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FLIGHT MODEL DEVELOPMENT OF THE WATER RESISTOJET PROPULSION SYSTEM FOR DEEP SPACE EXPLORATION BY THE CUBESAT: EQUULEUS

Abstract

In this study, the micro-propulsion system: AQUARIUS (AQUA ResIstojet propUlsion System) which is to be installed on the SLS EM-1 CubeSat: EQUULEUS is proposed. AQUARIUS consists of three components: a tank, a vaporizer, and thruster-heads with a whole volume of 2.5U. AQUARIUS uses a storable, safe, and non-toxic propellant: water. Liquid propellant storage allows design of all propulsion systems below 1 atm, reduction of dry mass ratio and simplification of feed line routing using soft tubes. The safety of this system also makes possible short period and low-cost development compared to conventional propulsion systems, because it becomes relatively easier to meet launcher's safety requirements. In addition, water has been arousing interest as a potential resource for future deep space exploration. In the future, the use of water collected in space is likely to be promoted

EQUULEUS will fly to the Earth-Moon L2 (EML2) point and conduct missions as follows: 1)trajectory control within a Sun-Earth-Moon region, 2)recording the Earth's plasmasphere, 3)observing lunar flash impacts, 4)characterizing the size, frequency, and distance of celestial bodies in cis-lunar space. Notably, this is the world's first demonstration of trajectory control techniques within the Sun-Earth-Moon region by a nano-spacecraft, leading to future space missions related to a deep-spaceport. The key technology is the micro-propulsion system AQUARIUS, which is expected to have two propulsion capabilities: 1) reaction control, 2) delta-V maneuver for a lunar flyby and EML2 liberation orbit insertion. The target performances are a thrust of 4 mN, a specific impulse of 70 s, and a delta-V of 70 m/s for 6U CubeSat.

To enable insertion into the first lunar flyby orbit, a delta-V of more than 10 m/s is required within the first couple of days after launch. For this mission, a resistojet has been selected for its simple structure and high reliability.

We completed the development and testing of engineering model (EM) of AQUARIUS last year. The thrust performance of AQUARIUS-EM was evaluated by using whole CubeSat systems. Thermal vacuum, vibration, and impact tests were also conducted. In the EM phase, some point to be improved were cleared from the view point of both software and hardware. The design of the flight model (FM) were improved and tested by using FM of the CubeSat systems. In the conference, the development and test results of the AQUARIUS-FM will be presented.