[illegible] SEPARATION

[illegible] SEPARATION

[illegible]

[illegible]

2007

1100051110

1100051110		

Lihat sebelah

DEVELOPMENT OF ASYMMETRIC BIO-SEPARATION MEMBRANES FOR PROTEIN (BSA) SEPARATION

By
Suriani Binti Ab Rahman

Research report submitted in partial fulfillment of
the requirements 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:
DEVELOPMENT OF ASYMMETRIC BIO-SEPARATION MEMBRANES FOR PROTEIN (BSA) SEPARATION oleh Suriani Binti Ab.Rahman No. Matrik UK 8128 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 Ali

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

Tarikh: 6/6/07

.....

Penyelia Kedua

Nama: En. Asmadi Ali@Mahmud

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

Tarikh: 4/6/07

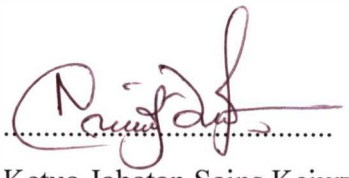
.....

Penyelia Ketiga

Nama: Dr. Amiza Mat Amin

Cop Rasmi: PROF. MADYA DR. AMIZA MAT AMIN
Ketua
Jabatan Sains Makanan
Fakulti Agroteknologi dan Sains Makanan
Universiti Malaysia Terengganu
21030 Kuala Terengganu.

Tarikh: 7/6/07



Ketua Jabatan Sains Kejuruteraan

Nama: Dr. Nora'aini Bt. Ali

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

Tarikh: 6/6/07

ACKNOWLEDGEMENT

In the name of ALLAH the most Gracious and Most Merciful

Praise and glory be to ALLAH the Almighty for the give which has granted me the strength and determination to complete this thesis.

I would like to express my appreciation and gratitude to my supervisor, Dr. Nora'aini Ali and co-supervisors, Mr. Asmadi Ali@Mahmud and Dr.Amiza Mat Amin for their patient, guidance, invaluable assistance and constructive criticisms. Immeasurable gratitude is forwarded to Mr.Ab.Rahman, Mr. Razali, Mr.Roslan and all lectures and Environmental Laboratory staff in KUSTEM.

I also would like to extend my warmest thanks to my family especially to my mom and dad for their never ending love and support who keep me strong, level headed and down to earth, to always remember our moral and how to keep our respect. I am deeply indebted to all my friends and all those who had contributed directly or indirectly not forgetting Mardiah and Panimalar who had gives me lots of inspiration and courage.

May ALLAH shower His blessing upon all of us. Thank you.

TABLE OF CONTENT

CHAPTER 2 LITERATURE REVIEW

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS/ SYMBOLS

Abbreviation/Symbol

A_k	Membrane porosity
BSA	Bovine Serum Albumin
C_b	Bulk concentration
C_f	Concentration of feed solution
C_p	Concentration of permeate solution
C_r	Concentration of retentate solution
D_s	Solute diffusivity for neutral molecule or generalized diffusivity for 1-1 type of electrolyte defined as $D_s = 2(D_1/D_2)/(D_1+D_2)$
F	Faraday constant, 96487 C/mol
H_2O	Water
H_F, H_D	Steric parameters related to wall correction factors under diffusion and convection conditions, respectively
Jv	Average solute flux over membrane surface
k	Mass transfer coefficient
MF	Microfiltration
MW	Molecular Weight
NF	Nanofiltration

NMP	*N*-Methyl-2-Pyrrolidone
NaCl	Sodium chloride
P_m	Permeability coefficients
P_s	Solute permeability
PSf	Polysulfone
R	Rejection
r_p	Pore radius
r_s	Solute radius
SEM	Scanning Electron Microscope
S_F, S_D	Distribution coefficient of solute by steric hindrance effect under diffusion and convection condition, respectively
UF	Ultrafiltration
Δx	Effective membrane thickness
η	Ratio of solute radius
σ	Reflection coefficient

