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DEVELOPMENT AND TESTING OF AN ENGINEERING MODEL OF A HYDROGEN PEROXIDE BASED 1N PROPULSION UNIT.

Abstract

Over the past few decades, the small satellite industry has rapidly grown, due to the increased versatility and reduced costs of the small platforms compared to the traditional satellites. In this frame, PM3 is a research project on a modular multi-mission platform founded by the Italian Ministry of Education, Universities and Research. The fundamental objective of the project is the study of a 50 kg class satellite platform characterized by the ability to accommodate multiple interoperable payloads. The primary propulsion unit, topic of this paper, is based on highly concentrated hydrogen peroxide as propellant and uses a 1N-class monopropellant thruster to accomplish the following tasks: orbital repositioning, station-keeping, and de-orbiting. The choice of using a green propellant instead of the more performing but extremely harmful hydrazine-based propellants allows the reduction of handling costs and the increase of safety. The aim of this paper is to illustrate the design and testing of the engineering model of this propulsion unit. The sub-system architecture is based on a simple unregulated blowdown discharge starting from a MEOP of 50 bar. The engine initial thrust in vacuum is 1N and then slowly decrease to 0.5 N at EOL as the tank pressure decreases. The fluidic line is composed by a custom piston-separated tank and few COTS components: an isolation valve, the fill and drain valves, and the firing valve. The tank is designed to be easily extended to increase propellant volume and meet the additional total impulse that may be required for other missions. Despite the EM version of the system, the overall design has been conceived, with the required amount of propellant, to be packed in a 1U envelope with the exclusion of the pressure sensors for the testing monitoring. The thruster catalyst chamber, whose design is based on a larger prototype previously developed at the University of Padua, has been 3D printed in stainless steel. The tank and fluidic manifold have been instead manufactured with standard mechanical processes for swarf removal in stainless steel and aluminium. During the characterization firing campaign several tests have been conducted to characterize the system behaviour with continuous firing tests up to 150 s. The engine has shown good decomposition efficiency, higher than 90%, and a stable behaviour at all the operative points.