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SPACE LIFE SCIENCES SYMPOSIUM (A1)
Life Support and EVA Systems (6)

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PHYSICOCHEMICAL AND BIOLOGICAL TECHNOLOGIES FOR FUTURE EXPLORATION MISSIONS

Abstract

Life Support Systems (LSS) are essential for human spaceflight. They are the key element for humans to survive, to live and to work in space. Ambitious goals of human space exploration in the next 40 years like a permanently crewed surface habitat on the Moon or a manned mission to Mars require technologies which allow for a reduction of system and resupply mass. Enhancements of existing technologies, new technological developments and synergetic components integration help to close the oxygen, water and carbon loops. In order to design the most efficient LSS architecture for a given mission scenario, it is important to follow a dedicated design process: definition of requirements, selection of candidate technologies, development of possible LSS architectures, characterization of LSS architectures by system drivers and evaluation of the LSS architectures. This paper focuses on the approach of a synergetic integration of Polymer Electrolyte Membrane Fuel Cells (PEFC) and microalgae cultivated in photobioreactors (PBR). LSS architectures and their benefit for selected mission scenarios are demonstrated. Experiments on critical processes and interfaces were conducted and result in engineering models for a PEFC and PBR system which fulfill the requirements of a synergetic integrative environment. The PEFC system (about 1 kW) can be operated with cabin air enriched by stored or biologically generated oxygen instead of pure oxygen. This offers further advantages with regard to thermal control as high oxygen concentrations effect a dense heat production. The PBR system consists of an illuminated cultivation chamber (about 2 liters), a nutrients supply and harvesting and analytics units. Especially the chamber enables a microgravity adapted cultivation of microalgae. However, the peripheral units still have to be adapted in order to allow for a continuous and automated cultivation and harvesting. These automation processes will be tested and evaluated by means of a parabolic flight experiment. Both engineering models are being specified in dimension, components, mass and energy flows. They will serve as a platform for getting operational experience, reliability data and identifying technical issues before the next step is to be realized: in-orbit verification in a spaceflight experiment.