitudes can open the chance on various types of space missions, taking advantage of the benefits of operating closer to the Earth. The challenge of these missions is the residual atmosphere that acts as a drag source in these low altitudes. Systems based on atmosphere-breathing electric propulsion (ABEP) technology can enable such missions and beneficially contribute to the design of VLEO satellite platforms. To increase the mission lifetime, an electric propulsion system (EP) combined with an intake system that collects the thermosphere's particles as propellant is needed to compensate the drag. Within the EU-funded DISCOVERER project, the Institute of Space Systems (IRS) developed and successfully tested the RF Helicon-based plasma thruster (IPT), using atmospheric propellant and thus eliminating the need of propellant tank. The electrodeless design of the thruster mitigates the erosion to its components caused by atomic Oxygen. Moreover, it delivers a quasi-neutral plasma plume, avoiding the use of neutralizer. The advanced antenna design (birdcage antenna) allows for a linear polarization fostering the acceleration of the charged propellant particles in combination with maximizing the electrical coupling efficiency and the load matching in the circuit.

Using the currently developed IPT laboratory model, a design study for the implementation of a downscaled version of the IPT is performed to fit a VLEO platform in the frame of the ESA Ram-CLEP project. Particular focus is given to the redesign of the birdcage antenna and the external magnetic field. The former is aided by the numerical tool XFdtd®. The latter is incorporated by introducing permanent magnets into the design to provide the external applied static magnetic field. The thruster comprises of a discharge channel, the birdcage antenna, permanent magnets and an injector. The ABEP system also consists of the intake and the PPU. The thruster's operation under vacuum conditions feature is incorporated into the design, aiming to increase the TRL during the project. This is achieved by thermal management analysis and investigating the application of the intake as a heating radiator.

In this paper, the current status of the IPT design with a particular focus on the birdcage antenna design and the thermal analysis is presented. Furthermore, follow-up activities, which include the use of the developed IPT laboratory model as a particle flow generator (PFG) and the end-to-end test of the complete ABEP system are also discussed.