

**PREPARATION AND CHARACTERIZATION OF
NANOFILTRATION-SURFACTANT (NFS) MEMBRANE FOR
DYES REMOVAL**

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I hereby declare that the work in this thesis project is my own except for quotations and summaries which have been duly acknowledged.

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ABSTRAK

Membran nanofiltration-surfaktan (NFS) telah disediakan melalui teknik fasa balikan kering / basah. Perumusan baru cecair polimer dengan kehadiran bahan utama iaitu surfaktan telah dibangunkan. Peranan surfaktan untuk menghasilkan tekanan rendah membran nanofiltration-surfaktan (NFS) ditemui. Dua jenis surfaktan dengan kategori yang berbeza telah digunakan iaitu sodium dodecyl sulfate (SDS) dan cetyltrimethylammonium bromide (CTAB) untuk mengkaji kesan prestasi membran serta sifat membran. Penambahan bahan tambahan iaitu PEG 600 sebagai pembuka liang telah dikatakan dapat meningkatkan prestasi membran. Data eksperimen menunjukkan bahawa, PEG 600 meningkatkan fluks air sehingga 214.72 L/m²h pada 5 bar tekanan operasi pada polimer berkepekatan rendah. Mempertimbangkan penambahan surfaktan akan meningkatkan prestasi-sifat membran, kajian keatas penambahan jenis surfaktan juga akan ditemui. Dari segi penyerapan air tulen (PWP), penambahan surfaktan anionic (SDS) dalam larutan polimer memberi PWP yang tinggi daripada 127.36 /m²h kepada 1370.33 L/m²h. Sementara, penambahan surfaktan kationik (CTAB) meningkatkan PWP kepada 1370.33 L/m²h. Dari segi fluks penyerapan dan penolakan garam, surfaktan CTAB sentiasa menunjukkan hasil yang memberangsangkan dengan penolakan tertinggi kira-kira 92%. Untuk kajian seterusnya, 3 jenis pewarna telah digunakan dengan kepekatan berbeza. Surfaktan SDS menunjukkan fluks tinggi kerana struktur membran lebih porous dan penolakan yang lebih rendah daripada kira-kira 25.397 L/m²h dan 50% masing-masing. Berbeza dengan CTAB yang menunjukkan trend bertentangan dengan fluks penyerapan rendah dan penolakan tinggi masing-masing kira-kira 8.972 L/m²h dan 99.9%. Selain itu, pencirian membran menggunakan FTIR untuk menentukan kehadiran surfaktan dalam larutan polimer serta orientasi molekul antara bahan yang digunakan. Selaras dengan data uji kaji, struktur membran yang dianalisa dengan SEM menunjukkan perbezaan yang signifikan. Selain itu, analisis terma membran dikaji menggunakan analisis TGA. Dimana, bagi membran tanpa surfaktan menghasilkan 2 peringkat penguraian. Manakala, penambahan surfaktan menghasilkan 3 peringkat penguraian dimana peringkat ketiga menunjukkan degradasi surfaktan. Oleh itu, kepekatan polimer yang paling tinggi dengan CTAB adalah formulasi polimer terbaik membran NFS.

ABSTRACT

Nanofiltration-Surfactant (NFS) membrane was prepared via dry/wet phase inversion technique. A new formulation of dope solutions with the present of key materials that is surfactant were developed. The role of surfactant for producing low pressure Nanofiltration-surfactant (NFS) membrane was also discovered. Two types of surfactant from different categories had been used which are sodium dodecyl sulfate (SDS) and cetyltrimethylammonium bromide (CTAB) to investigated the effect on membrane performance as well as membrane properties. Addition of additive which is PEG 600 as pore former has been said to increase the membrane performance. Experimental data shows that, PEG 600 increase the water flux of about 214.72 L/m²h at 5 bar operating pressure of the least polymer concentration. Considering addition of surfactant will improve the membrane performance-properties, study on addition of different type of surfactant had also been discovered. In terms of pure water permeation (PWP), addition of anionic surfactant (SDS) in polymer solution gives high PWP from 127.36 L/m²h to 849.16 L/m²h. While, addition of cationic surfactant (CTAB) increase PWP up to 1370.33 L/m²h. In terms of permeation flux and rejection of salts, CTAB surfactant always show promising results with highest rejection of about 92%. Prior to testing, 3 types of dyes (methyl violet, methyl blue and acid orange) were used with three different concentrations (10ppm, 15ppm and 20ppm). SDS surfactant shows higher flux considering the structure of the membrane more porous and lower rejection of about 25.397 L/m²h and 50% respectively. Different with CTAB that shows opposite trends of low permeation flux and high rejection of about 8.972 L/m²h and 99.9% respectively. Moreover, membranes were characterized by FTIR in order to determine the presence of surfactant in polymer solution as well as molecular orientation between materials used. To be in line with the experimental data, membrane structure was examined by SEM that shows significance different. Besides, thermal analysis of the membranes was studied using TGA analysis. Membrane without surfactant produced two stages of decomposition. Addition of surfactant show 3 stages of decomposition where the third stage show surfactant degradation. Thus, the highest polymer concentration with CTAB was the best polymer formulation of NFS membrane.

