Enhanced submerged membrane bioreactor combined with biosurfactant rhamnolipids: Performance for frying oil degradation and membrane fouling reduction

Lei Qin, Guoliang Zhang, Qin Meng, Hongzi Zhang, Lusheng Xu, Bosheng Lv

College of Chemical Engineering and Materials Science, Biological and Environmental Engineering, Zhejiang University of Technology, Hangzhou 310014, PR China
Department of Chemical and Biological Engineering, Zhejiang University, Hangzhou 310027, PR China
School of Environmental Science and Engineering, Zhejiang Gongshang University, Hangzhou 310018, PR China

Abstract

In this study, a novel submerged membrane bioreactor (SMBR) combined with rhamnolipids was developed to treat frying oil wastewater and control the problem of membrane fouling. To validate the feasibility of this new design, a hybrid SMBR with additional rhamnolipids (RSMBR) and a controlled SMBR (CSMBR) were run in parallel. Results demonstrated that RSMBR not only held high removal efficiency of oil up to 90% at short hydraulic time, but also exhibited 10 times higher membrane permeability in comparison to CSMBR. The presence of rhamnolipids greatly enhanced the contact and reaction between the microorganism and oil molecules. The great improvement in membrane filterability was associated with an increase in hydrophobicity of flocs as well as the increase of particle size from 53.06 to 145.54 μm. The oil strongly adhered to the surface of flocs by rhamnolipids, and consequently prevented larger oil droplets directly depositing on the membrane surface.

Keywords: SMBR, Rhamnolipids, Frying oil, Hydrophobicity, Membrane fouling

Abbreviations: CAM, contact angle measurement; CN–CA, cellulose nitrate and cellulose acetate; COD, chemical oxygen demand (mg/L); CSMBR, control SMBR; CMC, critical micelle concentration (mg/L); Dₐ, average size of the flocs (μm); DO, dissolved oxygen (mg/L); dₚ, particle size (m); FOG, fat, oil and grease; HRT, hydraulic retention time (h); Jₑ, permeate flux (L/m² h); kₑ, permeability (L/m²·h·kPa); MF, microfiltration; MLSS, mixed liquor suspended solids (mg/L); pₑ, transmembrane pressure (kPa); PP, polypropylene; RH, relative hydrophobicity; RSMBR, hybrid SMBR with additional rhamnolipids; SEM, scanning electron microscope; SMBR, submerged membrane bioreactor; SRT, solid retention time (day); TMP, transmembrane pressure (kPa); ζₑ, specific cake resistance (m/kg); ε, cake porosity; ρₑ, particle density (kg/m³); σₑ, conductivity (μS/cm).

Corresponding author. Address: College of Biological and Environmental Engineering, Zhejiang University of Technology, Hangzhou 310014, PR China. Tel./fax: +86 571 87953193; E-mail addresses: guoliangz@zjut.edu.cn (G. Zhang), mengq@zju.edu.cn (Q. Meng).

© 2012 Elsevier Ltd. All rights reserved.

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.08.103