Aerospace Europe Conference 2023
Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX *(to be filled by the organizers)*
Preferred Topics: SPEXPLO
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Type: Oral
Status of corresponding author: Regular

Title

Regenerative Fuel Cell System technologies development

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Abstract

Before 2030 the moon Moon should see a return of humans on its soil. This time the aim will be to stay on our closest satellite and prepare humans for longer missions towards Mars. Thus, the moonMoon will become an exciting playground for testing technologies and assessing permanent human life in space.
However, a lot of technological gaps are present and need to be addressed before thinking of a sustainable activity on the moonMoon is a reality. This is especially the case for space transportation (reliable lunar landers and rovers), habitat and human health (to provide efficient shelters for preserving human health) or ISRU (capability to use resources present on the moonMoon). A common point of all these different fields is the energy storage challenge. Indeed, the moonMoon's environment is known to be harsh with long periods of darkness and cold (many days to permanently). During these lunar nights, the sun cannot provide power anymore but most of the equipment must be maintained at ambient temperature (or even "On") requiring electrical (or thermal) power. Thus, energy must be stored during lunar days to be provided during the nights.
Most common energy storage systems today rely on mature battery technology. However, when energy for a long Lunar night is to be stored, the presently low energy density of batteries (around 200 Wh/Kg) becomes unattractive: to store enough energy for one rover (3 kW over 14+ days) gives at least 5 tons of batteries). Thus, a higher energy density system must be developed which is the case of RFCS (Regenerative Fuel Cell Systems). The principle is very simple. It consists of splitting the water molecule into H2 and O2 gases when energy from the sun is available and storing them. Then using the H2 and O2 in a Fuel Cell to produce electrical power during the night. An RFCS can reach energy density in a wide range, from 200-300 up to 1000 Wh/kg (low power, very high energy stored). Therefore, the total mass of the energy storage system can be drastically reduced. In long term vision, H2O value chain can be developed on the Moon and therefore RFCS can constitute a corner stone for all the future infrastructures. Based on these highly interesting advantages, ALAT is working with CNES on technologies maturation for RCFS. Three axes are pushed in this study: Realization of a TRL3 breadboard to be used for representative on ground test scenarios of lunar activities, development of a test bench and test of a novel passive management system, modeling activities on RFCS. This paper will present the results of this study and the upcoming activities on Air Liquide on RFCS.