[illegible]

BASED [illegible] DYES [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

CHARACTERIZATION OF NANOFILTRATION MEMBRANE BASED ON DYES REMOVAL APPLICATION

By
Nor Fadzillah Binti Abd Kadir

Research report submitted in partial fulfillment of
the requirement for the degree of
Bachelor of Technology (Environmental)

Department of Engineering Science
Faculty of Science and Technology
UNIVERSITI MALAYSIA TERENGGANU
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 bertajuk:
CHARACTERIZATION OF NANOFILTRATION MEMBRANE BASED ON DYES REMOVAL APPLICATION oleh NOR FADZILLAH BINTI ABD KADIR, No. Matrik UK 8051 telah diperiksa dan semua pembetulan yang disarankan telah dilakukan. Laporan ini dikemukakan kepada Jabatan Sains Kejuruteraan sebagai mematuhi sebahagian daripada keperluan memperolehi Ijazah SARJANA MUDA TEKNOLOGI (ALAM SEKITAR), Fakulti Sains dan Teknologi, Universiti Malaysia Terengganu.

Disahkan oleh:

.....

Penyelia Utama

Nama: Dr. Nora'aini binti Ali

Cop Rasmi: DR. NORA'AINI BINTI ALI
Ketua
Jabatan Sains Kejuruteraan
Fakulti Sains dan Teknologi
Universiti Malaysia Terengganu
21030 Kuala Terengganu

Tarikh: 24/5/07

.....

Penyelia Kedua (jika ada)

Nama: Encik Asmadi bin Ali @ Mahmud

Cop Rasmi: ASMADI ALI @ MAHMUD
Pensyarah
Jabatan Sains Kejuruteraan
Fakulti Sains dan Teknologi
Universiti Malaysia Terengganu
21030 Kuala Terengganu.

Tarikh: 24/5/07

.....

Ketua Jabatan Sains Kejuruteraan

Nama: Dr. Nora'aini binti Ali

Cop Rasmi: DR. NORA'AINI BINTI ALI
Ketua
Jabatan Sains Kejuruteraan
Fakulti Sains dan Teknologi
Universiti Malaysia Terengganu
21030 Kuala Terengganu

Tarikh: 24/5/07

ACKNOWLEDGEMENT

Assalamualaikum…First of all, I would like to thank to Allah for blessing me in completing my thesis. I would like to acknowledge my supervisor, Dr. Nora'aini for all the advices and comments that I would be able to perform this research with all her guidance. In addition to that, I would like to thank to Mr. Asmadi for his support and tolerance as the coordinator for the final project and also as my co-supervisor. Beside that, I would like to thanks to Mr. Rahman as my external advisor for his information and explanation about my final project title.

I also would like to extend my warmest thanks to my family especially to my parents, Abd Kadir Bin Bitan and Asma Binti Yahya and my siblings, Nor Fadzliana, M.Faridzul, M.Fadzlan and M.Fadzilrul for their love and support who keep me strong.

Lastly, I would like to thank my friends and course mate (Farhanah, Menaka, Suriani and Raihana) and all those who had contributed directly or indirectly not forgetting Mohd Shahril who had gives me lots of inspiration and courage. Not forgetting master students (Norhidayah and Nurud Suria) for their advisor. It is an honour and great pleasure indeed to have the opportunity work with you all. God bless and hope all of you to have successful career and enjoyable life. Thank you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

Ak	-	Membrane porosity
C_b	-	Bulk concentration
C_f	-	Concentration of feed solution
C_p	-	Concentration of permeate solution
C_r	-	Concentration of retentate solution
Ds	-	Solute diffusivity
DMAc	-	Dimethylacetamide
DMF	-	Dimethylformanode
DMSO	-	Dimethylsulfoxide
DSPM	-	Donnan-steric pore model
EDL	-	Electric double layer
EKA	-	Electrokinetic analyzer
F	-	Faraday constant
H_D, H_F	-	Steric parameter related to wall correction factor under diffusion and convections, respectively
J_s	-	Average solute flux over membrane surface
J_v	-	Water flux
k	-	Mass transfer coefficient
KCl	-	Potassium chloride
MF	-	Microfiltration

MWCO	-	Molecular Weight Cut-off
NF	-	Nanofiltration
NaCl	-	Sodium Chloride
NMP	-	N-methyl-2-pyrrolidinone
PEEK	-	Polyetheretherketone
PEI	-	Polyetherimide
PES	-	Polyethersulfone
Ps	-	Salt permeability
PSF	-	Polysulfone
P_m	-	Water permeability
PVP	-	Polyvinylpyrrolidone
RB5	-	Reactive Black 5
RO	-	Reverse Osmosis
R_{obs}	-	Observed rejection
R_{real}	-	Real rejection
rs	-	Solute radius
rp	-	Pore radius
SEM	-	Scanning Electron Microscope
S_F, S_D	-	Distribution coefficient of solute by steric hindrance effect under diffusion and convections, respectively
SHP	-	Steric Hindrance Pore
TFC	-	Thin film composite
TMS	-	Teorell-Meyer-Sievers
TMU	-	Tetramethylurea
UF	-	Ultrafiltration

