Abstract

The study consists of four experimental phases to investigate the cultivation and application of Anammox organisms for high nitrogen wastewater. Experimental phase I focused on the enrichment of Anammox culture from conventional seed sludges which are from upflow anaerobic sludge blanket reactor (UASB), activated sludge, and anaerobic digester. Anammox cultures were gradually developed within four months under strictly control environment in the sequencing batch reactors (SBR). The time sequences were 7 h react, 30 min settle, and 15 discharge. The development was observed through the near perfect nitrite removal and an 80% ammonium conversion which was further confirmed by the Fluorescene in situ hybridization (FISH) using PLA46 and Amx820 probes and the scanning electron microscope examination. An inoculation of Anammox seed sludge can accelerate the start-up operation to be within two-month time.

Experimental phase II emphasized on factors affecting Anammox operation. The optimum NH_4^+ to NO_2^- ratio was found close to the stoichiometric value of 1:1.32. The deviation caused a poor system performance either the left-over of NH_4^+ or NO_2^- concentrations in the effluent. Inhibition of Anammox activity was observed at ammonium or nitrite concentrations over 120 mg N l^{-1} and moderately higher for phosphate concentration at 170 mg P l^{-1}. Optimum specific removal rates were obtained near 0.05 g N.(g MLSS. d)$^{-1}$ at reaction time of 24 to 48 hours and sludge concentration of 1,000 mg MLSS l^{-1}. Concurrent operations of Anammox and denitrification were observed in experimental phase III in both SBR and UASB reactors. COD concentration and COD to N ratio were found to affect Anammox reaction by allowing the out-completion for denitrification, especially at COD concentration of greater than 400 mg l^{-1} and COD to N ratio of over 2. A greater tolerance was observed in SBR reactor with double in COD to N ratio. High COD loading up to 8 g l^{-1} cause a wipe-out of Anammox organism and could not be recovered over time.

Experimental phase IV decribed a kinetic model development based on Anammox activity and possibly denitrification with the presence of COD in wastewater. The models were well described system performance especially during steady state conditions but not acclimatization. This was due to a shift of microbial communities in favor Anammox organisms in the early stage when conventional seed sludges were used. This might take up to 4 months of process adjustment and could be shorter if Anammox seed was used.