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A WATER-FED MICRO-RESISTOJET FOR THE DELFFI FORMATION FLYING MISSION

Abstract

The full potential of distributed space systems, comprising of small satellites, may only be achieved if those satellites have the ability to control their relative position and velocity within the system. For this reason, a significant amount of research is presently ongoing towards the design and development of effective micro-propulsion systems for nano-satellites.

The next milestone in the nano-satellite roadmap of Delft University of Technology, is the DelFFi mission, consisting of two triple unit CubeSats as part of the international QB50 project. One of the objectives of these satellites is a formation flying demonstration in a very low-altitude Earth orbit. For this demonstration to be successfully accomplished, a high performance, low cost, compact micro-propulsion system is required.

The paper will describe the main characteristics, development and preliminary testing of the propulsion system designed by Delft University of Technology for the DelFFi satellites. The educational environment in which the satellites are developed require low-cost, non-hazardous propellants that can be easily stored at high density. For this reason, a water-fed micro-resistojet has been developed. Micro-machining and Micro Electro Mechanical Systems (MEMS) production processes have been used to produce the thruster sections.

The system is capable of providing a Delta-V of 15 m/s, with a thrust force in the range of 0.5 to 9.5 mN, a maximum total wet mass of 460 g and a peak power consumption of less than 10 W. The compliance to those requirements has been validated by means of a micro-propulsion thrust stand, specifically designed for this thrust range.

The paper will first elaborate on the propulsion system design, including propellant pressurization, heating chamber geometry, isolation and nozzle design. The manufacturing and testing processes will be discussed, and the analytical modelling and experimental performance of the system will be presented. This new micro-resistojet propulsion system is expected to be the first of its type to be flight demonstrated on a CubeSat and will enable new missions opportunities such as formation flying and constellations. It represents an important baseline from which more advanced, higher performance systems, such as arcjet and solar thermal propulsion, can be developed.