Optimizing nutrient recovery from urine for space missions

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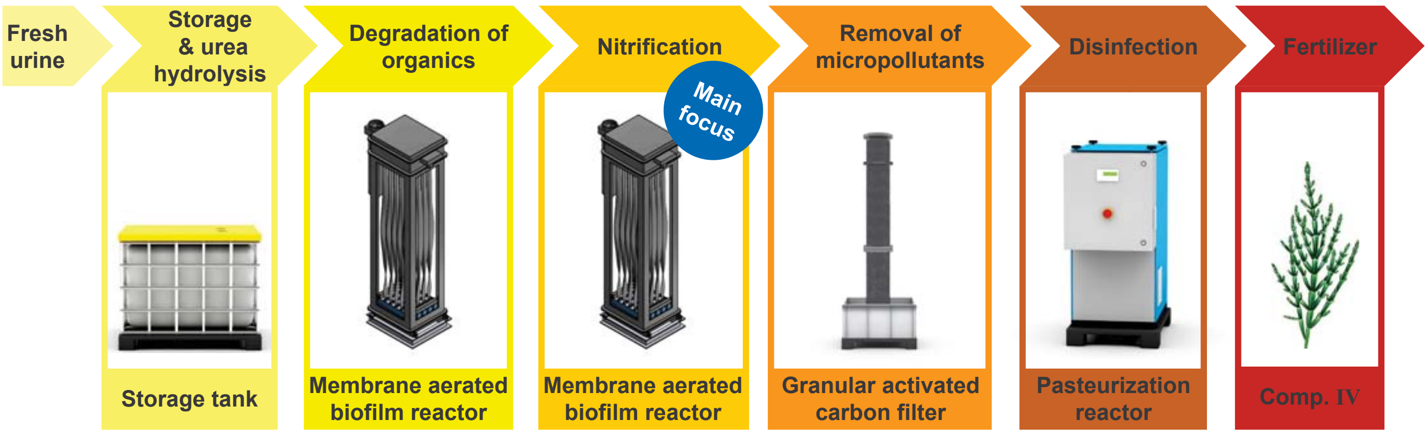

Fig. 1: Proposed urine treatment chain for space application combining urine treatment technology of Eawag with MELiSSA
Input: human urine. Output: chemically stable fertilizer free of micropollutants and pathogens for the photoautotrophic compartment (Comp. IV) of the MELiSSA loop. No base is added, therefore only half of the ammonia is nitrified. Stable nitrification reactor performance is possible if the pH is controlled with the inflow rate.

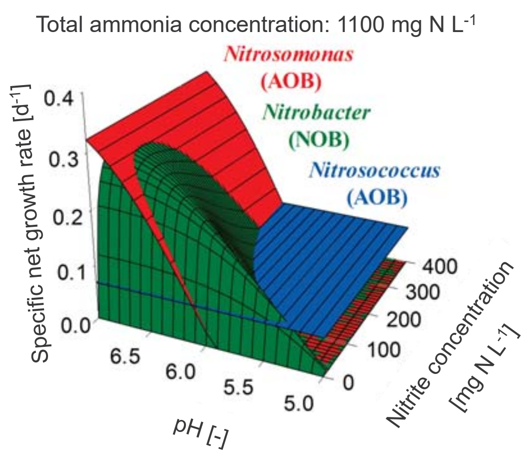

Fig. 2: Small stable operation range
Stable nitrate production requires that the nitrite oxidizing bacteria (NOB) *Nitrobacter sp.* grow faster than the ammonia oxidizing bacteria (AOB) *Nitrosomonas sp.* and *Nitrosococcus sp.* High inflow rates will result in the accumulation of nitrite and the washout of NOB, while low inflow rates foster the growth of the acid-tolerant AOB *Nitrosococcus sp.* and the production of harmful nitrogen oxide gases. Figure by courtesy of A. Fumasoli.

How to increase process reliability?

1. Model of the biological processes

- Treatment units: degradation of organics and nitrification
- Calibrate and validate mechanistic model

2. Control strategies

- Model all treatment units and their inter-connections
- Determine optimal parameters for process control
- Try out different control strategies

3. Axenic cultures

- Identify dominant nitrifying and heterotrophic bacteria in the system and reproduce axenic cultures of identified bacteria
- Compare performance of synthetic and natural consortia
- Integrate results in the mechanistic model

Picture references: VUNA Ltd., OxyMem Ltd., WAGO Ltd., Dynamita Ltd.