Mitigation of membrane biofouling via immobilizing Ag-MOFs on composite membrane surface for extractive membrane bioreactor

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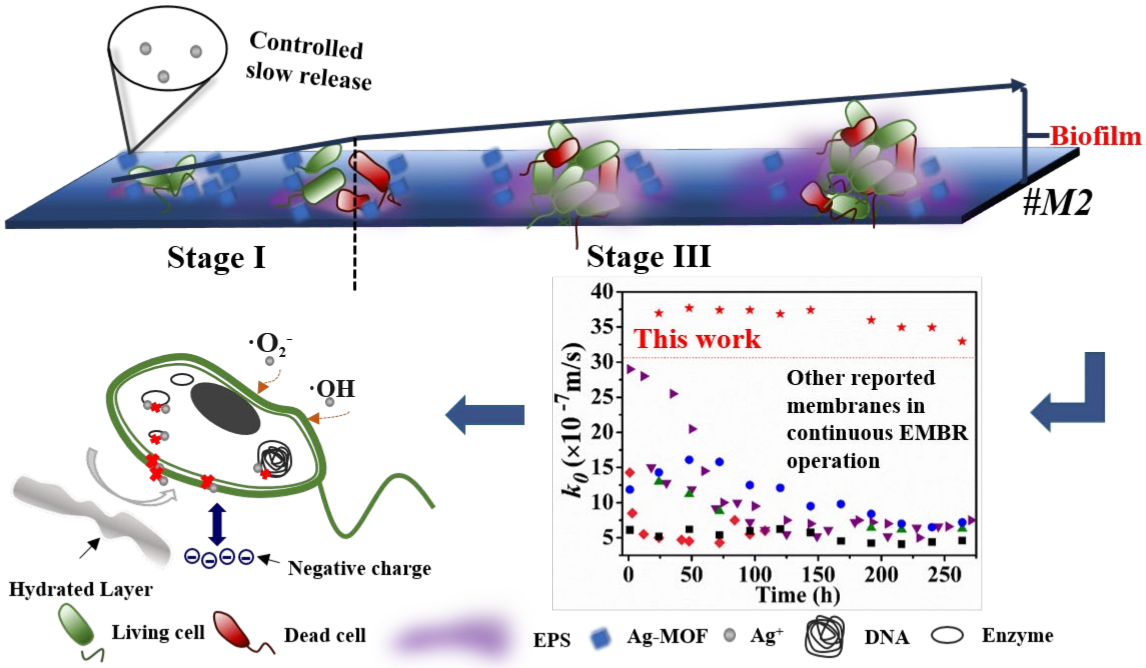
ABSTRACT

The extractive membrane bioreactor (EMBR) combines an extractive membrane process and bioreactor to treat highly saline recalcitrant organic wastewater, in which the organic contaminations diffuse through a semi-permeable polydimethysiloxane (PDMS) composite membrane from the feed wastewater to the receiving biomedium. During the long-term EMBR operation, membrane biofouling is an inevitable phenomenon, which is one of the main obstacles impeding its wide applications. The excessive biofilm deposited on membrane surface could significantly reduce the organic mass transfer coefficient of composite membranes by more than 40% [1, 2]. Therefore, in this work, the silver (Ag)-metal organic frameworks (MOFs) were synthesized and immobilized on the PDMS surface of nanofibrous composite membranes to mitigate the membrane biofouling. The robustness of Ag-MOFs coating on membrane surface was well demonstrated by ultrasonic treatment. In addition, the silver nanoparticles (AgNPs) were coated on the PDMS surface of composite membranes for comparison. In contrast with the unmodified composite membrane, the AgNPs-coated and Ag-MOFs modified composite membranes possessed less hydrophobic and negatively charged surfaces due to the coating layers. Although the modified membranes exhibited lower phenol mass transfer coefficients (k_0's) in the aqueous-aqueous extractive membrane process due to these additional modification layers, both AgNPs-coated and Ag-MOFs modified membranes displayed better long-term performance in the 12-days continuous EMBR operations due to their excellent anti-biofouling properties. Moreover, the Ag-MOFs modified membrane exhibited the most stable EMBR performance among the composite membranes developed in this work and other reported membranes with a finally stabilized k_0 of 33.0×10^{-7} m/s (89% of initial k_0). The least amounts of proteins, polysaccharides and total suspended solids (TSS) on the surface of tested Ag-MOFs modified membrane also demonstrated its

outstanding biofouling resistance. This excellent anti-biofouling performance should be attributed to the stable, controlled and long-lasting Ag^+ release from Ag-MOFs, as well as its less hydrophobic and negative charged surface properties, which made it undergo the k_0's increasing and gradual stabilization stages in the long-term EMBR operations.



KEYWORDS

Extractive membrane bioreactor; metal organic framework; biofouling; highly saline organic wastewater; nanofibrous composite membrane

REFERENCES

[1] Y. Liao, S. Goh, M. Tian, R. Wang, A.G. Fane, Design, development and evaluation of nanofibrous composite membranes with opposing membrane wetting properties for extractive membrane bioreactors, Journal of Membrane Science, 551 (2018) 55-65.

[2] Y. Liao, M. Tian, S. Goh, R. Wang, A.G. Fane, Effects of internal concentration polarization and membrane roughness on phenol removal in extractive membrane bioreactor, Journal of Membrane Science, 563 (2018) 309-319.

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