Effect of Mg^{2+} on Nitrification Capability of Aerobic Granules When Treating Synthetic Wastewater

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1. Introduction

Aerobic granulation as a novel wastewater biotechnology is favored for the treatment of various wastewaters. Compared with conventional activated sludge treatment process, aerobic granular process possesses distinctive advantages such as excellent settling capacity and greater biomass retention. This technology, however, is still under investigation due to instable structure of the aerobic granules. It was reported that Mg^{2+} could improve the morphology and accelerate the aerobic granulation through enhancing microbial activity and extracellular polymeric substances (EPS) production (Xiao-Ming Li et al., 2008). Up to now, little information could be found on the change in nitrification capacity of aerobic granules after Mg^{2+} addition.

2. Methods

Two identical sequencing batch reactors (SBRs), R1 and R2 were run under the same operation conditions (except Mg^{2+} concentration) to treat synthetic wastewater with 5mg/L and 50mg/L of Mg^{2+} being added, respectively. Chemical oxygen demand (COD), ammonium, nitrate and nitrite were determined according to standard methods. Some physicochemical characteristics of granules including granular size distribution, mixed liquor (volatile) suspended solids (ML(V)SS), and sludge volume index (SVI) were also determined in this study.

3. Results and Discussions

3.1. Overall performance of pollutants removal

As for TN removal, R2 also showed a slightly higher performance than R1. The TN removal efficiency increased from 43% (day 1) to 59% (day 23) in R1, while from 44 % (day 1) to 64 (day 23) in R2. The average TN removal rate in R1 and R2 were 51% and 53 %, respectively (Fig. 3-1). In addition, according to the simultaneous nitrification-denitrification ratio data to its higher biomass concentration (Fig. 3-2), Mg^{2+} addition might strengthen the SND capacity during the granulation process, which may have some contribution to the enhanced NH_4-N and TN removal.

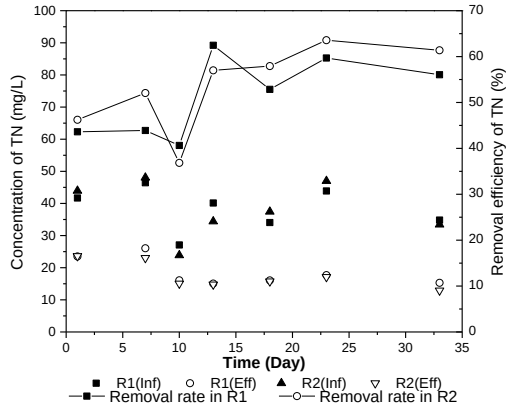

Fig. 3-1. Nutrient concentration profiles in R1 and R2 during the granulation

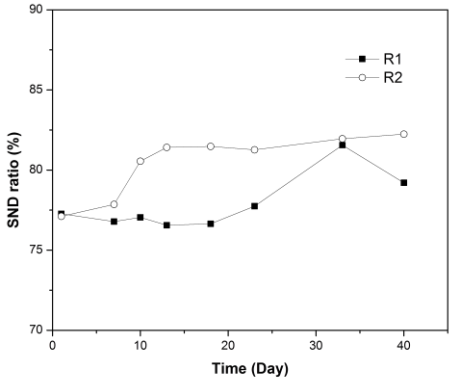

Fig. 3-2. Simultaneous nitrification-denitrification ratio in R1 and R2 during the granulation

3.2. Formation of aerobic granules

The biomass in R2 grew represented relatively faster than that in R1 according to the variation of ML(V)SS (Fig. 3-3) At the beginning of operation, the seed sludge was introduced into R1 and R2 with MLSS of 4.79 and 4.41 g/L to initiate the granulation process, respectively. At first, the sludge bulking was observed after aeration, and the discharge of sludge floc in R1 resulted in MLSS decrease to 4.1 g/L in R1 on day 5. In contrast, the sludge in R2 was not discharged at the beginning of operation. The biomass grew slow in both reactors before day 18, during which the size of sludge kept bellow 0.2 mm. After day 18, the biomass increased remarkably from 4.15 to 7.41 g/L in R1 and 5.14 to 7.80 g/L in R2. According to Fig 3-3(B),

