SEPARATION OF MONO AND DIVALENT IONS USING
[illegible] NANOFILTRATION MEMBRANE

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FAKULTI SAINS DAN TEKNOLOGI
KOLEJ UNIVERSITI SAINS DAN TEKNOLOGI MALAYSIA

2005

Separation of mono and divalent ion using asymmetric nanofiltration membrane / Edwin Kebing Mering.

Lihat sebelah

SEPARATION OF MONO AND DIVALENT IONS USING ASYMMETRIC NANOFILTRATION MEMBRANE

By

Edwin Kebing Mering

Research Report submitted in partial fulfillment of
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JABATAN SAINS KEJURUTERAAN
FAKULTI SAINS DAN TEKNOLOGI
KOLEJ UNIVERSITI SAINS DAN TEKNOLOGI MALAYSIA

PENGAKUAN DAN PENGESAHAN LAPORAN
PROJEK PENYELIDIKAN I DAN II

Adalah ini diakui dan disahkan bahawa laporan penyelidikan bertajuk:

SEPARATION OF MONO AND DIVALENT IONS USING ASYMMETRIC NANOFILTRATION MEMBRANE

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ABBREVIATION/SYMBOLS

Abbreviation/Symbol

COD	Chemical Oxygen Demand
DSPM	Donnan Steric Pore Model
INOS	Institute Oceanography
MF	Microfiltration
$MgSO_4$	Magnesium Sulphate
NaBr	Sodium Bromide
NaCl	Sodium Chloride
Na_2SO_4	Disodium Sulphate
NF	Nanofiltration
NMP	*N*-methyl-2-pyrrolidone
PES	Polyethersulfone
PVP	Poly(vinyl pyrrolidone)
RO	Reverse Osmosis
SEM	Scanning Electronic Microscope
UF	Ultrafiltration
A_k	Porosity of the membrane
D_{ip}	hindrance diffusivity (m/s)
F	Faraday constant (C mol^{-1})
j_i	ion flux (based on membrane area) (m/s)

Abbreviation/Symbol

K_{ic}	hindrance factor for convection
K_{id}	hindrance factor for diffusion
R	gas constant (J mol^{-1} K^{-1})
r_p	effective pore radius (m)
r_s	Stoke radius of ion and solutes
T	Absolute Temperature (K)
V	Solute velocity (m/s)
X_d	Effective membrane charge (mol /m^3)
z_i	Valence of ion
Δx	Effective membrane thickness (m)
Ψ	Electrical potential in axial direction (V)
ΔP	Applied pressure
μ	Viscosity of solution (Pa s)

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ABSTRACT

The aim of this study was to investigate the separation of mono and divalent ions using asymmetric nanofiltration (NF) membranes in different salt solutions (NaCl, Na_2SO_4, NaBr and $MgSO_4$) with standard concentration of 0.01 M. The separation of mono and divalent ions was important to be studied in understanding the applications of the membrane in industrial applications and water treatment. Asymmetric nanofiltration (NF) membranes were developed by the dry/wet phase inversion method from casting solutions containing 21% polyethersulfone PES as polymer, 72% *N*-methyl-2-pyrrolidone (NMP) as solvent and 7% Poly(vinyl pyrrolidone) (PVP) as additive using a semi automated electrically controlled casting machine. The steric and Donnan effects were two major factors to be considered. The rejection of the each salt solution was measured in order to determine the membrane performance. The permeability of each membrane was determined by measurement of pure water flux as a function of applied pressure. The deviation from the average value of permeability coefficient for all membranes varied between 6-16%. The results obtained were coherent with the theory of separation and transportation of salts for nanofiltration membranes where the membranes were found to be a negatively charge membrane. The rejections of the salts by the membranes were found to decrease in the following sequence: Na_2SO_4 > $MgSO_4$> NaCl > NaBr with the rejection range of 52-56%, 36-53%, 23-39% and 14-27% respectively according the rejection sequence. It was postulated that fabricated membranes were considered to be loose NF membranes with moderate negatively charged density.

ABSTRAK

Kajian ini telah dijalankan bertujuan untuk menyelidik pemisahan mono-ion dan dwi-ion menggunakan membran asimetrik penuras nano dalam larutan garam yang berbeza iaitu NaCl, Na_2SO_4, NaBr dan $MgSO_4$ dengan kepekatan piawai 0.01 M. Kajian mengenai pemisahan mono-ion dan dwi-ion adalah penting untuk dikaji supaya dapat memahami aplikasi di dalam perindustrian dan rawatan air. Membran asimetrik penuras nano disediakan dengan menggunakan kaedah fasa pembalikan basah/kering dengan larutan acuan yang mengandungi 21% polietersulfon (PES) sebagai polimer, 72% *N*-metil-2 pirrolidon (NMP) sebagai pelarut dan 7% polivinilrolidan (PVP) sebagai aditif dengan mengunakan mesin pengacuan elektrik separa automatik. Kesan sterik dan Donnan merupakan dua faktor utama yang perlu ditekankan. Penyingkiran untuk larutan garam dinilai untuk menentukan kecekapan membran. Ketelapan membran ditentukan dengan menentuukur fluks air tulen dengan tekanan yang berbeza. Sisihan ketelapan bagi semua membran adalah dalam julat di antara 6-16%. Hasil kajian yang diperolehi digunakan untuk menentukan keberkesanan atau kecekapan membran dan didapati menepati teori untuk pemisahan larutan garam untuk membran penuras nano dimana membran terhasil seperti dijangka merupakan membran bercas negatif. Penyingkiran larutan garam oleh membran dalam turutan menurun adalah seperti berikut $Na_2SO_4 > MgSO_4 > NaCl > NaBr$ dengan julat penyingkiran 52-56%, 36-53%, 23-39% dan 14-27% masing-masing mengikut turutan penyingkiran disebut. Maka, membran yang dihasilkan diramalkankan sebagai membran longgar dan berliang dengan ketumpatan cas yang sederhana.