EFFECT OF ETHANOL COMPOSITION IN COAGULATION BATH ON MEMBRANE PERFORMANCE

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FAKULTI SAINS DAN TEKNOLOGI
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EFFECT OF ETHANOL COMPOSITION IN THE COAGULATION BATH ON MEMBRANE PERFORMANCE

By

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KUSTEM

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LIST OF ABBREVIATIONS/ SYMBOLS

ABBREVIATION

A	Membrane area (m^2)
cP	centi-Poise
Cf	Concentration of feed
Cm	Membrane surface
Cp	Concentration of permeate
Cr	Concentration of retentate
Cw	Concentration of wall
C_2H_5OH	Ethanol
D	Diffusion coefficients
$D_{i,\infty}$	Diffusivity
DMAc	N,N-dimethylacetamide
ET	Ethanol
INOS	Institute of Oceanography
Jv	Flux ($m^3 / m^2.s$)
k	Mass transfer coefficient
KUSTEM	Kolej Universiti Sains dan Teknologi Malaysia
$\mu_i^{\ o}$	Mobility of ion
M	Molar
µm	micrometer

ABBREVIATION

MF	Microfiltration
MW	Molecular weight
MWCO	Molecular Weight Cut-Off
N	Nonsolvent
NaCl	Sodium Chloride
NF	Nanofiltration
NMP	N-Methyl Pyrrolidone
OH	Hydroxyl group
P	Polymer
P_m	Permeability Coefficients
PES	Polyethersulfone
PSf	Polysulfones
PVDF	Polyvinylidene Diflouride
PWF	Pure Water Flux
r	Stirrer blade
R&D	Research and Development
Robs	Observation rejection
Rreal	Real rejection
RH	Relative Humidity
RO	Reverse Osmosis
S	Solvent
SEM	Scanning Electron Microscopy
SO_4	Sulphone group
TIPS	Thermally Induced Phase Separation

ABBREVIATION

UF	Ultrafiltration
US	United States
v	Kinematic viscocity
v/v	Volume per volume
w/w	Weight per weight
wt%	Weight percent
δ	The thickness of the boundry layer
$\delta_{t,w}$	Solubility parameter

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ABSTRACT

Nanofiltration (NF) is one of the famous membrane separations in worldwide. On this present investigation, the selected polymer to generate a high performance asymmetric NF membrane was Polyethersulfones (PES). The PES flat sheet membranes were casted from 21 wt % PES in *N*-Methyl Pyrrolidone (NMP) by an electrical casting machine using the phase inversion processes. The effect of coagulation medium, ethanol (0-100%) and water (100-0%) on the morphology of PES flat sheet membrane was studied using the SEM at INOS, KUSTEM. While the performances of the PES membrane were obtained from the pure water flux (PWF) experiment and salt solution rejection experiment. An attempt has been made to correlate the effect of ethanol composition in coagulation bath on membrane performance, its morphology and the properties of this flat sheet membrane. The results obtained of permeability coefficient for pressure in the range of 0-10 bar for ET 0, ET 50 and ET 100 were about, 11.971, 8.464, and 3.0823 (m^3/m^2.s.MPa), respectively. The sequence of permeability coefficient, Pm was as followed: Pm ET 0 > Pm ET 50 > Pm ET 100. Meanwhile the rejections range for ET 0, ET 50 and ET 100 were about 0-10%, 0-17%, and 0-20%, respectively and the following order, the rejection rate: ET 0 < ET 50 < ET 100. The morphology of membranes were vary from finger-like to sponge-like with the increased of ethanol composition in coagulation bath. From this research, the higher ethanol composition created thick skin layer, the water fluxes were declined when rejection were enhanced. Meanwhile the lower composition of ethanol resulted the thin skin layer on the membrane, the water fluxes were enhanced and rejections were declined. For the optimum composition of ethanol, ET 50 was almost near to the optimum range which is 40-50% of ethanol composition in coagulation bath. For the best membrane performance, ET 50 was selected due to the criteria of high rejection with moderate flux, which suitable for the industrial application.

ABSTRAK

Penuras nano (NF) ialah salah satu cara pemisahan membran yang semakin mendapat tempat di seluruh dunia. Kajian yang dijalankan ini memilih Polietersulfona (PES) sebagai bahan polimer untuk menghasilkan membran asimetrik NF yang berprestasi tinggi. Membran kepingan rata dari bahan PES berkuantiti 21 wt % di dalam N-Metil Pirolidon (NMP) diacu dengan menggunakan mesin pengacuan elektrik yang menjalankan proses fasa balikan. Kesan medium pengentalan iaitu etanol (0-100%) dan air (100-0%) pada struktur membrane kepingan rata PES dikaji menggunakan SEM di INOS, KUSTEM. Sementara itu, prestasi membrane PES dikaji menggunakan persamaan fluks air tulen (PWF) dan formula penyingkiran. Kajian yang akan dijalankan ini menghubungkaitkan kesan campuran etanol dalam perendaman pengentalan terhadap prestasi, struktur dan ciri-ciri membrane kepingan rata tersebut. Keputusan fluks air tulen yang diperolehi adalah untuk ET 0, ET 50 dan ET 100 di antara 3.30×10^{-6} m/s, 8.70×10^{-6} m/s and 11.23×10^{-6} m/s, mengikut turutan. Manakala turutan fluks air tulen ialah seperti berikut: ET 100 > ET 50 > ET 100. Julat penyingkiran yang diperolehi dalam kajian ini untuk ET 0, ET 50 dan ET 100 adalah di antara 0-10%, 0-17% dan 0-20%, mengikut turutan dan kadar penyingkiran adalah seperti berikut: ET 0 > ET 50 > ET 100. Morfologi membran yang dihasilkan adalah di antara bentuk *finger-like* hinggalah *sponge-like* dengan meningkatnya komposisi etanol di dalam perendaman pengentalan. Daripada kajian ini, apabila kandungan etanol tinggi di dalam air, ia akan menghasilkan membran berlapisan luar yang tebal, pekali kebolehtelapan dan kadar fluks NaCl berkurang dan penyingkiran akan semakin meningkat. Sebaliknya berlaku apabila kandungan etanol yang rendah dalam air akan menghasilkan membran yang berlapis luar nipis, pekali kebolehtelapan dan kadar fluks NaCl akan meningkat dan penyingkiran akan semakin berkurangan. Komposisi optimum ethanol dalam perendaman pengentalan adalah di antara julat 40-50% dimana ET 50 menghampiri julat ini. Untuk membran berprestasi terbaik, ET 50 telah dipilih berikutan memenuhi kriteria mempunyai penyingkiran tinggi dan fluks sederhana, yang sesuai untuk aplikasi dalam industri.