

SCIENCE & ENGINEERING CHAPTER

ANNUAL INTERNATIONAL CONFERENCE SYIAH KUALA UNIVERSITY (AIC UNSYIAH)

AAC Dayan Dawood, Darussalam - Banda Aceh, Indonesia. November 29-30, 2011

PROCEEDINGS



Editors:

Hesti Meilina, Indonesia
Hizir, Indonesia
Abdul Razak Salleh, Malaysia
Amir T.P. Najafabadi, Iran
Mohammad Jawaid, India



EDITORIAL BOARD

Editor-In-Chief

Dr. Hesti Meilina (Environmental Engineering, Indonesia)

Editorial Members:

Dr. Hizir Sofyan (Mathematics, Indonesia)
Dr. Abdul Razak Salleh (Mathematic, Malaysia)
Dr. Amir T.P. Najafabadi (Mathematic, Iran)
Dr. Mohammad Jawaaid (Engineering, India)

Organizer:

Syiah Kuala University Research Institute

Publisher:

Syiah Kuala University Press
Kopelma Darusalam - Banda Aceh 2311, Indonesia

NOTICE OF DISCLAIMER

The authors and publisher of these proceedings have used their best efforts in preparing and collecting the materials. These efforts include the development, research and testing of these theories to determine their effectiveness. However, the publisher bears no responsibility for any damage resulting from any inadvertent omission or inaccuracy in the proceedings. Further, the authors and publisher make no warranty of any kind, expressed or implied, with regard to the documentation contained in these proceedings. The authors of papers published in these proceedings have transferred their copyright to Syiah Kuala University. The opinions expressed by the authors do not necessarily reflect those of Syiah Kuala University and are solely the responsibility of the authors.

All manuscripts printed in these proceedings were reproduced directly from the softcopies submitted by the authors (unedited), with only minor editorial amendments. Although all efforts were made to ensure the accuracy and correctness of the format, the Committee of Annual International Conference Syiah Kuala University will not be responsible or liable for any unintentional errors made during the publication or any conflict of interest of these proceedings.

Individual readers of these proceedings and nonprofit libraries acting for them are freely permitted to make fair use of the material, such as to copy a paper for use in teaching or research. Permission is granted by Syiah Kuala University Press to quote from these proceedings with the customary acknowledgment of the source. Republication or systematic or multiple reproduction of any material in these proceedings is permitted only with written permission from Syiah Kuala University Press.

Request to republish or reproduce papers from these proceedings should be addressed to Syiah Kuala University Press, Kopelma Darussalam, Banda Aceh 23111, Indonesia.

MESSAGE FROM THE RECTOR



On behalf of Syiah Kuala University (Unsyiah), I would like to extend my warmest welcome to all participants to the Annual International Conference of Syiah Kuala University 2011 (AIC-UNSYIAH 2011).

Syiah Kuala University is the largest and the oldest national university in Aceh Province, Sumatera Island, Indonesia. The university was established on June 21st, 1961. The establishment of UNSYIAH was driven by a spirit to form an institution to bring the Acehnese to become educated, knowledgeable and pious to God Almighty.

UNSYIAH has a vision to establish itself as an innovative, independent, and outstanding university in terms of the development of science, technology, humanities, sport and arts, in order to produce qualified graduates who highly honor moral and ethical values.

This year, UNSYIAH has hosted a series of events commemorating its 50th anniversary. As part of the celebration, the university held an interdisciplinary academic conference between of November 29-30, 2011. The conference included plenary addresses, oral & poster parallel sessions and a tsunami/historical sites tour.

I would like to thank our keynote and invited speakers for their time and support for this conference. I am excited to witness such development in the research scene.

Lastly, I would like to thank the Organizing Committee for their hard work in making this event successful. To all participants, I wish you fruitful interactions with your peers and our foreign friends as well as, an enjoyable stay in Banda Aceh.

Thank you.
Sincerely

Professor Dr. Darni Daud, M.Ed
Rector of Syiah Kuala University

MESSAGE FROM THE CHAIRMAN



I would like to take an opportunity to warmly welcome all the participants of the Annual International Conference of Syiah Kuala University 2011 (AIC- UNSYIAH 2011) to Banda Aceh, Indonesia.

