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MODULES-PBR – LESSONS LEARNED

Abstract

Based on a scientific demand, the German Space Agency, DLR, has initiated a programmatic approach to gather a team of scientists, ensuring the research-characteristics of ModuLES (Modular Life Support and Energy Systems). The scientific and technical development and thus understanding of Life Support Energy Systems being based on ecological, sustainable processes is the basis for future applications in space as well as on ground.

As first part in the ModuLES concept a Photobioreactor (ModuLES-PBR) was characterized, designed and tested on ground and in parabolic flights. A Photobioreactor was chosen as first module, because microalgae serve with their photosynthetic activity for 50The overall goal of this ModuLES-PBR is the development of an energy-efficient and highly effective photobioreactor-system with clearly defined in- and outputs. The PBR is designed for a maximum efficiency with respect to oxygen production and carbon dioxide uptake as well as the optimization of closure-level of the nutrient loop during operation for various environmental conditions.

The core unit consists of a bioreactor that allows the cultivation of the microalga Chlamydomonas reinhardtii with highly efficient photosynthetic gas exchange rates. The efficiency of the system depends upon the quality and quantity of light, liquid mixing, gas supply and mixing, gas exchange for optimization of dissolved oxygen concentration in the algae solution to prevent bubble formation, medium composition and the growth phase of the microalgae. A second unit, which was added to the system after PBR-verification, is used for media recycling and algae filtration and is a first step for optimizing the nutrient-loop closure, which is essential for long duration operations.

The ModuLES-PBR was tested in ground- and parabolic flight campaigns over a duration of the past 2 years – and a summary will be given in this paper. The technical complexity of the system has kept growing with the project duration and new units will need to be added to close the loop appropriately. Thus, the presently researched media recycling will be addressed, as well as adaptations for a spaceflight design.