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TRL-6 VALIDATION OF A NOVEL MASS GAUGING METHOD FOR ELECTRIC PROPULSION TANKS ON-BOARD THE 70TH ESA PARABOLIC FLIGHT CAMPAIGN

Abstract

By 2030 nearly 50% of the telecommunication satellites will include Electric Propulsion (EP) systems as the only propulsion technology. These systems have also been chosen for state-of-the-art spacecraft (SC) in the science and exploration framework of the European Space Agency, such as the Bepi-Colombo SC or the Lunar Orbital Platform space station.

In the EP systems, traditional pressure-volume-temperature (PVT) mass retrieval techniques are limited to operational lifetimes of ~ 10 years, mainly because the degradation of the pressure sensors introduces systematic errors that increase the uncertainty of the retrieval. These errors are larger the longer the missions and the larger the propellant tanks are; the retrieval reaches uncertainty levels that lead to end the mission, even though the propellant may not yet be completely consumed. Furthermore, longer missions with larger SC increase the required amount of propellant to be stored in the tanks, from the traditional 200-350 kg to 800-1500 kg, which increase the uncertainty of the PVT retrievals when the temperature sensors can only be placed in the skin of the propellant tanks.

We proposed a novel mass retrieval algorithm based on the PVT retrieval technique (A. Soria-Salinas, et al., 2017). This method demonstrated, under laboratory conditions, a Technology Readiness Level 4 (TRL-4) maturity and an accuracy improvement of a factor of 8 with respect to the classical PVT retrieval. This new algorithm also included the advantage of using the existing telemetry of current propellant tanks for the retrieval of mass; no hardware development was required for its implementation.

We present the validation performed under representative on-orbit reduced-gravity conditions on-board the A310 ZERO-G in the 70th ESA parabolic flight campaign. The experiment was selected by the ESA Education Fly Your Thesis! Program, consisting of a testing campaign with three parabolic flights. The experiment was composed by six small-scale CO_2 propellant tanks pressurized at an End Of Life (EOL) scenario under nominal thermal-duty cycles. In this work, we shall illustrate:

1. The experiment setup for TRL-6 validation under reduced-gravity conditions within the Airbus A310 ZERO-G testing platform.
2. The mass retrieval results from the parabolic flights in two different configurations, simulating accelerations as a consequence of on-orbit maneuvers and/or external accelerations, under EOL mass conditions.

3. The final retrieval accuracy according to TRL-6 standard.