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REGENERATIVE FUEL CELL SYSTEM (RFCS) FOR ENERGY STORAGE AND PROVISION DURING LUNAR NIGHT SURVIVAL

Abstract

Argonaut is Europe's autonomous access to the Moon, allowing ESA to play a significant role on the lunar surface. The lunar night survival poses a critical challenge for the Argonaut mission. During the 14-day-long lunar night, temperatures on the Moon plummet to a chilling -150C. This extreme cold can adversely affect equipment, batteries, and even crew survival. One of the possibilities to survive the lunar nights is to use a Regenerative Fuel Cell System (RFCS). RFCS is an ideal solution to meet these specific energy requirements, offering increased specific energy when compared to batteries with the advantage of autonomous thermal energy management and potential utilization of excess thermal energy during the night. A regenerative fuel cell system can operate in two modes: charge and discharge mode. During the discharge mode (lunar night), the fuel cell stack is fed fuel and oxidizer and converts them into electricity, while the electrolyser stack remains inactive. During the charge mode (lunar day), the electrolyser stack uses the electrical energy to split water into hydrogen and oxygen, which can be stored and later used as fuel. The choice to have a separate electrolyser and fuel cell allows to tune the system for the application depending on the external constraints and operational demands. This technology is currently being developed under ESA Contract No. 4000138948/22/NL/CGD with a target maturity of TRL5. The design phase has been completed and the assembly and pre-commissioning activities have started. New solutions for gas management and system integration are being developed and will be presented. These new solutions will allow for the RFCS to perform in relevant environment conditions (mechanical, vacuum, temperatures similar to moon environment). This paper presents the recent progress of the development of this RFCS. Initially, the challenge of survivability during lunar nights and the benefit of the RFCS technology for this application with key requirements is introduced. The concept and the design of the TRL5 RFCS is presented. Finally, the first test results in preparation of the global commissioning and

the expected performances are presented.