Desalination and Water Treatment
www.deswater.com
doi: 10.5004/dwt.2023.30002

312 (2023) 1–13
November

Influence of *in-situ* NaClO backwashing on the biological performance and membrane fouling behavior in a granule-based SNAD-MBR process

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Received 10 June 2023; Accepted 26 September 2023

ABSTRACT

A granule-based simultaneous nitrification, anammox, and denitrification process in a membrane bioreactor (SNAD-MBR) was performed to investigate the influence of *in-situ* NaClO backwashing on biological performance and membrane fouling. First, the limit of the NaClO concentration for the SNAD granules was determined (20 mg/g·SS) in a short-term batch test. Then, three *in-situ* NaClO backwashing strategies (NaClO concentrations of 5–15 mg/g·SS with backwashing frequencies of 1/10–1/30 min) were implemented during long-term SNAD-MBR process. The results showed that the removal efficiencies of total nitrogen (TN) and chemical oxygen demand decreased from 92.69% and 94.19% to 81.82% and 85.39%, respectively, with an increase in the NaClO concentration in spite of a reduction in backwashing frequency. The deterioration of the biological performance could be explained by the inhibitory activities of the functional bacteria after long-term exposure to NaClO. Nevertheless, the stable contributions of autotrophic and heterotrophic processes to TN removal ($E_{anammox}$ of 91.23%, $E_{denitrification}$ of 8.77%) indicated a negligible impact of NaClO backwashing on the balance of the nitrogen removal pathways. Furthermore, membrane fouling was significantly suppressed when *in-situ* NaClO backwashing was performed with a relatively high frequency (1/1–10/20min) and a low concentration (5–10 mg/g·SS). However, a higher NaClO concentration (15 mg/g·SS) exacerbated membrane fouling, although the backwashing frequency was low. Meanwhile, the high fouling potential of the SNAD granules resulted from the high production of soluble microbial products (especially tryptophan protein-like substances) under NaClO stress. The possible underlying mechanism was the trade-off between the membrane scrubbing effect by NaClO and the variable physico-chemical properties of the SNAD granules. The optimal *in-situ* NaClO backwashing strategy that considered the process performance, membrane fouling, and permeate production was a NaClO concentration of 15 mg/g·SS and a backwashing frequency of 1/20 min. The results provide guidance for *in-situ* NaClO backwashing of the SNAD-MBR process.

Keywords: Simultaneous nitrification, anammox and denitrification (SNAD); Membrane bioreactor; Membrane fouling; NaClO backwashing; Chemical cleaning

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