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Anammox-based systems for nitrogen removal from mainstream municipal wastewater

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Abstract

Nitrogen removal from municipal wastewater with the application of deammonification process offers an operational cost reduction, especially if it is combined with a maximal use of organic content of wastewater for biogas production. In this thesis, two approaches for integration of the deammonification process into the municipal wastewater treatment scheme were studied.

The first approach is based on ammonium concentration from municipal wastewater by ion exchange followed by biological removal of ammonium from the concentrated stream by deammonification process. Experiments with synthetic and real municipal wastewater showed that strong acid cation resin is suitable for ammonium concentration due to its high exchange capacity and fast regeneration. Since NaCl was used for regeneration of ion exchange materials, spent regenerant had elevated salinity. The deammonification biomass was adapted to NaCl content of 10-15 g/L by step-wise salinity increase. The technology was tested in batch mode with 99.9 % of ammonium removal from wastewater with ion exchange and up to 95 % of nitrogen removal from spent regenerant by deammonification process.

The second studied approach was to apply anammox process to low-concentrated municipal wastewater in a moving bed biofilm reactor (MBBR) and integrated fixed film activated sludge (IFAS) system without a pre-concentration step. After a 5 months period of transition to mainstream wastewater the pilot plant was operated during 22 months and stable performance of one-stage deammonification was proven. Clear advantage of IFAS system was shown. The highest stable nitrogen removal efficiency of 70 % and a nitrogen removal rate of 55 g $N/(m^3 \cdot d)$ was reached. Moreover, the influence of operation conditions on competition between ammonium oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB) was studied by literature review, batch tests and continuous pilot plant operation.

Key Words

Wastewater, Nitrogen removal, Ion exchange, Deammonification, Anammox, Mainstream

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