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Anaerobic/oxic/anoxic process with endogenous denitrification for nutrient removal from low C/N wastewater

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Introduction:

Biological nutrient – nitrogen and phosphorus (N and P) – removal (BNR) from low carbon to nitrogen (C/N) wastewater is challenging due to the required balance of the different metabolic demands of functional microorganisms by providing appropriate process factors. BNR is economical and eccologcal friendly approach for nutrient removal from wastewater. BNR is achieved through nitrification, denitrification and enhanced biological phosphorus removal (EBPR) process with the nitrifiers, denitrifiers, phosphorus accumulating organisms (PAOs) and glycogen accumulating organisms (GAOs). An anaerobic/oxic/anoxic (A/O/A) configuration with endogenous denitrification of 2 h/2 h/4 h at a dissolved oxygen (DO) concentration of DO ≥2 mg/L in the oxic phase and DO <0.5 mg/L in the anoxic phase during 30 days was investigated.

Materials and methods:

- Synthetic wastewater: 30±2 mg NH_4-N/L, C/N ratio 4, C-source: sodium acetate
- A/O/A configuration: 2 h/2 h/4 h
- DO ≥2 mg/L -oxic phase and DO <0.5 mg/L -anoxic phase
- Activated sludge aclimatized on N and P removal, A/O/A configuration and acetate
- COD (chemical oxygen demand), NH_4-N, NO_3-N, NO_2-N, PO_4-P, N total and MLSS (mixed liquor suspended solids) determined according to Standard methods (1998)
- Temperature, DO concentration and pH value – WTW Dur Ox and WTW 3210 Oxi, and WTW SenTix 41 and WTW 330i

Discussion and conclusion:

- The achieved average removal efficiencies of COD, NH_4-N, total N and P amounted as follows: 90.4 %, 91.4 %, 80.3 % and 59.2 % (Figs. 1-3)
- During the anaerobic phase PAOs and GAOs used the organics and stored them as polyhidroxyalkanoates (PHA), with PAOs P release. During this phase the competition for organics between PAOs and GAOs takes place
- During oxic phase NH_4-N oxidation occured, with NO_2-N and NO_3-N accumultion, with detected N loss. The oxic phase was not long enough for complete NH_4-N oxidation. Also, P-removal was measured. During oxic conditions PAOs use stored PHA for PO_4-P uptake, recovery of glycogen pools and the cells growth
- During the anoxic phase denitrifying phosphorus accumulating organisms (DPAOs) contributed to additional P accumulation, and denitrifying glycogen accumulating organisms (DGAOs) contributed to additional N removal – endogenous denitrification
- The results suggest that for higher N and P removal efficiency more electron donors (organic compounds) should be provided, i.e. a higher C/N ratio, as well as extending the oxic phase to ensure complete NH_4-N oxidation.

Results:

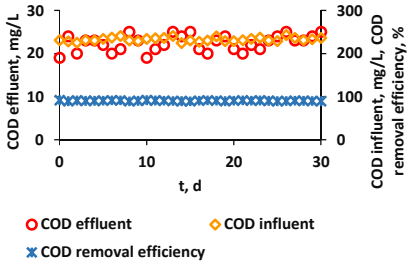

Figure 1. Influent, effluent and COD removal efficiency in A/O/A process with endogenous denitrification

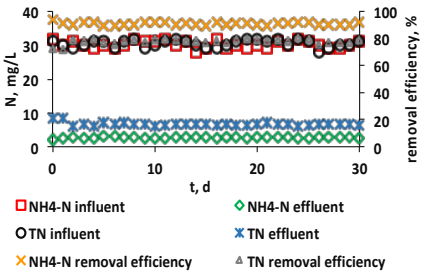

Figure 2. Influent, effluent and removal efficiency of NH_4-N and total nitrogen in A/O/A process with endogenous denitrification

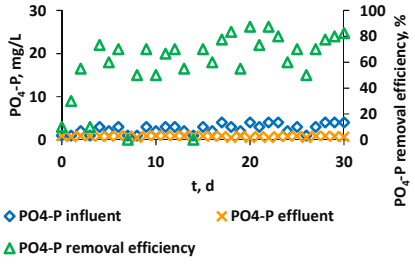

Figure 3. Influent, effluent and PO_4-P removal efficiency A/O/A process with endogenous denitrification

References:

APHA, 1998. Standard Methods for the Examination of Water and Wastewater, APHA.