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SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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DESIGN OF AIR INTAKE FOR AIR BREATHING ION ENGINE

Abstract

Very low earth orbit satellites enable researchers to find out about aeronomy, accurate gravity and magnetic field mapping, and high-resolution earth surveillance. They orbit the earth at an altitude of lower than 250 km, where the effect of atmospheric drag cannot be discounted. In order to use this orbit, some kind of propulsion for drag make-up is required and propellant mass increase proportionally to the mission time. The Air Breathing Ion Engine (ABIE) is a new type of electric propulsion system which can be used to compensate the drag of a satellite. In the ABIE propulsion system, the low density atmosphere surrounding the satellite is taken in and used as the propellant for the Electron Cyclotron Resonance (ECR) ion engines to reduce the required propellant mass. Therefore ABIE is a promising propulsion system for aerodynamic drag free missions longer than two years. Feasibility and performance of the ABIE depend on the compression ratio and an air intake efficiency. Generally, pressure of a discharge camber is lower than a propellant tank pressure in propulsion system, and the propellant flows to the reaction chamber from the tank. In the case of ABIE, a static pressure of atmosphere which corresponds to tank pressure is lower than the discharge chamber pressure. The air intake is the most important component to realize the ABIE. The temperature of the atmosphere is from 700K to 1100K at 200km, which is sufficiently low compared with the orbital velocity of 8km/s. Therefore, it can be said it is a uniform and well collimated supersonic flow parallel to the orbital direction. Moreover, the density is thin enough and it is a free molecular flow. The air intake consists of a collimator section and a reflector section. The collimator section will be composed of gaps between concentric cylinders. This part does not intercept the entering neutral particles, and they impact the reflection part on the downstream side directly. However, the backflow from the discharge chamber to the upstream side through the collimator section cannot easily leak out, because it is thermalized to the same level of temperature as the chamber walls and it has a velocity in a random direction. We simulate the relation between the ABIE and the rarefied atmosphere on such a super low earth orbit in a vacuum chamber. We will report the results of the air intake performance.