Challenges of Life Support/Medical Support for Human Missions (8)
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MICROALGAE FOR ADVANCED CLOSED LIFE SUPPORT SYSTEMS: TECHNICAL ANDBIOLOGICAL CHALLENGES

Abstract

A base on the Moon surface or a mission to Mars are potential destinations for human spaceflight, according to current space agencies' plans. The increased mission duration and further distance from Earth will require a Life Support System (LSS) as independent as possible from Earth's resources. Current LSS physico-chemical technologies at the ISS can recycle water and regain O2 from the exhaled CO2, but they are not able to produce food, which can currently only be achieved using biology. A future LSS will most likely include some of these technologies currently in use, but will also need to include biological components. A potential biological candidate are microalgae, which compared to higher plants, offer a higher harvest index, higher biomass productivity and require less water. Several algae species have already been investigated for space applications in the last decades, being *Chlorella vulgaris* a promising species. *C. vulgaris* is a spherical single cell organism, with a mean diameter of 6 m. It can grow in a wide range of pH and temperature levels and CO2 concentrations and it shows a high resistance to cross contamination and to mechanical shear stress, making it an ideal organism for long-term LSS. At the Institute of Space Systems (IRS), research on *C. vulgaris* for space applications has been carried out since 2010. The aim of the research is to allow the cultivation of microalgae in space to produce both oxygen and food for long duration missions. That implies both the design of the system and the cultivation techniques. The constrains and requirements for the design are highly dependent on the mission conditions. An important design driver is the gravity level which can include microgravity and reduced gravity (Moon/Mars surface). Several studies and experiments have been taken place at IRS considering all potential scenarios, including the microgravity experiment PBR@LSR, launched to ISS in 2019, and a Moon/Mars photobioreactor preliminary study. However, before microalgae can be used as a LSS component, both technical and biological issues need to be solved: long-term performance and stability, radiation effects on algae, selection of the required hardware, sizing the system, operation under Moon/Mars gravity and downstream processing to edible food. This paper gives an overview on the results of the microalgae-based biological research at IRS and discusses the questions still open until such a system can be used as part of a LSS for long duration missions.