Xd	-	Effective charged density
$\Delta x/Ak$	-	Ratio of membrane porosity to membrane thickness
ξ	-	Ratio of fixed charge density to salt concentration
σ	-	Reflection coefficient,
Δx	-	Membrane thickness
ΔP	-	Difference pressure
η	-	Liquid viscosity
ε	-	Membrane surface porosity
τ	-	Tortuosity factor

LIST OF APPENDIX

APPENDIX

ABSTRACT

Dyes effluents from textile industries are discharged without proper treatment and causes extensive environmental pollution. Various physico-chemical processes such as coagulation, flotation and chemical oxidation are conventional treatment processes for textile effluent but these treatment processes are ineffective for dye removal. Nanofiltration (NF) membrane becomes an attractive alternative to the conventional separation processes in the treatment of wastewater because of its high removal efficiencies for dyes. Hence the objective of this study is to investigate the effect of shear rates toward the membrane permeability and separation of charge solute using theoretical model, membrane structure and membrane surface charge. The membranes permeability and performance were determined based on the pure water flux, sodium chloride permeation test and dyes. The fine structural details of nanofiltration membrane were evaluated in terms of effective pore radius, zeta potential and ratio of effective membrane thickness to membrane porosity. The measurement was conducted using steric-hindrance pore (SHP) model and electrokinetic analyzer (EKA) measurement. Through the observation using scanning electron microscopy (SEM), it was shown that the produced membrane exhibited a finger like structure. The rejection ability towards Cl^- ions was shown in the following manners: $R_{SR}=353.9s^{-1} > R_{SR}=232.6s^{-1} > R_{SR}=161.8s^{-1}$. The same trend was observed for the removal of Reactive Black 5 (RB5) case which the higher shear rate shows the highest rejection (>80%). It could conclude that, the higher shear rate is the better orientation of polymer molecules in the membrane structure and at the same time giving great properties in term of effective pore radius, effective membrane thickness, membrane porosity, ratio of effective membrane thickness to membrane porosity and surface charge. These findings suggested that the best shear rate casting is lying on $353.9s^{-1}$ and these membrane produce a feasible process and shown a great potential of applying PSf membrane in separating dyes wastewater.

ABSTRAK

Sisa bahan pewarna dari industri tekstil dibuang tanpa rawatan yang sesuai menyebabkan pencemaran kepada alam sekitar. Pelbagai proses fizikal-kimia seperti pengentalan, pengapungan dan pengoksidaan kimia adalah proses rawatan yang biasa digunakan untuk merawat bahan buangan tekstil tetapi proses rawatan ini masih tidak berkesan untuk menyingkirkan sisa pewarna yang dibuang. Membran penuras nano (NF) menjadi alternative dalam rawatan air sisa kerana ia berkesan dalam menyigkirkan pewarna. Maka objektif bagi kajian ini adalah untuk mengkaji kesan kadar ricih ke atas struktur membran (NF) dan prestasinya serta mencirikan morfologi dan parameter struktur berdasarkan teori model bagi aplikasi kepada pewarna. Ketelapan membran dan prestasinya ditentukan berdasarkan fluks air tulen dan ujian ketelapan larutan natrium klorida dan seterusnya diaplikasikan kepada penyingkiran pewarna. Struktur halus bagi membran penuras nano di nilai dari segi keberkesanan jejari liang, cas pada permukaan membran dan nisbah ketebalan membran kepada keliangan membran. Pengukuran dilakukan menggunakan model steric-hindrance pore (SHP) dan cas pada permukaan membran ditentukan menggunakan alat penganalisa electrokinetik (EKA). Melalui pemerhatian menggunakan pengimbas elektron mikroskopik (SEM), menunjukkan penghasilan struktur jari-jemari pada struktur membran. Kebolehan penyingkiran terhadap ion Cl^- ditunjukkan dalam keadaan berikut: $R_{SR}=353.9s^{-1} > R_{SR}=232.6s^{-1} > R_{SR}=161.8s^{-1}$. Paten yang sama turut ditunjukkan oleh kes penyingkiran "Reactive Black 5" dimana kadar ricih tertinggi menunjukkan penyingkiran tertinggi (>80%). Dapat di andaikan, kadar ricih yang lebih tinggi menyebabkan orientasi molekul polimer dalam struktur membran adalah lebih baik. Penemuan ini turut mengemukan kadar ricih yang terbaik adalah pada $353.9s^{-1}$ dan membran yang dihasilkan adalah berkesan dan menunjukkan potensi yang tinggi dalam penyingkiran pewarna.