SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS (D2)
Future Space Transportation Systems Verification and In-Flight Experimentation (6)

Author: Dr. Lionel Marraffa
European Space Agency (ESA), The Netherlands, lionel.marraffa@esa.int

SOUNDING ROCKET FLIGHT TEST OF PROPELLANT MANAGEMENT TECHNOLOGIES

Abstract

A major design target for cryogenic upper stages of future European launchers is a delayed ignition (as it happened for ROSETTA spacecraft) or multiple ignition capability. Re-ignition capability of the upper stage is mandatory for injecting spacecraft into most orbits other than standard GTO from Kourou. During such missions, microgravity phases ranging from a few seconds to several hours occur between the propelled phases of the flight. An adequate management of the propellant fluids in the tanks of the upper stage is indispensable during stage coasting. At present, only storable propellant stages are qualified for such missions in Europe. In the case of cryogenic fluids thermal aspects strongly interfere with propellant management strategies and complicate technical solutions. In-flight testing is required to explore and validate advanced technical concepts, before they can be used on real upper stages.

In the frame of the Future Launcher Preparatory Program (FLPP), within the Cryogenic Upper Stage Technology project, the European Space Agency (ESA) has commissioned ASTRIUM to develop and validate two concepts of Propellant Management Devices (PMD) for liquid hydrogen (LH2) and liquid oxygen (LOX) tanks. The selected concepts [1] are based on start basket design, utilizing surface tension forces to trap the required amount of fuel allowing chilling down and restarting the engine. In the absence of moving parts, these concepts are inherently reliable.

In order to test and validate these PMD concepts under realistic flight conditions, the TEXUS sounding rocket system is being qualified to carry a cryogenic experiment setup onto a suborbital trajectory. For the TEXUS mission, liquid Nitrogen has been selected as a cryogenic fluid for the experiments. Liquid Nitrogen offers the advantage of being both compatible with launch vehicle safety requirements and representative of the cryogenic fuels. The TEXUS flight test opportunity has been offered by DLR. The first cryogenic TEXUS mission is planned for March 2011.

During the mission it is planned to test two scaled-down PMD models under microgravity conditions. The test specimens are representative of the LH2 and LOX devices and might be qualified for future Ariane 5 or other next generation upper stages. During the flight, the focus shall be on the phase immediately preceding engine restart: the influence of pressurisation and de-pressurisation, as well as of draining and of heat input shall be studied.

[1] Philipp Behruzi et al., Future Propellant Management Device Concepts for Restartable Cryogenic Upper Stages , AIAA 2007-5498, 43rd Joint Propulsion Conference Exhibit, Cincinnati, OH, 2007