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PII: S0376-7388(17)31055-4
DOI: <http://dx.doi.org/10.1016/j.memsci.2017.11.075>
Reference: MEMSCI15771

To appear in: *Journal of Membrane Science*

Received date: 12 April 2017
Revised date: 30 November 2017
Accepted date: 30 November 2017

Cite this article as: Sushuang Li, Jianquan Luo and Yinhua Wan, Regenerable biocatalytic nanofiltration membrane for aquatic micropollutants removal *Journal of Membrane Science*, <http://dx.doi.org/10.1016/j.memsci.2017.11.075>

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Regenerable biocatalytic nanofiltration membrane for aquatic micropollutants removal

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Abstract

A trade-off between operation stability and activity regeneration limits the application of biocatalytic membrane, and when it is applied for micropollutants removal from drinking water under flow-through mode, a high removal efficiency is required. To address these issues, a regenerable nanofiltration (NF) biocatalytic membrane was fabricated by immobilizing laccase on polydopamine/ polyethyleneimine (PDA/PEI)-coated NF membrane via physical adsorption. The effect of base membrane properties, dopamine coating time, PEI molecular weight, loading pH on the biocatalytic membrane performance was investigated in terms of permeability, enzyme loading and activity. It was proved that electrostatic and hydrophobic interactions between laccase and PEI molecules were the main immobilization mechanisms, and 750000 Da PEI molecule was selected to immobilize laccase at pH 5. The bisphenol A (BPA) removal by such biocatalytic membrane under flow-through mode was improved mainly due to its enhanced rejection ability (pore narrowing and surface hydrophilicity enhancement by the PDA/PEI layer). To further increase the BPA removal, the synthetic and natural mediators were introduced to improve the laccase-induced BPA oxidation by accelerating electron transfer, and the BPA removal kept higher than 97% during 7 reuse cycles without detectable loss of mediators. Moreover, traces of BPA in water was enriched on the surface of the biocatalytic membrane by pressure-driven filtration, thus improving BPA biodegradation by the laccase-mediator system. The biocatalytic membrane could be fast regenerated by chemical cleaning and reloading, and during the storage or operation, the leaked enzymes were also able to be recaptured. This work not only proposed a novel concept of regenerable biocatalytic NF membrane,

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