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CHLAMYDOMONAS REINHARDTII IN A CLOSED SYSTEM

Abstract

The primary requirement of a bioregenerative life support system is to handle the complexity of variable environmental conditions in an efficient and sustainable way. For an entire system design it is mandatory to understand the behavior of each subsystem under these explicit conditions. In a modular approach the biochemical and physicochemical in- and outputs of each subsystem need to be investigated and optimized before combining several modules to create a larger and more complex system.

Within the scope of ModuLES (Modular Life Support and Energy Systems), initiated and funded by the German Space Agency, DLR, a photobioreactor (PBR) with the unicellular microalgae Chlamydomonas reinhardtii was selected as the starting point of this research. The PBR and its subsystems were designed to understand the behavior and physiology of Chlamydomonas in a closed system - in regards to production of oxygen under a given supply of carbon dioxide, nutrients and light energy.

On ground, Chlamydomonas is the most researched unicellular algae around the globe, but when considering cultivating it in a microgravity environment over a long duration of time, several areas which have never been researched show up. In general, research on ground is conducted in an open system, but for spaceflight application, a closed system is a basic requirement. The importance to understand the general behavior and physiology in a closed system is therefore a prerequisite for successful operation of a PBR in Space.

Thus as a first step, the design is based on a chemostatic process which allows the investigation of environmental impacts on the microalgae culture with a set of sensory devices and a sampling unit supporting the physiological research. With these results the next step towards a turbidostatic performance can be realized. As an interface to other subsystems an oxygen removal and carbon dioxide supply in a liquid to gas exchange system is implemented. To achieve the recycling of media, a filtration, analysis and resupply unit is designed to reduce the needed resupply mass for spaceflight applications to a minimum. The obtained performance data can now be used to design the next component of ModuLES in the form of a new module utilizing the PBR output.