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Simultaneous anammox and denitrification process: start-up performance and mathematical simulation

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ABSTRACT

The start-up performance of the simultaneous anammox and denitrification (SAD) process was studied in an upflow anaerobic sludge blanket (UASB) reactor with an effective volume of 10 L. The activity of heterotrophic denitrifying bacteria (DNB) increased when the C/N ratio was 0.25 over 53 d. Ammonia removal efficiency (ARE), chemical oxygen demand removal efficiency (CRE), nitrogen removal efficiency (NRE), and nitrogen removal rate (NRR) reached 93.27% ± 0.20%, 82.25% ± 0.04%, 82.39% ± 0.57% and 0.90 ± 0.02 kg/(m^3·d), respectively. A kinetic model of the biological reaction system of the SAD process start-up was developed based on the experimental data and a modified mathematical model (ASM1). The effectiveness of the model was verified based on the experimental data, and the nitrogen removal performance and changes in functional bacteria of the coupled system under different C/N ratios were investigated. The simulation revealed that the concentration and activity of anaerobic ammonia-oxidizing bacteria (AnAOB) gradually decreased, and DNB gradually increased, as the C/N ratio increased from 0.3 to 1.0. The optimal synergy of AnAOB and DNB and a stable NRE of 85.36% ± 0.48% were achieved when the C/N ratio was 0.6. Under this condition, the contributions of the anammox and denitrification processes to nitrogen removal ($E_{anammox}$ and $E_{denitrification}$) were 88.33% ± 0.23% and 11.67% ± 0.23%, respectively.

Keyword: Simultaneous anammox and denitrification; Nitrogen removal; C/N ratio; Functional bacteria; Mathematical simulation

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