This conference was organized by The Syiah Kuala University Research Institute. The Institute is honored to host this distinguished and meaningful event. This conference signifies yet another achievement by the Research Centre in bringing together scholars from all over the world to promote scholastic work. It is also in line with the University's commitment to the advancement of knowledge through pursuing scientific discoveries and technological innovation.

The response for the conference has been overwhelming. We are glad to have received abstract submissions and approximately 180 papers from 9 countries, however due to limitation of time slots only about 107 papers will be able to be presented. Among the participants, there are not only experienced experts and researchers but also postgraduate students from emerging areas such as agriculture, marine and fisheries, biology and chemistry in general, health sciences, law and politic, education, history and economics. The presented papers have been published in three different chapters; Life Sciences, Sciences and Engineering, and Education and Social Sciences.

We hope that participants will exploit the great opportunity provided by this conference to link with some of the world's best minds and establish collaborative ties. We also hope that it will spur inspirations for more innovative ideas. We look forward to welcoming you in the Annual International Conference of Syiah Kuala University 2011 and wish you a pleasant and enjoyable stay in Banda Aceh.

Thank you.
Sincerely

Dr. Musri Musman, M.Sc
Chairman/Director of Syiah Kuala University Research Institute

Preparation of asymmetric cellulose acetate membrane by phase inversion method of cellulose pulp from wood of sengon (*Paraserianthes falcataria*)

C. M. Rosnelly

Department of Chemical Engineering, Syiah Kuala University, Banda Aceh 23111, Indonesia. Corresponding author: cutnelly@gmail.com

Abstract: Cellulose acetate ultrafiltration membrane is one of kinds process of membrane which has been utilized in separation and purification processes. Cellulose acetate can be obtained from acetylation of cellulose sengon wood (*Paraserianthes falcataria*). Wood Sengon was used because it has potential as a raw material. There are three steps of cellulose diacetate manufacturing process: (1) activation of cellulose using acetic acid, (2) acetylation using acetic anhydride as reactant and sulfuric acid as catalyst, (3) hydrolysis. At each operating process was observed at 50°C. Preparation of cellulose diacetate membrane using phase inversion method by addition of cellulose diacetate as polymer; N,N-Dimethyl formamide (DMF) as solvent, water as non-solvent, and Polyethylene glycol (PEG). Membrane pore size was determined by measuring Molecular Weight Cut Off (MWCO) using Dextran and Bovin Serum Albumine (BSA) as standard solution. Membrane morphology was observed by Scanning Electron Microscope (SEM). Cellulose acetate of acetyl content of 39.66% and number average molecular weight 130,221 Da was obtained 30 minutes of activation time; one hour acetylation, and 15 hours hydrolysis. The addition of PEG produced a thicker layer and suppress the formation of macrovoid. SEM analysis shows a denser structure membrane morphology with better regularity of pore shape. The resulting membranes which were coagulated at lower temperature shows dense structure. High flux with low rejection obtained from the membrane with greater porosity and pore distribution. MWCO determination was based on the value of 80% rejection of dextran and BSA standard solution and the obtained pore size ranges obtained ≤ 67 kDa, and is still categorized as ultrafiltration membrane.

Key words: *Paraserianthes falcataria*, cellulose diacetate, inversion, cellulose diacetate membrane, ultrafiltration.

Introduction

Membrane is semipermeable barriers that separates two phases and restrict the transport of various substances in a specific way (Strathmann, 1990). In recent years, membranes and technology of membranes have grown from a labory scale. To day, technology of membranes are used on a large scale such as medical care/ medical industry (hemodialysis, purification of enzymes, antibiotics, etc), food industry (concentration of fruit juice, sugar purification, waste water treatment, etc), other industries (desalination and salt production, waste water treatment dan recovery of valuable, etc.) (Shibata, 2004).

Technology of membrane more efficient and economical because the processes are faster, low energy consumption, operation at mild temperatures, the non-addition of chemical products (Mulder, 1996; Coutinho, 2009). In Indonesia, utilization technology of membrane is not to develop in good because the materials of membrane is very difficult to find. Cellulose acetate suitable as membrane materials because is an environmental friendly substance. Cellulose acetate can be found from acetylation process of cellulose. In Indonesia, Sengon plant is many grow and fast growing species and has potential as a raw material from its high cellulose content. Cellulose from wood pulp of Sengon (*Paraserianthes falcataria*) had be used for making membrane (Rosnelly et al., 2009, 2010).

