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ELECTRICAL PRESSURIZATION CONCEPT FOR THE ORION-ESM PROPULSION SYSTEM

Abstract

The Orion Multi-Purpose Crew Vehicle (MPCV) is the next generation spacecraft that NASA currently develops to send humans and cargo to the moon and beyond and return them back to earth safely.

The vehicle, which will be launched by the new Space Launch System (SLS), is designed to support long-duration deep space missions. The first exploration mission is planned to take place end of 2019 as an uncrewed lunar flyby mission followed by a second exploration mission in 2023 taking astronauts to the moon. The MPCV resembles its Apollo predecessors and will consist of a habitable Crew Module (CM) and a disposable European Service Module (ESM) that provides power, life support, and in-space propulsion. The ESM is subcontracted to ESA with Airbus DS GmbH as industrial partner being responsible for its development.

This paper focuses on the pressurization system of the ESM propulsion subsystem. To pressurize the propulsion subsystem, an electrical pressurization concept is used on the man-rated spacecraft. Separate pressurization for the oxidizer and the fuel tank permits mixture ratio adjustments and prevents vapor mixing of the two hypergolic propellants. The pressure in the propellant tanks is adaptable and conditioned according to the engine needs via a bang-bang regulation concept. The overall design of the pressurization system will be presented. To realize the regulation concept, the pressurization system mainly consists of a series of bi-stable and mono-stable solenoid valves that are commanded by a dedicated pressure regulation unit. For activation and deactivation of the mono-stable regulation valves, the pressure regulation unit acquires and evaluates a set of tank pressure values and commands the valves accordingly. The special weighting of the pressure signals leads to a single fault tolerance against loss of a sensor signal. In the full paper, the tank pressure evaluation and regulation is discussed in more detail.

During long duration missions of the MPCV a pressure ratio shift of the separately pressurized fuel and oxidizer tanks is likely to be observed due to different thermal excursions in cruise phases, where active pressurization is turned off. This requires an active correction of the pressure ratio prior main engine firings of the vehicle. The paper presents the operation logic and the pressurization strategy of the electrical pressurization concept to fulfill the engine needs during a mission.