الملخص

غشاء السطح النانو فلتر ان اف اس حضر بواسطة تقنية الطور الجاف/ الرطب . تشكيله جديده من المحاليل مع مواد جديده التي تكون السطح تما تطويرها . دور السطح لاجل انتاج ضغط منخفض لغشاء السطح النانو فلتر كان ايضا قد اكتشف . نوعين من السطحيات من فئات مختلفه قد استعملت وهي كبريتات دوديسيل الصوديوم اس دي اس وبروميد ثلاثي ميثيل الامونيوم استيل سي تي اي بي لمعرفة التأثير علي سطح الغشاء وخصائص الغشاء . المادة المضافه كانت بي اي جي 600 لزيادة فعالية الغشاء . بيانات التجارب اوضحت هذا بي اي جي 600 يزيد من تدفق الماء حوالي 214.72 لتر لكل متر مربع في الساعه عند 5 بار ضغط مؤثر عند اقل تركيز من البوليمر بالإضافة ان السطح سوف يطور خصائص فعالية الغشاء وتما اكتشاف نوع مختلف من السطح في هذه الدراسة من حيث بي دبليو بي السطح الايوني اس دي اس في محلول البوليمر يعطي بي دبليو بي عاليه جدا من 127.36 لتر لكل متر مربع في الساعه الي 849.16 لتر لكل متر مربع في الساعه بينما اضافة السطح الكاتيوني سي تي اي بي يزيد بي دبليو بي الي 1370.33 لتر لكل متر مربع في الساعه . من حيث التدفق ورفض الملح . اس تي اي بي دائما يبين نتائج عاليه للرفض حوالي 92% قبل اختبار ثلاث انواع من الصبغات كانت قد استعملت مع ثلاث تركيزات مختلفه سطح اس دي اس اوضح تدفق عالي باعتبار تركيب الغشاء اكثر مساميه واقل رفض حوالي 25.397 لتر لكل متر مربع في الساعه و 50% علي التوالي . اختلاف اس تي اي بي يبين العكس تدفق ورفض عالي حوالي 8.972 لتر لكل متر مربع في الساعه و 99.9% علي التوالي علاوة علي ذلك الاغشيه كانت قد حلت باستخدام الاشعه تحت الحمراء اف تي ار لتحديد السطح الجديد في محلول البوليمر كدوران الجزئي بين المواد المستعمله . تركيب الغشاء امتحن بواسطة اس اي ام الذي بين اهمية الفرق . بالجانب الي التحليل الحراري للاغشيه درس باستخدام التحليل الحراري الوزني تي جي اي بالتالي التركيز العالي للبوليمر مع سي تي اي بي كان افضل تركيب للبوليمر في غشاء ان اف اس

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LIST OF ABBREVIATIONS

°C	degree celcius
kDa	kilo dalton
ml	mililiter
µm	micrometer
M	molar
ppm	part per million
BOD	biological oxygen demand
COD	chemical oxygen demand
CMC	critical micelle concentration
CV	coagulation value
CTAB	cetyltrimethylammonium bromide
DSC	differential scanning calorimetry
FTIR	fourier-transform infrared
LiCl	lithium chloride
MWCO	molecular weight cut-off
MF	microfiltration
MgSO ₄	magnesium sulphate
MgCl ₂	magnesium chloride
NF	nanofiltration
NFS	nanofiltration-surfactant
NMP	N-methyl-2-pyrrolidone
PES	polyethersulfone
PVP	poly(vinyl pyrrolidone)
PEG	poly(ethylene glycol)
PWP	pure water permeation
RO	reverse osmosis
SEM	scanning electron microscope
SDS	sodium dodecyl sulfate
Na ₂ SO ₄	sodium sulphate
NaCl	sodium chloride

TIPS	thermally induced phase separation
TGA	thermogravimetric analysis
UF	ultrafiltration
UV-Vis	ultraviolet-visible
H ₂ O	water
ZnCl ₂	zinc chloride

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