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Effect of poly(ethylene glycol) on the properties of mixed matrix membranes for improved filtration of highly concentrated oily solution

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Abstract. Mixed matrix membrane (MMM) composed of organic and inorganic materials has been widely studied for its potential use in water and wastewater treatment, owing to its improved properties compared to the pristine membrane. In this work, the filtration performance of MMM composed of polyethersulfone (PES) and hydrous manganese oxide (HMO) nanoparticles was further improved by adding pore forming agent - poly(ethylene glycol) (PEG) into dope solution to improve membrane hydrophilicity and structural morphology so as the developed membranes are suitable for handling highly concentrated oily solution (30,000 ppm oil concentration). Compared to the structure of control PES membrane that was composed of irregular microvoids, the presence of PEG and hydrophilic nanomaterial in the MMM was able to form extended finger-like structure from top to the bottom section of membrane and enhance its surface hydrophilicity, significantly improving water permeability. The improved water flux of MMM did not compromise the rejection rates of oil and chemical oxygen demand (COD) as the MMMs achieved comparable separation efficiency like the control membrane. The findings of this work revealed the potential use of MMM for the treatment of highly concentrated oily wastewater.

Keywords: mixed matrix membranes; PEG; HMO; oil rejection; flux

1. Introduction

Mixed matrix membrane (MMM) composed of organic and inorganic materials has been widely researched for water purification (Jamshidi Gohari *et al.* 2013) and wastewater treatment (Jamshidi Gohari *et al.* 2014a). The advancement in the nanomaterial synthesis over the last decade had opened up the opportunity to further improve the MMM performance with respect to surface hydrophilicity, water permeability, antifouling resistance and solute removal rate.

Some of the nanomaterials that have been used for MMM fabrication are titanium dioxide (TiO2) (Ong *et al.* 2015), hydrous aluminum oxide (HAO) (Jamshidi Gohari *et al.* 2015), halloysite nanotube-hydrous ferric dioxide (HNT-HFO) (Wan Ikhsan *et al.* 2018) and iron oxide (Al-Husaini *et al.* 2019). In addition to these nanomaterials, our group had worked on hydrous manganese oxide (HMO) nanoparticles for MMM synthesis and used the membrane particularly for oily solution

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• The findings of this work revealed the potential use of MMM for the treatment of highly concentrated oily wastewater.

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