Paper ID: 43481
interactive
student

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

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THE ELEMENTS BALANCE IN THE SYSTEM COMBINING NITRIFICATION AND AEROPONIC CULTIVATION

Abstract

Water and nutrients recovery are essential in regard to future deep space missions. In order to create self-sufficient extraterrestrial outpost connection between each subsystem in life support system is necessary. This is the case especially with regard to the wastewater treatment system, solid waste management and biomass production. Simultaneous use of physicochemical and biological methods provides possibility to recover water and nutrients. Thus, biological method of wastewater treatment such as nitrification process potentially might support plant cultivation. Recently common type of cultivation is soil less cultivation e.g. aeroponic. This cultivation method has few advantages in comparison to the conventional design of plantation. First of all, it provides better oxidation in plant system, water usage in this system is definitely lower, but also it provides increased crop yield. On any manned space object (such as space station, but also future extraterrestrial colony) several wastewater streams are formed. They could be derived into two groups: blackwater (urine and feces) and grey water with condensate. The first type is rich in nitrogen and phosphorus. The latter is rather clean, but might includes surfactants. Taking that into consideration it could be assumed, that blackwater should be used for nutrient recovery and grey water for eventual necessary dilution. Since one of the most required element in nutrient solution for crops is $N - NO_3$, application of the nitrification process is evident. This paper describes path and mass flow of nitrogen, phosphorus, potassium and magnesium in system, which includes nitrification reactor and aeroponic cultivation plant. In this concept Tomato and Potato are chosen as crops with two highly various required nutrient solution composition. Wastewater reactor is fed with urine, which is before partly diluted with grey water, due to possible inhibition caused by high concentration of ammonia. Treated stream provides $1.18gN \cdot L^{-1}$. Tomato requires $0.21gN \cdot L^{-1}$ and Potato requires $0.68gN \cdot L^{-1}$ in each case dilution is needed. The results show urine and grey water treated in biological process, such as nitrification can meet requirements for aeroponic nutrient solution. This is the case especially with regard to nitrogen. However, dilution of the stream will be necessary, and also other elements supplementation. This paper also describes possible ways (such as feces combustion) to receive required elements, which cannot be gain in biological process.