UNIVERSITI TEKNOLOGI MARA

FABRICATION AND CHARACTERIZATION OF GRAPHENE OXIDE-POLYVINYLPYROLLIDONE-POLYETHERSULFONE (GO-PVP-PES) FLAT SHEET AND HOLLOW FIBER COMPOSITE MEMBRANES FOR OIL-WATER SEPARATION

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Postgraduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

With rapid growth of oil and gas and petrochemical industry, the pollution of oily wastewater has become one of the major worldwide issues. Membrane-based separation/filtration systems is one of the technologies that can be used for removing trace oil levels. It is also suitable for portable application due to small footprint, simple and effective operation. The application of this technology is however affected by oil fouling, which can reduce the membrane lifetime, flux, and removal efficiency. As a result, membrane fouling remains the major challenge for the successful application of membrane technology in oily wastewater treatment. Membrane fouling can be suppressed by enhancing the surface hydrophilicity. In this work, a series of graphene oxide-polyvinylpyrrolidone-polyethersulfone (GO–PVP-PES) composite flat sheet (FS) and hollow fiber (HF) membranes were fabricated by blending various amount (0.5 and 1.0 wt%) of GO and PVP into the PES matrix and utilized for oil–water separation. GO is selected due to its hydrophilicity, mechanical robustness, surface area and antibacterial properties while PVP is known for its role as a pore former during the membrane fabrication by phase inversion. GO was first prepared and characterized by using fourier-transform infrared (FTIR) spectroscopy, scanning electron microscopy (SEM), x-ray diffraction (XRD), thermogravimetric analysis (TGA) and Brunauer-Emmett-Teller (BET) nitrogen adsorption/desorption before being used as a membrane filler., The PES-1.0GOPVP membrane exhibits the lowest contact angle value (42°) and the highest pure water flux (230 LMH) as compared to bare PES membrane. The formulation of PES-1.0GOPVP was then used for the preparation of flat sheet (FS) and hollow fibre (HF) membranes. The FS and HF membrane properties were then investigated in term of contact angle, pore size, mechanical strength, surface roughness (AFM) and membrane morphology (SEM). While similar dope composition was used for the fabrication of HF and FS membranes, the morphology and pore size were significantly varied, owing to the way the membranes were fabricated. The surface roughness of the GO-PVP-PES composite membranes were apparently smoother than the bare PES membrane due to the integration of hydrophilic GO into the polymer matrix by filling in membrane pores. Significant enhancement of hydrophilicity was observed for both composite FS and HF membranes, where the water contact angle value decreased from 74.8° to 42.2° and 71.4° to 49.8°, respectively. The flux of the composite membranes increased up to 150% of the bare membranes especially when 1.0 wt% of GO was added. Although higher oil rejection (~99%) was observed for HF membranes that possess smaller pores, the permeation flux was maintained due to the improved flow dynamic. Lower oil rejection (up to 50%) was observed for FS membranes, which might be due to its big pore sizes particularly at the bottom surface. As more oil droplets formed on the membrane surface and prevented water molecules to pass through the membrane, fouling might occur rapidly. The results obtained in this work suggest that surface hydrophilicity, pore size of membranes and oil–water separation performances was greatly affected by membrane shape. Owing to many advantages of HF membranes, this type of membrane has great potential for commercial applications.

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