Chemical Engineering Journal 213 (2012) 338–345

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Partial nitrification adjusted by hydroxylamine in aerobic granules under high DO and ambient temperature and subsequent Anammox for low C/N wastewater treatment

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HIGHLIGHTS

- Nitritation/denitritation is achieved by hydroxylamine dosing in aerobic granules.
- Hydroxylamine can selectively inhibit NOB over AOB in aerobic granules.
- Hydroxylamine is the key parameter for development of AOB-based granules.
- Nitritation effluent with little nitrogen is treated by Anammox/denitrification.
- Anammox could be applied to treat low ammonia wastewaters.

ARTICLE INFO

Article history:
Received 7 June 2012
Received in revised form 16 October 2012
Accepted 19 October 2012
Available online 27 October 2012

Keywords:
Aerobic granules
Hydroxylamine
Low C/N wastewaters
Anammox

ABSTRACT

Partial nitritation–Anammox process is regarded as a promising nitrogen removal method for nitrogen removal from low C/N wastewaters. In the present work, stable partial nitrification was successfully achieved by 10 mg/l hydroxylamine dosing in aerobic granules under experimental conditions of pH 7.8–8.2, dissolved oxygen (DO) above 5 mg/l and temperature around 25 °C. When the NH_4–N and COD were fixed at 100 mg/l and 400 mg/l, the TN removal efficiency was 57% with a NO_2–N/NO_x–N ($NO_2 + NO_3$)–N ratio of 99.8% in the effluent. Meanwhile, 79% COD was removed by aerobic granules, which was regarded as beneficial to the following Anammox. Sequentially, a mixture of the SBR effluent and raw influent with an average NO_2–N/NH_4–N ratio of 1.67 was fed to an Anammox reactor. The COD and TN removal efficiencies reached 77% and 81%, respectively, through coupling of Anammox and denitrification. SEM detection showed that the main composition of aerobic granules was coccus and bacilli bacteria. FISH results demonstrated that ammonia-oxidizing bacteria (AOB) became the dominant bacteria of aerobic granules, which further proved the important effects of hydroxylamine on the achievement of partial nitrification by aerobic granules under conditions of high DO and ambient temperature.

1. Introduction

Nitritation is the oxidation of ammonia to nitrite, which could be further removed by anaerobic ammonium oxidation (Anammox) or heterotrophic denitrification. Compared to the conventional nitrification/denitrification processes, the methods of nitrogen removal via nitrite not only reduces the aeration consumption by 25% during nitritation but also saves the organic matter requirement by 40% and 100% for the subsequent denitrification and Anammox processes, respectively [1].

In the common nitritation systems, the key factor of maintaining nitritation is to accumulate nitrosifying bacteria (i.e. AOB) over nitrifying bacteria (i.e. NOB) by several control strategies including low DO [2,3], high free ammonia (FA) and free nitrous acid (FNA) [4], high temperature, real-time aeration duration control [5], inorganic carbon (IC) [6,7] and some NOB inhibitory compounds. Besides, nitritation process was easy to operate under a combination of these control factors, such as the SHARON (Single tank reactor for High activity Ammonium Removal Over Nitrite) process operated at high temperature (35 °C), pH (7–8), low DO and low sludge retention time (SRT) [8].

Nitritation process could be carried out in aerobic granules [9,10], which is characterized as high biomass retention due to excellent settlability in pursuit of high nitrogen loads and wide

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http://dx.doi.org/10.1016/j.cej.2012.10.014