

Proposed List of MELiSSA PhD Topics

Topic Title: MELiSSA loop: Description of the S, P, and Na/K -cycles.

Keywords: Mass Balance, Circularity limitation, limiting electrolytes

Abstract

MELiSSA stands for “Micro-Ecological Life Support System Alternative”. The nature of the MELiSSA project is characterized by a biological and chemical/physical approach based on first principles modelling and implementation of a suitable deterministic engineering approach with the goal of developing a closed life-support system. The MELiSSA loop as a regenerative life support system has to maximize the recovery of the main consumables (e.g. water, oxygen food), as a key to develop a closed and self-sustainable process. Circularity of chemical elements is by nature the key challenge of closed life support systems, and so far, no project has yet demonstrated such a circularity over a full loop, a long period of time and multiple cycles.

Considering the mandatory biological processes for food production and waste processing, the modelling and especially the sensitivity to limitation and toxicity cannot be limited to the four major elements (i.e. C, H, N, O). Other elements such as S and P shall be progressively studied at unit processes and loop level, not only because they are part of the produced biomass but mainly because their concentration can be limiting and block nominal metabolic pathways via limitation or toxicity and induce degraded mode.

After these 4 major chemical elements comes first S and P. Sodium is semi-exogenous and often, associated to potassium, considered as the first risk of toxicity and accumulation inducing disorders in osmotic pressure control.

Within this PhD it is proposed to progress on modelling maturity (i.e. MRL) via the OSCAR approach for the S, P, Na, K cycles. This maturity gain shall address availability, assimilation characterisation, optimal and limited metabolisms, metabolic indicators, deterministic modelling leading later-on to predictive control of the full loop.

This work shall include metabolomic study as well some experimental investigations and demonstrations.

Impact on MELiSSA Project:

Mass balance, loop performances, degraded modes.

Potential MELiSSA Partners:

UCA, U Anvers, U Napoli, ETHZ, EAWAG.

References:

- OSCAR, ALISSE, Predictive control,..

Cornet J.F., Dussap C.G., Cluzel P., Dubertret G. (1992)

“A structured model for simulation of cultures of the cyanobacterium *Spirulina Platensis* in photobioreactor: II Identification of kinetic parameters under light and mineral limitations”. *Biotechnology and Bioengineering*, Vol 40, 826-834

Gros J.B., Poughon L., Lasseur C., Tikhomirov A.

Recycling efficiency of C,H, O,N,S and P elements in a biological life support system based on microorganisms and higher plants. Advances in space research, vol 31, N1, p 195-199, 2003

ALISSE criteria presentation. Version 1, issue 0, 18th November 2009.

ESA Technical Note 137.4 Appendix. Applicable document for using Oscar Methodology System Engineering applied to the MELiSSA data management system: requirements

Candidate's background requirements:

Candidates preferably possess a degree in biology, chemistry, biotechnology or bioengineering. They have to be familiar with metabolic pathways analysis, process engineering and simulation tools.