Diego Paredes 2009

PhD thesis at the Martin-Luther-University Halle-Wittenberg, Centre for Engineering Sciences, Germany

"Investigations on nitrogen transformation processes and stimulation of anaerobic ammonium oxidation activity in an experimental laboratory-scale wetland system"

Concluding remarks

The results showed that the inoculation of active anammox biomass was successful for improving nitrogen removal in experimental laboratory-scale subsurface horizontal-flow constructed wetlands (SSHF CWs). By this it was possible to increase nitrogen removal rates from 0.56 g N m^{-2} d^{-1} up to 5.8 g N m^{-2} d^{-1}. After inoculation anaerobic ammonium oxidation was the main nitrogen transformation and removal process. Partial nitrification, denitrification and plant uptake played a minor role. At low ammonium loads applied in the system nitrification-denitrification became the main mechanism for nitrogen removal and anammox played a minor role.

Higher nitrogen removal rates obtained through anammox processes will have a direct impact on size and investment costs for wastewater treatment systems based on SSHF CWs because less area will be needed, however it requires further research in order to scale up the results.

There are several methodologies for designing SSHF CWs including first order kinetics, area based methods, loading charts, etc., but most of them are based on the high oxygen demand for nitrification processes. The obtained results in this research open a door for improving and enhancing the nitrogen removal in subsurface wetlands with a lower oxygen requirement process: the anaerobic oxidation of ammonium. This process will cope with the main disadvantage that has been identified with SSHF CWs, the low oxygen transfer rate.

Because the low oxygen transfer rate in SSHF CWs, a combination of vertical flow and SSHF CWs can be used for nitrogen removal. The first one is more engineered, aerobic and normally requires pumps or some mechanical devices to apply intermitent load into the system which allows a forced aeration. The second one (SSHF CW), less aerobic, can be defined and constructed for denitrification process, however in most of the cases organic carbon source becomes a limitation.

Promoting anammox process in SSHF CWs will handle the limitations of aeration and carbon source in one single unit with minimum technical aspects.

Future research should be addressed to applied and basic topics. In applied research guidelines like how to start up full scale systems, how to inoculate them with active anammox biomass, how to enhance appropiated environmental conditions for establishment anammox process in SSHF CWs, effects of different temperature, soil matrix and plants should be developed. In basic research, nitrogen transformation processes and interactions of nitrogen and sulphur cycles are examples of still open questions.