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FAKULTI SAINS DAN TEKNOLOGI

UNIVERSITI MALAYSIA TERENGGANU

2007

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THE EFFECT OF COAGULATION BATH TEMPERATURE AND FORCED CONVECTION RESIDENT TIME ON THE MEMBRANE STRUCTURAL PARAMETERS AND ITS SEPARATION PERFORMANCE OF ASYMMETRIC ULTRAFILTRATION MEMBRANE

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By
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Research report submitted in partial fulfillment of
The requirements for the degree of
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Department of Engineering Science
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2007

JABATAN SAINS KEJURUTERAAN
FAKULTI SAINS DAN TEKNOLOGI
UNIVERSITI MALAYSIA TERENGGANU

PENGAKUAN DAN PENGESAHAN LAPORAN
PROJEK PENYELIDIKAN I DAN II

Adalah ini diakui dan disahkan bahawa laporan penyelidikan bertajuk:
THE EFFECT OF COAGULATION BATH TEMPERATURE AND FORCED CONVECTION RESIDENT TIME ON THE MEMBRANE STRUCTURAL PARAMETERS AND ITS SEPARATION PERFORMANCE OF ASYMMETRIC ULTRAFILTRATION MEMBRANE oleh Nurbaiti Binti Abdul Hanid No.Matrik UK 8511 telah diperiksa dan semua pembetulan yang disarankan telah dilakukan. Laporan ini dikemukakan kepada Jabatan Sains Kejuruteraan sebagai memenuhi sebahagian daripada keperluan memperolehi Ijazah SARJANA MUDA TEKNOLOGI (ALAM SEKITAR), Fakulti Sains dan Teknologi , Universiti Malaysia Terengganu.

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LIST OF SYMBOLS

EKA	-	Electron kinetic analyzer
CBT	-	Coagulation bath temperature
Cp	-	Concentration of permeate solution
Cf	-	Concentration of feed solution
Cr	-	Concentration of retentate solution
Cb	-	Bulk concentration
FCRT	-	Forced convection resident time
MF	-	Microfiltration
NaCl	-	Sodium chloride
NMP	-	N-methyl-2-pyrrolidone
PSF	-	Polyethersulfone
RO	-	Reverse osmosis
PVP	-	Polyvinylpyrrolidone
SEM	-	Scanning Electron Microscopy
UF	-	Ultrafiltration

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ABSTRACT

The membrane produced was imposed by two rheological factors, which applied with different coagulation bath temperature at 10 °C, 30 °C, and 50 °C and different forced convection resident time which was at 10 s, 15 s, and 20 s. Tho objective of this study is to investigate the effect of those rheological factors to the steric and charges on the separation performance and fine structural details of UF membranes. By using the same composition, an uncertainty imposed by the membrane material upon separation performances can be eliminated. The membrane is fabricated using a ternary dope formulation of 14.4% Polysulfone (PSF), 81.6% N–methyl–2 pyrrolidone (NMP), and 4% water by a dry/wet phase inversion process using an electrically controlled flat sheet membrane casting machine. The rheological factor had a great effect on morphology and liquid–liquid separation performances of membranes. The membrane performances were evaluated by the permeation experiments of aqueous NaCl solution and pure water flux measurement to estimate the membrane properties and membrane structures The Spiegler-Kedem membrane transport mechanism was used to evaluate the membrane structural parameters. The fine structural details of the UF membrane were evaluated in terms of pore radius r_p, ratio of effective membrane thickness to membrane porosity, Δ_x / A_k and surface charge. The surface charge was obtained through the Electron Kinetic Analyzer (EKA). The measurement was conduct using the steric-hinderence-pore (SHP) model. The percentage of rejection of coagulation bath temperature was in following manner: *R* CBT 10 °C > *R* CBT 50 °C > *R* CBT 30 °C. While the rejection ability of forced convection resident time towards the Cl^- ions were as following manner: *R* FCRT 10 s > *R* FCRT 15 s > *R* FCRT 20 s. The result showed that at 50 °C coagulation bath temperature, the membrane produced has the highest permeability rate with moderate salt rejection percentage. While, at 15 s forced convection resident time applied, the membrane produced has high permeability with high selectivity performance. The correlation of rheological factor and the membrane structural parameters in asymmetric membranes with various fabrication conditions has been recognized as an approach in membrane research, which provides a platform to produce a defect-free asymmetric membrane with potential improvement on the membrane performance.

ABSTRAK

Membran yang dihasilkan dikenakan dengan dua factor rheologikal iaitu suhu larutan pengental yang berbeza iaitu pada 10 °C, 30 °C, dan 50 °C dan masa tahanan daya perolakan yang berbeza iaitu 10 s, 15 s, dan 20 s. Objektif kajian ini adalah untuk mengkaji kesan factor rheologikal tersebut terhadap cas permukaan dan parameter struktur membran UF. Dengan menggunakan komposisi yang sama, sebarang ketidakpastian prestasi penyingkiran dapat di hapuskan. Membran tersebut dihasilkan menggunakan komposisi campuran tiga bahan iaitu 14.4% polisulfon (PSF), 81.6% N-metil-2 pyrrolidon (NMP), 45 air menerusi kaedah pembalikan fasa kering/basah dengan menggunakan mesin pengacuan elektrik. Faktor rheologikal banyak mempengaruhi struktur morfologi dan prestasi pemisahan larutan. Prestasi membran dinilai melalui ujian ketelapan larutan NaCl dan fluks air tulen yang menentukan ciri-ciri dan stryktur membran. Mekanisma pemindahan Spiegler–Kedem digunakan untuk menentukan parameter struktur membran. Parameter struktur dinilai dari segi radius liang,r_p, nisbah ketebalan membran terhadap keliangan, $\Delta x/A_K$ dan cas permukaan. Cas permukaan diukur menggunakan Electron Kinetic Analyzer (EKA). Model steric-hinderence pore (SHP) digunakan untuk memdapatkan parameter struktur tersebut.Peratusan penyingkiran suhu air rendaman pengentalan adalah seperti berikut: *R* CBT 10 °C > *R* CBT 50 °C > *R* CBT 30 °C. Manakala, kebolehan penyingkiran membran yang di kenakan masa tahanan daya perolakan terhadap ion Cl^- adalah seperti berikut: *R* FCRT 10 s > *R* FCRT 15 s > *R* FCRT 20 s. Keputusan yang diperolehi menunjukkan pada suhu 50 °C, membran yang dihasilkan mempunyai kadar ketelapan yang tinggi dan kadar penyingkiran yang sederhana. Manakala pada 15 saat masa tahanan daya perolakan, membran yang terhasil mempunyai kadar ketelapan dan penyingkiran yang tinggi. Gabungan kedua-dua keadaan tersebut dapat memghasilkan membran berprestasi tinggi. Korelasi antara faktor rheologikal dan parameter struktur membran dalam membran asimetrik dengan keadaan fabrikasi yang berbeza adalah satu pendekatan dalam kajian membran untuk menghasilkan membran asimetrik yang sempurna dengan peningkatan dalam prestasi membran tersebut.