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Performance of anammox UASB reactor treating low strength wastewater under moderate and low temperatures

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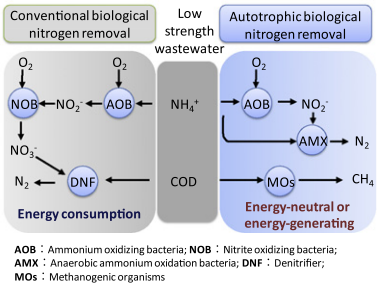
HIGHLIGHTS

- Performance of anammox reactor treating low strength wastewater was studied at 16–30 °C.
- Low strength nitrogen could be efficiently removed via anammox at 16–30 °C.
- Anammox granular sludge was formed at 30 °C and maintained at 16–25 °C.
- Greenhouse gas N_2O emission was very low in this anammox UASB reactor.

GRAPHICAL ABSTRACT



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ABSTRACT

An integrated approach to enhance and maintain high anammox activity and abundance in an upflow anaerobic sludge blanket (UASB) treating low strength wastewater under moderate and low temperatures was developed. A quantitative PCR assay showed the abandance of anammox bacteria to be $1.68 \pm 0.08 \times 10^9$ copies/ml in mixed liquor when the temperature was 30 °C and was maintained at the level of $1.93 \pm 0.41 \times 10^9$ copies/ml in mixed liquor at 16 °C. A nitrogen removal rate (NRR) of up to 5.72 kg N/m^3/d was achieved with a hydraulic retention time (HRT) of 0.12 h at 30 °C, while nitrite and ammonium removal efficiencies were 94.35% and 92.81%, respectively. NRR decreased with a decrease in temperature and was maintained at 2.28 kg N/m^3/d with an HRT of 0.28 h when at 16 °C, while nitrite and ammonium removal efficiencies were 92.31% and 78.45%, respectively. The emission rate of the greenhouse gas N_2O was below 0.006% of the NRR in the anammox UASB reactor treating low strength wastewater.

1. Introduction

For decades, aerobic nitrification with subsequent anoxic denitrification was a widely used process for the removal of ammonium from polluted water. The discovery of anaerobic oxidation of ammonium (anammox) coupled with nitrite reduction with N_2 as the end product in natural and man-made ecosystems (Mulder et al., 1995; Thamdrup and Dalsgaard, 2002) challenged this view and has been recognized as an attractive alternative N-removal process (Kartal et al., 2010).

The anammox process was first described in a denitrifying fluidized-bed reactor (Mulder et al., 1995), and has subsequently been widely applied in high-strength ammonia wastewater treatments (de Graaff et al., 2011; Tang et al., 2011). However, the study of sewage treatment via anammox bacteria was limited (Ma et al., 2011).

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