EFFECT OF ZEOLITIC IMIDAZOLATE FRAMEWORK-8 AND MULTI-WALLED CARBON NANOTUBE ON THE PERFORMANCE OF PVDF MEMBRANE

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We hereby declare that We have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Kebimbangan utama dalam teknologi membran adalah kekotoran membran yang berlaku semasa proses penapisan, menyebabkan pengurangan fluks air dan merosotkan prestasi sistem penapisan membran. Banyak pendekatan telah diperkenalkan untuk mengatasi kekotoran berkenaan termasuk penggabungan nanopartikel ke dalam matriks membran polimer seperti partikel nano perak (AgNPs), zink oksida (ZnO), zeolit (ZIFs) dan karbon nanotiub (CNT). Oleh itu, rangka zeolitik imidazolat 8 (ZIF-8) yang disintesis dan karbon nanotiub berdinding pelbagai (MWCNTs) telah digunakan sebagai additif bukan-organik di dalam kajian ini dengan masing-masing berkomposisi 0.1wt.%, 0.3wt.% dan 0.5wt.%. Penyediaan polyvinildifluorida (PVDF) membran telah dilakukan melalui kaedah campuran fizikal. Kemudian, membran yang disediakan telah dicirikan dengan menggunakan pancaran mikroskopi elektron (SEM), sebaran tenaga spektrometri x-ray (EDX), dan pengukuran sudut kontak untuk mengkaji struktur mereka dari segi sifat morfologi dan hidrofilik. Ujian prestasi kebolehtelapan air dan ujian penapisan telah dilakukan menggunakan air tulen, larutan bovine serum albumin (BSA) dan larutan humic acid (HA) untuk menilai tahap kekotoran membran tersebut. Walaupun fluks berkurang dari masa ke masa, didapati bahawa membran ZIF-8/PVDF dengan kepekatan 0.5wt% mempunyai peratusan tertinggi penolakan larut untuk larutan BSA (>92%) dan larutan HA (>94%) berbanding dengan membran yang lain. Secara keseluruhan, membran nanokomposit telah menunjukkan penambahbaikan dari segi hidrofilik, kebolehtelapan dan kadar penolakan larut berbanding membran asli PVDF. Sifat anti-kekotoran membran juga telah ditingkatkan dengan kadar pemulihan fluks yang lebih tinggi dan kadar penurunan fluks yang lebih rendah telah berjaya dicapai berbanding dengan membran asli PVDF.

ABSTRACT

The main concern in membrane technology is the membrane fouling, which occurs during the filtration process, causing a reduction in water flux and deteriorates the stable performances of membrane filtration system. Several approaches were introduced to eliminate the organic fouling including the incorporation of nanoparticles into a polymer membrane such as silver nanoparticles (AgNPs), zinc oxide (ZnO), zeolitic imidazolate frameworks (ZIFs) and carbon nanotubes (CNTs). Therefore, the synthesized zeolitic imidazolate framework 8 (ZIF-8) and multi-walled carbon nanotubes (MWCNTs) were used as inorganic additives in this work with composition of 0.1wt.%, 0.3wt.% and 0.5wt.%, respectively. The preparation of polyvinyldifluoride (PVDF) membranes was done via physical blending method. The prepared membranes were then characterized by using scanning electron microscopy (SEM), energy dispersive x-ray spectrometry (EDX), and contact angle analysis to investigate their structures in terms of morphology and hydrophilicity properties. Water permeability and filtration performance test were performed using pure water, bovine serum albumin (BSA) and humic acid (HA) solution to evaluate the fouling resistance of the prepared membranes. Even though the fluxes decreased over time, it was found that the ZIF-8/PVDF membrane with 0.5 wt.% concentration has the highest percentage of solute rejection for both BSA (>92%) and HA (>94%) solution as compared to MWCNT/PVDF membranes and pure PVDF membrane. Overall, the nanocomposite membranes showed an improvement in the hydrophilicity, permeability, and solutes rejection rate compared to pristine PVDF membrane. The anti-fouling properties of nanocomposite membranes also has been enhanced with higher flux recovery rate values and lower flux decline rate were achieved as compared to pristine PVDF membrane.

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