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DESIGN OF A MODULAR 1U PROPELLANT TANK FOR CUBESATS HTP MONOPROPELLANT PROPULSION SYSTEM

Abstract

Nowadays, the demand of providing CubeSats for a propulsion system is increasing parallel to their growing market and applications. However, today there exist few nearly off-the-shelf European propulsion solutions. In this context, the European Space Agency launched a call to identify the most promising European Propulsion Systems for CubeSats. The University of Pisa participated to this ESA call with the CHIPS project (CubeSat HTP Innovative Propulsion System) focused on the design, manufacturing, and testing of an affordable chemical monopropellant propulsion system for CubeSats which uses hydrogen peroxide as the propellant.

The CHIPS baseline design fits in 2U, and it has to generate a maximum thrust of 0.5 N with a specific impulse of up to 160 s.

To fulfill the physical constraints, performance requirements, and limited budget a blowdown configuration has been devised with a beginning-of-life pressure higher than 25 bar. The hydrogen peroxide concentration has been selected up to 98% wt. Such as high concentrated H2O2 requires a careful selection of material for its compatibility with the propellant. Thus, the identification of miniaturized off-the-shelf components compatible with HTP and operating at high pressures is challenging. The market offers different solutions for most hydraulic components regarding the feed line. However, the thruster and the storage sub-systems remain the critical components that need a custom design and manufacture.

The purpose of this paper is to present the design of an innovative tank for CubeSats. The preliminary idea is to confine the storage system to 1U to allow for a modular and easy-to-interface subsystem. The main design driving factors are to maximize the propellant volume and reduce the mass and the cost. The first major issue is the selection of compatible materials with HTP, to guarantee a low decomposition rate and long-term storage capability. Different manufacturing processes compatible with the selected materials have been evaluated, which affect the achievable shapes and thus the volume optimization process. Various shapes, such as cylindrical and cuboidal ones, have been analyzed, in terms of both the propellant volume fraction and the decomposition rate.

A tradeoff between the selected materials, processes, and different tank configurations, such as piston, bladder, bellow, and diaphragm, has been carried out to achieve the best configuration that fulfills the design objectives.

The outcome of this design process aims to give a modular 1U tank solution for CubeSat not only for the CHIPS project but extendable to other monopropellant propulsion system applications.