SPACE LIFE SCIENCES SYMPOSIUM (A1)
Life Support, habitats and EVA Systems (7)

Author: Dr. Stefan Belz
University of Stuttgart, Germany, belz@irs.uni-stuttgart.de

Mr. Jens Bretschneider
University of Stuttgart, Germany, bretschneider@irs.uni-stuttgart.de
Mr. Harald Helisch
University of Stuttgart, Germany, helisch@irs.uni-stuttgart.de
Ms. Gisela Detrell Domingo
Technical University of Catalonia (UPC), Spain, gisela.detrell@upc.edu
Mr. Jochen Keppler
University of Stuttgart, Germany, keppler@irs.uni-stuttgart.de
Mr. Winfried Burger
University of Stuttgart, Germany, burger@irs.uni-stuttgart.de
Mr. Ali Yesil
University of Stuttgart, Germany, yesil@irs.uni-stuttgart.de
Mr. Marco Binnig
Institute of Space Systems, University of Stuttgart, Germany, mail@binnig-marco.de
Prof. Stefanos Fasoulas
University of Stuttgart, Germany, fasoulas@irs.uni-stuttgart.de
Mr. Norbert Henn
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, norbert.henn@dlr.de
Dr. Peter Kern
Airbus DS GmbH, Germany, peter.kern@airbus.com
Mr. Heinz Hartstein
Airbus DS, Germany, heinz.hartstein@airbus.com
Dr. Carsten Matthias
Airbus DS, Germany, carsten.matthias@airbus.com

PREPARATORY ACTIVITIES FOR A PHOTOBIOREACTOR SPACEFLIGHT EXPERIMENT ENABLING MICROALGAE CULTIVATION FOR SUPPORTING HUMANS IN SPACE

Abstract

Biological technologies are an essential step to close the carbon loop in life support systems (LSS), which is important for future and far-distant exploration missions. Based on photosynthesis and able to be combined with physicochemical systems, microalgae are able to generate edible biomass and release oxygen. Algae cultivation in aquatic reservoirs reaches up to ten time higher growth rates and significant lower energy and volume investments than higher plants, and neither a hydroponic basis nor soil are needed. Up to 30% of human food can be covered by algae biomass, limited by the high protein content of edible algae species. Research on the biology is important (driving question: what happens to microalgae in space environment?), but it is also challenging from a technical point of view to provide a mass and energy efficient photobioreactor (PBR) system and downstream processing (driving question: how to cultivate and use microalgae?). Mass und energy benefits strongly depend on cultivation techniques, illumination (sun light, artificial) and gravity level (g in space or partial g on planetary surfaces), but also on the mission scenario (transfer, orbit, surface). The paper gives an overview of past microalgae studies and current developments for space applications. Need of research for single technologies within a PBR system is identified in terms of technological readiness (TRL), particularly the supply with carbon dioxide, cultivation chamber, oxygen extraction, illumination control, optical density measurement, sensors for carbon dioxide, oxygen and pH value, absorber/filters for humidity and volatile organic compounds, techniques of nutrients supply and harvesting, as well as techniques of downstream processing (such as cross-flow filters). From this point, the experimental setup of a PBR experiment on the International Space Station is presented focusing on three major objectives. It will demonstrate the functionality/feasibility in a real environment, the short- and long-term (half a year at least) performance of photosynthetic conversion of concentrated carbon dioxide into biomass and oxygen, and the stability of the algae system under microgravity and higher radiation conditions.