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Fouling characteristics of a membrane bioreactor and nanofiltration hybrid system for municipal wastewater reclamation

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HIGHLIGHTS

- Large amounts of polysaccharides with small MW are produced by the MBR.
- Polysaccharide-like substances show a fluorescence peak at Ex = 230 nm/Em = 420 nm.
- Hydrophobic and hydrophilic fractions are responsible for fouling of the MBR.
- Polysaccharide-like substances are found for as major foulants of the NF membranes.
- Membrane properties provide a strong effect on flux decline of the NF membranes.

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ABSTRACT

A laboratory-scale membrane bioreactor (MBR) and nanofiltration (NF) hybrid system has been built to investigate effects of changes in characteristics of effluent organic matter by the MBR on fouling characteristics of the NF membranes. Large amounts of polysaccharide-like substances with small molecular weight and strong fluorescence intensity at the excitation wavelength of 230 nm and the emission wavelength of 420 nm were produced by microbial growth in the MBR. These substances had a great influence on fouling formation of the NF membranes. Fouling characteristics of the MBR were governed by both hydrophobic and hydrophilic fractions while hydrophilic fractions were found as major constituents of the desorbed NF membrane foulants. Flux decline rates of the NF membranes were closely associated with differences in their fouling layer compositions, meaning that performances of the NF membranes (i.e., flux decline) could be influenced by the membrane characteristics (i.e., surface zeta potential and contact angle).

1. Introduction

Membrane technologies, including microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO), have gained great attention as alternatives to the conventional wastewater treatment process consists of sedimentation or sand filtration, and activated sludge process (ASP) due to their cost effectiveness and high quality effluents (Wintgens et al., 2002; Chon et al., 2010, 2012a). In recent years, integrated membrane systems using low pressure membranes (i.e., MF and UF) followed by high pressure membranes (i.e., NF and RO), or MBRs coupled with NF and/or RO membranes, have been widely used to enhance the removal of micropollutants in the recycled water and mitigate fouling formation on the NF and RO membranes for municipal wastewater reclamation (MWR) (Tam et al., 2006; Chon et al., 2011, 2012a). In spite of significant advancement in membrane technology, fouling layer formation on the membrane surfaces is still a major obstacle for practical application of membrane processes to MWR since it can lead to a severe permeate flux decline and increase operational and maintenance costs (Vrijenhoek et al., 2001; Wang et al., 2008). Fouling phenomena of the membrane processes used for MWR could be attributed to the effluent organic matter (EfOM) in the secondary sewage effluents (Chon et al., 2012b,c).

In the MBR process, mixed liquor suspended solids (MLSS), colloidal and dissolved organic matter could strongly contribute to fouling formation (Liang et al., 2002). EfOM produced from the

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