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Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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VALIDATION OF A NEW MASS GAUGING METHOD FOR ELECTRIC PROPULSION TANKS ON-BOARD THE 70TH ESA PARABOLIC FLIGHT CAMPAIGN

Abstract

In the new generation of telecommunication satellites the Electric Propulsion (EP) technology is chosen as main propulsion system for the spacecrafts. The current forecast is that by 2030 nearly 50% of the platforms will include these kind of systems as the only propulsion, and that the amount of propellant stored in the spacecraft tanks will be increased from the traditional load of 200-350 kg to the 800-1500 kg range in order to cope with the long duration of the missions (up to 15 years).

In this scenario, traditional mass retrieval techniques appear to be insufficient because their accuracy decrease over large propellant tanks and long missions duration. However, the accuracy requirements when measuring the propellant mass over the spacecraft lifetime remains the same, and thus new mass retrieval techniques are needed.

We have recently proposed a novel mass retrieval algorithm based on one of the three classical approaches commonly used in current spacecraft propellant tanks, i.e., the PVT retrieval technique, based in pressure, volume and temperature (PVT) readings (A. Soria-Salinas, et al., 2017). This method demonstrated, in laboratory conditions, and thus at a Technology Readiness Level 4 (TRL-4) maturity, an accuracy improvement of a factor of 8 with respect to the classical PVT retrieval technique. Furthermore, this algorithm included the advantage of using the existing telemetry of current propellant tanks; no hardware development was required for the implementation of this new retrieval.

In order to increase the TRL of this new technology to TRL-6, a validation in representative on-orbit gravity conditions was performed on-board the A310 ZERO-G at the 70^{th} ESA parabolic flight campaign. The experiment was selected within the ESA Education Fly Your Thesis! program, where three parabolic flights were performed. The experiment was composed by six small-scale CO_2 propellant tanks pressurized at an End Of Life (EOL) scenario. In this work, we will illustrate:

1. Heat transfer and mechanical modelling of the experiment assembly with computational fluid dynamic (CFD) and finite element method (FEM) analysis of the experiment flight model.
2. Mass retrieval results from the parabolic flights in three different configurations, one per parabola, and comparative analysis if the accuracy achieved in comparison with ground tests.
3. The effect of different gravity loading conditions over the mass retrieval overall accuracy when considering thruster ignitions, external accelerations or spacecraft maneuvers scenarios.