

IAF SPACE PROPULSION SYMPOSIUM (C4)
Joint Session between IAA and IAF for Small Satellite Propulsion Systems (8-B4.5A)

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GROUND TEST RESULTS OF THE WATER RESISTOJET PROPULSION SYSTEM AQUARIUS
FLIGHT MODEL INSTALLED ON A 6U CUBESAT: EQUULEUS

Abstract

In this study, a micro-propulsion system named AQUARIUS (AQUA ResIstojet propUlsion System) is proposed. AQUARIUS is the propulsion system for the 6U CubeSat EQUULEUS (EQUilibriUm Lunar-Earth point 6U Spacecraft), which is to be launched in 2020 by NASA SLS (Space Launch System). The AQUARIUS-FM (Flight Model) has been assembled and experienced several tests.

EQUULEUS is a deep space explorer whose destination is the Earth – Moon Lagrange point (EML2). This space craft will conduct the following missions; 1) demonstration of trajectory control in the Sun – Earth – Moon region, which, if successful, is the first achievement as a nanosatellite, 2) imaging the Earth's plasmasphere, 3) observation of lunar flash impact and 4) measurement of the dust in cis-lunar region. AQUARIUS has the following performance requirements: a thrust of 4 mN, a specific impulse of

70 s and a delta-V of 70 m/s. In particular, AQUARIUS plays a significant role in achieving a delta-V of more than 10 m/s within the first several days, which is required to enter the first lunar flyby orbit.

AQUARIUS uses water as a propellant. Water is one of the most desirable propellants for CubeSats because of its non-toxicity, safety and storability. These advantages contribute to easier handling, which reduce the cost and shorten the period of development. Its storability also allows all the feeding systems to operate under low pressure. Furthermore, water is likely to exist in space, which means it has the potential of in-situ resource utilization in the future. AQUARIUS is mainly composed of three components: a tank, a vaporizer and thruster-heads. The tank has a bladder in it, which contains 1.224 kg of water. Argon gas with a pressure of around 50 kPa is filled between the tank and the bladder. The vaporizer is important to completely separate liquid water and water vapor. AQUARIUS has 6 thruster heads, 2 delta-V thrusters and 4 reaction control thrusters. The whole volume of AQUARIUS is about 2.5U.

In the conference, the latest development status of the AQUARIUS-FM will be presented, focusing on the results of the ground tests, especially the thrust performance tests. AQUARIUS reutilizes the waste heat of the communication devices of EQUULEUS. The thermal environment of AQUARIUS in the whole system may be quite different from that of AQUARIUS alone even if the thermal environment was simulated. In that sense, the thrust evaluation for the whole spacecraft is important for orbital operation.