Evaluation of mainstream nitrogen removal by simultaneous partial nitrification, anammox and denitrification (SNAD) process in a granule-based reactor

The mainstream anaerobic ammonium oxidation (anammox) has attracted extensive attention recently, particularly due to its potential of transforming current wastewater treatment plants from energy consuming to energy neutral or positive. However, the presence of biodegradable chemical oxygen demanding (COD, 20–80 mg COD L\(^{-1}\)) in the mainstream anammox reactor stimulates the growth of heterotrophic bacteria, which would compete for oxygen with ammonia-oxidizing bacteria (AOB) and for nitrite with anammox bacteria, thus interfering with the autotrophic nitrogen removal process. In the present work, with consideration of granule size distribution, a one-dimensional model describing the mainstream simultaneous partial nitrification, anammox and denitrification (SNAD) in a granule-based reactor was established, calibrated and validated, based on the long-term experimental results. Through applying the verified model, simulation studies were conducted and the results showed that the effluent total nitrogen concentration of <5 mg N L\(^{-1}\) could be achieved at C/N ratio of 0.2–0.6, DO concentration of 0.2–0.4 mg L\(^{-1}\) and granule radius of 300–600 μm. The combined effects indicated that the SNAD process with TN removal efficiency >90% was obtained at C/N ratio and DO concentration of 0.2–1.0 and 0.2–0.4 mg O\(_2\) L\(^{-1}\) respectively. Finally, the various granule size distribution patterns were simulated, which confirmed that the size distribution needed to be incorporated in the model to accurately describe the granular anammox system, considering a model based on a uniform granule size does not reflect the real situations. These results provide guides to optimize the operation of mainstream granular autotrophic nitrogen removal process.

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