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Coupling sequencing batch airlift reactor (SBAR) and membrane filtration: Influence of nitrate removal on sludge characteristics, effluent quality and filterability ☆

Bui Xuan Thanh [a], Mathieu Spérandio [b,c,d], Christelle Guigui [b,c,d,*], Roger Ben Aim [b,c,d], Junfeng Wan [b,c,d], Chettiyapan Visvanathan [a]

[a] Environmental Engineering and Management Program, School of Environment, Resources and Development, Asian Institute of Technology, P.O. Box 4, Klong Luang, Pathumthani 12120, Thailand
[b] Université de Toulouse; INSA, LISBP, 135 Avenue de Rangueil, F-31077 Toulouse, France
[c] INRA, UMR792 Ingénierie des Syst. Biologiques et des Procédés, F-31400 Toulouse, France
[d] CNRS, UMR5504, F-31400 Toulouse, France

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ABSTRACT

This study investigates the sludge and effluent characteristics of a new process of coupling an aerobic granular sludge bioreactor with a membrane filtration. The effluent and mixed liquor of sequencing batch airlift reactor (SBAR) were analyzed at various aeration shear stresses when fed with high nitrate containing wastewater. The presence of nitrate nitrogen and aerobic/anoxic condition was able to improve the sludge characteristics in terms of biomass retention, density and settling ability in SBAR. MLSS and SVI could reach 9 g/L and 44 mL/g respectively at the aeration rate of 0.6 cm/s. The presence of nitrate and the denitrification process could minimize the fouling potential. The membrane fouling can be better correlated to SBAR sludge characteristics than biomass concentration. The high aeration rate in the reactor increased the fouling resistance due to production of large MW soluble microbial products (30–50 kDa). The soluble fraction of SBAR effluent contained mainly hydrophilic substances when nitrate is present in the wastewater.

1. Introduction

Membrane bioreactors have become attractive treatment systems in wastewater treatment works around the world due to its advantages such as compactness, high treated effluent quality and less sludge production. However, several operational factors such as type of wastewater, sludge loading rate, sludge age, MLSS concentration and mechanical stress tend to influence the fouling propensity of the membrane. There is poor understanding on fouling tendency and sludge characteristics in the case of high nitrate containing wastewater. Nitrate is a common pollutant in domestic and industrial wastewaters. Its presence in wastewater could be natural and/or resulting from chemical reactions (nitrification from ammonia and/or nitrogenous compounds). Nitrate was found to enhance the elimination of soluble microbial products (SMP) in membrane bioreactor [1]. The anoxic/aerobic stage can improve the nitrogen removal through denitrification process and form a compact and stable aerobic aggregate in the reactor [2]. Currently, the literature on the effect of nitrate on quality of the sludge and membrane filterability is limited.

This research aims to evaluate a new process based on coupling an aerobic granular sludge bioreactor with a membrane filtration. Hence, the fouling capacity of effluent of the sequencing batch airlift reactor (SBAR) treating nitrate-containing wastewater at various air shear rates was investigated. In addition, the fouling behaviour, the SBAR effluent characteristics at different aeration rates which simulate the operating conditions of the conventional and granulation SBAR have been compared.

2. Materials and methods

Synthetic wastewater was prepared from glucose, sodium propionate, sodium acetate and ethanol, each component contributing for 25% of total COD (850 ± 150 mg/L). Ammonium chloride was added to achieve the COD/N ratio of 20 while the nitrate nitrogen ($NaNO_3$) concentration was about 100 mgN/L during the experiment. pH of the feed was maintained in the range 7.4–7.8, by adjusting the amount of $NaHCO_3$ solution. The other nutrient and trace element of feed wastewater was similar to [3].

The SBAR has a working volume of 17 L and exchange volume of 47%. A plate is positioned vertically in the middle of the reactor for dividing the column into two zones namely raiser and down comer. The SBAR operation includes 4 batches per day with each batch consists of: filling without aeration during 30 min, aeration during 4 h 30 min, settling without aeration during 30 min and finally effluent withdrawal without aeration during 30 min. The reactor was operated at aeration rates of 0.8 cm/s (days 1–37), 2.2 cm/s (days 38–79) and

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* Corresponding author. Université de Toulouse; INSA, LISBP, 135 Avenue de Rangueil, F-31077 Toulouse, France.
E-mail address: christelle.guigui@insa-toulouse.fr (C. Guigui).

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