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MICROALGAE FOR SPACE APPLICATIONS: PBR@LSR AND BEYOND

Abstract

The Life Support System (LSS) onboard the ISS allows the recycling of water and recovery of oxygen from the astronauts' exhaled carbon dioxide, using physico-chemical technologies, but is not able to produce food. For Low Earth Orbit missions, the cost of bringing the required supplies from Earth and the resupply interval possibilities are reasonable. However, looking at potential future destinations, such as a Moon base or a mission to Mars, the longer duration and further distance from Earth might make it necessary to be as independent from Earth's resources as possible. Currently, the only option to produce food in situ is through living organisms. Thus, a microalgae based photobioreactor (PBR), able to produce potential microalgal food supplements and oxygen, might be one of the biotechnological options to complement current LSS. Microalgae based systems, although still not used as part of a LSS, have been widely investigated, both for Earth and space applications. The Institute of Space Systems (IRS) at the University of Stuttgart carries out research on the use of microalgae for space applications, looking both at the design of the required infrastructure and the cultivation techniques for the long-term cultivation and hybrid application of microalgae in space. For microgravity applications, the experiment Photobioreactor at the Life Support Rack (PBR@LSR) was initiated in 2015 by the German Aerospace Center (DLR) and the IRS with Airbus Defence and Space as prime for the flight hardware. After several successful breadboard experiments at the IRS lab, the experiment was sent to the ISS in May 2019. Unfortunately, due to an unexpected hardware failure the experiment ended prematurely - after two weeks of operations. The samples of those first weeks came down in September 2019, and are currently being analyzed. With the short duration of the experiment, the feasibility of xenic long-term cultivation of microalgae (*Chlorella vulgaris*) under space conditions and the performance of a hybrid

life support system (combining physico-chemical and biotechnological components) could not be proven. Thus, further research on microgravity-based PBR is still required. In parallel to the further research on microgravity-based systems, other scenarios and their influence in the infrastructure design are currently being considered, with special focus on the use of partial gravity for a Moon/Mars base. This paper will summarize the results of the PBR@LSR experiment and the next steps both regarding micro-gravity and Moon/Mars surface scenarios.