A CONTINUOUS LOOP OF BIOREACTORS TO PROVIDE FOR LIFE SUPPORT IN SPACE

Francesc Gòdia MELiSSA Pilot Plant – Claude Chipaux Laboratory. Universitat Autònoma de Barcelona, Spain
francesc.godia@uab.cat
Enrique Peiro, MELiSSA Pilot Plant – Claude Chipaux Laboratory. Universitat Autònoma de Barcelona, Spain
Carolina Arnau, MELiSSA Pilot Plant – Claude Chipaux Laboratory. Universitat Autònoma de Barcelona, Spain
David García, MELiSSA Pilot Plant – Claude Chipaux Laboratory. Universitat Autònoma de Barcelona, Spain
Laura Alemany，MELiSSA Pilot Plant – Claude Chipaux Laboratory. Universitat Autònoma de Barcelona, Spain
Laurent Poughon, Université Clermont Auvergne, CNRS, SIGMA Clermont, Institut Pascal, Clermont-Ferrand,France
Claude-Gilles Dussap Université Clermont Auvergne, CNRS, SIGMA Clermont, Institut Pascal, Clermont-Ferrand,France
Olivier Gerbi Sherpa Engineering, La Garenne-Colombes, France
Brigitte Lamaze, ESA-ESTEC, Noordwijk, The Netherlands
Chistophe Lasseur ESA-ESTEC, Noordwijk, The Netherlands

Key Words: MELiSSA, Life Support, Bioreactors, Control, Continuous operation

MELiSSA project is developing Life Support technologies for long-term Space missions. The goals of the MELiSSA loop are the recovery of food, water and oxygen from wastes, i.e. CO2 and organic wastes, using light as a source of energy. It is conceived as a series of compartments, each one performing a specific function within this cycle, inspired in the terrestrial ecological systems. Each one of the compartments is colonized with specific bacteria or higher plants depending on its dedicated function. The MELiSSA Pilot Plant is a facility conceived for the demonstration of this technology, the development of the MELiSSA compartments and its integration to build the complete MELiSSA loop. It uses laboratory rats as a demonstrator of the crew.

The experimental results from the connection of a 100L air-lift photobioreactor culturing the cyanobacteria Arthrospira platensis, producing oxygen with an isolator with rats as the mock crew, as oxygen consumers, is presented. Several experiments of continuous connection with duration of 4-5 weeks have shown the robustness of the system and the ability of the control system to adjust the dynamics of the oxygen production compartment to that of the oxygen consumption compartment, while maintaining a desired percentage of oxygen in the gas phase of the animal compartment. The key variable used to adjust the production of the photosynthetic compartment to the consumer's compartment is the illumination intensity in the photobioreactor, governed by the control system of the MELiSSA Pilot Plant. To note, the demand of oxygen by the consumers is changing following 12 hours day/night periods. The results show a very precise adjustment of the operation of the integrated system and a fast capacity of the control system to drive the oxygen level to a given set point. The evolution and mathematical modeling of the different variables of the integration, such as oxygen production and CO2 consumption in the photobioreactor, the oxygen consumption and CO2 production in the animal compartment, the illumination intensity, percentage of oxygen in the gas phase and operational conditions of the system at several experimental conditions will be discussed.