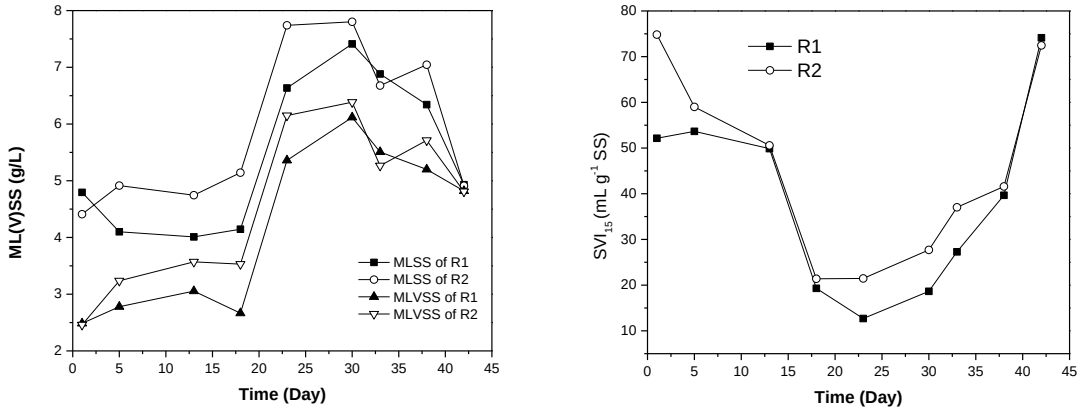

Fig. 3-3 Changes in MLSS and MLVSS in R1 and R2 during granulation (A), SVI_{15} (B) and MLVSS/MLSS ratio.

3.3. Specific oxygen utilization rate and nitrification capacity

Specific oxygen utilization rate and nitrification capacity can reflect the activities of bacteria especially nitrifying bacteria in the granule. Granules in R2 showed relatively higher nitrification capacity than those in R1 during the granulation.

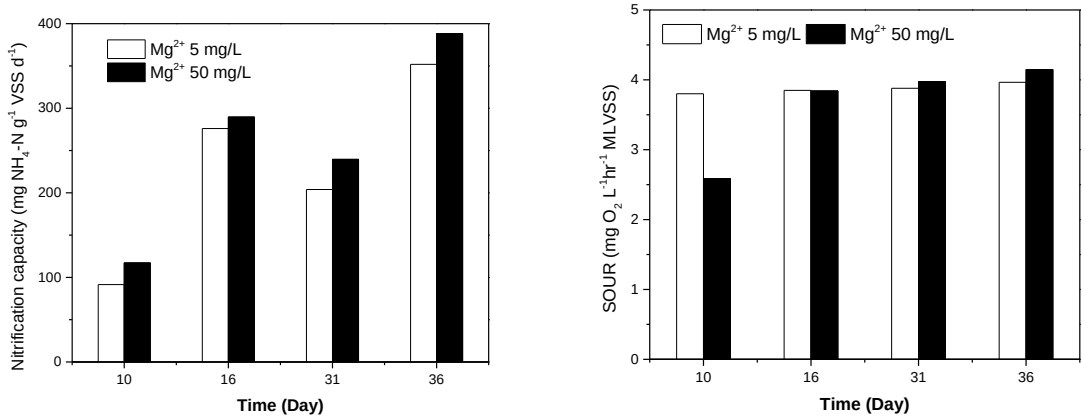

Fig. 3-5. Nitrification capacity and SOUR in R1 and R2 during the granulation

4. Results and Discussions

The nutrient removal performance, SND, nitrification capacity and SOUR in R2 had improved than that in R1, which indicated that Mg^{2+} augmentation could stimulate the sludge granulation process through the biochemical function.