Treatment of ammonia rich effluents from anaerobic digesters

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The use of nitrogen fertilizer and increased human induced nitrogen pollution has made the nitrogen removal an important element in the wastewater treatment process. The conventional nitrification/denitrification treatment has achieved the most widely full-scale application. However the discovery of Anaerobic Ammonium Oxidation (Anammox) provides a "short-cut" option of ammonia removal via the anaerobic oxidation of ammonium with nitrite as electron acceptor (Mulder et al., 1995). Ammonium is partially oxidized into nitrite by aerobic ammonium oxidation bacteria (aerAOB) under oxygen limited condition. Then the present ammonium and nitrite composed the substrate for autotrophic Anammox bacteria and nitrogen gas is produced. The principle of partial nitritation (1) and Anammox (2) is described by the reactions below (Verstraete, 2007):

$$NH_4^+ + 1.5O_2 + 2HCO_3^- \rightarrow NO_2^- + 3H_2O + 2CO_2 \quad (1)$$

$$NH_4^+ + 1.32NO_2^- + 0.66HCO_3^- \rightarrow 1.02N_2 + 2.03H_2O + 0.66CH_2O_{1.5}N_{0.15} + 0.26NO_3^- \quad (2)$$

One stage partial nitritation/Anammox process has attracted worldwide research interest while facing various problems which limit the full scale application. One of the major problems is the long start up time due to the low growth rate of the Anammox bacteria. Optimization of process parameters as well as "preservation and reactivation" of biomass have been investigated attempting to accelerate the start up (Zhang et al., 2005; Vlaemink et al., 2007).

The study of salinity, which is an environmental stress as well as a feature of some waste water stream (e.g. such as landfill leachate, industrial wastewater from tannery, seafood processing, desulphurization, etc), has been studied on its impact of the partial nitritation/Anammox process. However, the tolerance level varies among different authors and the mechanism remains unclear (Windy et al., 2005; Kartal et al., 2006; Dapena-Mora et al., 2010).

Extracellular polymer substances (EPS) have been believed to play an important role in the sludge granulation and biofilm formation (Sheng et al., 2010). The one stage partial nitritation/Anammox process involves the cooperation of two major functioning groups and requires special juxta positioning. Thus it is necessary to investigate the role of EPS in the formation of granules during Anammox enrichment as well as operation under stress.

The **objective** of this research is to improve the understanding and functionality of the full cycle of the single reactor partial nitritation/Anammox process through lab scale experiments, chemo-microbiological analysis. Mathematical modelling from other studies will be used to verify the results. Aiming at solving the problems of long start-up, salinity and investigating the role of EPS, the research is divided into the following four sub-objectives:

1) Investigation of a fast start-up of the process, which includes the selection criteria of seeding sludge and the respective cultivation strategy.
2) Study of salt adaption strategy of aerAOB and Anammox mixed culture cultivated from WWTP and marine/coastal sediment.
3) Treatment of wastewater with high salinity and ammonium concentration using adapted sludge.
4) Investigation of the role of extracellular polymeric substances (EPS) in the formation and maintenance of biofilm and/or aggregates.

References

Dapena-Mora, A.; Vázquez-Padín, J.R.; Campos, J.L.; Mosquera-Corral, A.; Jetten, M.S.M.; Méndez, R. (2010) Monitoring the Stability of an Anammox Reactor under High Salinity Conditions. *Biochemical Engineering Journal*, **51**: 167-171.

Kartal, B.; Koleva, M.; Arsov, R.; van der Star, W.; Jetten, M.S.M.; Strous, M. (2006) Adaptation of a Freshwater Anammox Population to High Salinity Water. *Journal of Biotechnology*, **126**: 546-553.

Sheng G.; Yu H.; Li X. (2010) Extracellular Polymeric Substances (EPS) of Microbial Aggregates in Biological Wastewater Treatment Systems: a Review. *Biotechnology Advances*, **28**: 882-894.

Vlaeminck, S. E.; Geets, J.; Vervaeren, H.; Boon, N.; Verstraete, W. (2007) Reactivation of Aerobic and Anaerobic Ammonium Oxidizers in OLAND Biomass After Long-term Storage. *Applied Microbiology and Biotechnology*, **74**: 1376-1384.

Verstraete, W. (2007), Course Notes for "Biotechnology Process for Environmental Sanitation", University of Ghent, Belgium

Windey K; De Bo I; Verstraete W. (2005) Oxygen-limited Autotrophic Nitrification-denitrification (OLAND) in a Rotating Biological Contactor Treating High Salinity Wastewater. *Water Research*, **39**: 4512-4520.

Zhang, L.; Xiao, W. (2005) Cultivation of Anaerobic Ammonium Oxidation Bacteria and Their Performance in an Up-flow Anaerobic Sludge Bed Reactor. *East China University of Science and Technology*, **31**, 99-102.