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

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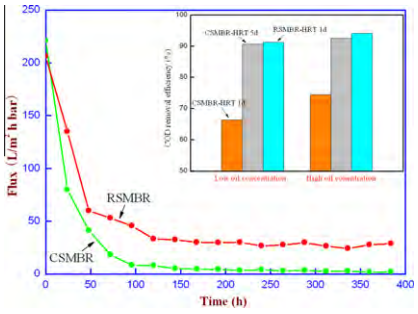
HIGHLIGHTS

- Pilot scale SMBR enhanced by rhamnolipids was developed for oily wastewater treatment.
- The removal efficiency of oil and grease can be increased up to 90% at short HRT.
- RSMBR exhibited 10 times higher membrane permeability than conventional SMBR.

GRAPHICAL ABSTRACT



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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.

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); D_A, average size of the flocs (μm); DO, dissolved oxygen (mg/L); d_p, particle size (m); FOG, fat, oil and grease; HRT, hydraulic retention time (h); J_p, permeate flux (L/m^2 h); L_p, permeability (L/m^2 h kPa); MF, microfiltration; MLSS, mixed liquor suspended solids (mg/L); p_{TM}, 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); α, specific cake resistance (m/kg); ε, cake porosity; ρ_p, particle density (kg/m^3); σ, conductivity (μS/cm).

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