LIST OF APPENDICES

ABSTRACT

More recent studies have demonstrated that conventional process such as chromatography, electrophoresis, affinity purification, etc. widely used in protein separation and purification now days. However, these processes are limited to separation of protein solutes and shown that the purity of protein obtained significantly less. Ultrafiltration has become an alternative technology for protein separation over conventional bioseparation processes due to its high throughput of product. A systematic study on the influence of different polymer concentration and shear rate for ultrafiltration membrane in separating BSA protein was performed to determine the best formulation and shear rate condition. Asymmetric ultrafiltration membranes were produced using ternary composition consist of polysulfone, N-methyl-2-pyrrolidone and water by a dry/wet phase inversion using an electrically controlled flat sheet membrane casting machine. The membrane morphology and pore radius had been characterized by using Scanning Electron Microscope (SEM) and Steric Hindrance Pore (SHP) model. The membrane performance was determined based on the pure water flux, sodium chloride and BSA protein solution permeation test. Analysis of BSA protein was analyzed by using UV-vis spectrophotometer. Based on BSA ultrafiltration experiment, rejection ranging from 94.3% to 100% was obtained for membranes fabricated with polymer concentrations of 11wt%, 13wt%, 15wt% and 17wt%. The optimum polymer concentration for protein separation is 17wt% which exhibit 100% rejection. In conjunction to this profound polymer concentration, the effect of shear rate at 176.23s^{-1}, 234.98s^{-1}, 352.47s^{-1} and 704.93s^{-1} has been analyzed. This study has proposed that membrane fabricated at a shear rate about 704.93s^{-1} with a polymer concentration of 17wt% is the optimum asymmetric polysulfone ultrafiltration membrane for BSA protein separation. This research has indicated that polymer concentration and shear rate affects the membrane performance and structural properties, consecutively enhancing the membranes ability for BSA separation.

ABSTRAK

Kebanyakan kajian pada masa kini menunjukkan proses seperti kromatografi, elektroporisis dan lain-lain lagi biasanya digunakan secara meluas dalam proses pemisahan dan penulenan protein. Walaubagaimanapun, proses ini menghadkan pemisahan larutan protein dan mununjukkan protein tulen yang dihasilkan adalah kurang. Penuras ultra merupakan teknologi alternatif bagi pengasingan protein berbanding dengan proses pengasingan yang biasa disebabkan penghasilan produk yang tinggi. Satu kajian yang sistematik ke atas kesan kepekatan polimer dan kadar ricih yang berbeza bagi membran penuras ultra dalam pengasing protein Bovine Serum Albumin (BSA) telah dijalankan untuk menentukan kepekatan polimer dan kadar ricih yang terbaik. Membran penuras ultra asimetrik telah dihasilkan menggunakan komposisi campuran tiga bahan yang terdiri daripada polisulfon, N-metil-2-Pirrolidon dan air melalui kaedah pembalikkan fasa kering/basah dengan menggunakan mesin penghasilan kepingan rata elektrik. Morfologi dan jejari liang membran dicirikan menggunakan Mikroskop Pengimbas Elektron (SEM) dan model Liang Halangan Sterik. Ketelapan membran dan prestasi penyingkiran garam ditentukan berdasarkan fluks air tulen dan ujian ketelapan larutan natrium klorida dan protein BSA. Analisis protein BSA dilakukan menggunakan UV-vis spectrophotometer. Berdasarkan kajian penapis ultra BSA, penyingkiran protein BSA berjulat antara 94.3% hingga 100% telah diperolehi daripada membran dihasilkan dengan kepekatan polimer 11wt%, 13wt%, 15wt% dan 17wt%. Kepekatan polimer yang optimum bagi penghasilan protein BSA adalah 17wt%. Setara dengan kepekatan polimer yang optimum ini, kesan kadar ricih dalam julat 176.23 s^{-1} hingga 704.93s^{-1} telah dianalisa. Kajian in telah mencadangkan bahawa membran yang dihasilkan pada kadar ricih 704.93s^{-1} dengan kepekatan polimer 17wt% merupakan membran polisulfone ultra penuras asimetrik yang sesuai bagi pengasingan protein BSA. Ini menunjukkan bahawa kepekatan polimer dan kadar ricih memberi kesan kepada prestasi dan ciri-ciri struktur membran di mana meningkatkan kebolehan membran dalam pengasingan protein BSA.