Material and Methods.

Materials

Cellulose acetate (CA) used as the membrane forming polymer (acetyl content 39.66% with molecular weight of 130,221 Da) was produced from erlier researcher by activation, acetylation, and hydrolysis of wood sengon. The solvent used was dimetyl formamide

(DMF) was procured from Merck and water as non solvent. Poroging agent used was polyethylene glycol 1450 Da (PEG) was procured from Sigma. Both of Dextran 12 kDa and Bovin Serum Albumin 67 kDa were procured from Sigma.

Preparation of solution polymer and preparation of membrane

Solution of CA was prepared by dissolving in precence and absence of poroging agent PEG 1450 Da in a polar solvent DMF. Cellulose acetate was added in ratio 1:3; 1:4; 1:5; 1:6 respect to DMF while PEG 1450 Da was added 20% with respect to the weight of CA. Mechanical stirring was did in flask for 2 hr at room temperature until the CA and PEG were entirely dissolved to form a homogenous solution (dope solution) (Modification of Mahendran et al., 2004; Chou et al., 2007)

Asymetric membrane are generally prepared by the phase inversion. Dope solution then cast on a glass plate at a 0,2 mm thickness and is left to evaporate time for 30 seconds. Next, the glass plate were immersed into the coagulation bath (15°C: room temperature, 50°C) and left until the gelled membrane formed and preserved in pure water before characterization (Modification of Mahendran et al., 2004; Chou et al., 2007). The morphology of membranes was examined using a Scaning Electron Microscope (SEM) JSM - 5310 LV, Jeol Japan. The experimental setup for measuring flux and retention of standard solution (dextran and BSA) for CA membrane were carried ouat in the ultrafiltration instruments. The feed was held in a trans membrane pressure (ΔP) of 1,2 bar and was recirculated at a flow rate 34 L/hr. The flux was determined when the flow rate stabilized. The pore size distribution was determined using dentran (12 kDa) and BSA (67 kDa) with concentration in the feed solution was kept at 200 ppm for each solution. Molecular weight cut-off (MWCO) is a pore characteristics of membrane is related to rejection for a given molecular weight of a solute above 80% (Mahendran et al., 2004). The concentration of dextran and BSA were determined using UV-spectrophotometer. The flux (J_w) was calculated by the following equation (Mulder,1996):

$$J_w = V / (A \cdot \Delta t) \quad (1)$$

Where:

- J_w = water/solution flux (in L/m².hr)
- V = quantity of permeate collected (in L)
- Δt = the sampling time (hr)
- A = the membrane area (m²)

The retention R was calculated as follows (Mulder, 1996):

$$\%R = [1 - C_p/C_f] \times 100\% \quad (2)$$

Where C_f and C_p are the solute concentration in the feed and permeate.

Results and Discussion

Membranes be obtained from a homogenous solution (dope solution) in ratio1:6 of CA respect to DMF. Before characterization, compaction of all the membranes at a higher pressure than the operating pressure were did to obtain a steady state flux and need about 30 minutes for compacting. Flux of all the compacted membranes were measured after an initial stabilization period 10 minutes.

Analysis of SEM the membrane morphology shows an asymmetrical structure consisting of a dense top-layer and a porous sub-layer. The top layer formed first when the casting solution was immersed in water coagulation bath. Molecules of CA at interface aggregate rapidly so that the dense skin formed when the solvent of DMF desolvates rapidly into the water coagulation bath (Young & Chen, 1995; Javliya et al. 2008). Membrane with addition of PEG shows a denser structure of membrane morphology with better regularity of pore shape, so has a better pore density (porosity) distribution of large and visible pores. Macrovoid formed for membrane without addition of PEG. Poroging agent PEG can increase the viscosity of the solvent so that affinity solvent with non solvent more slowly. The macrovoid gradually disappeared with addition PEG (Chou et al., 2007). At the higher of

water coagulation bath temperature, the structure of membrane morphology is more tenuous with a bigger pore size and greater number of pores so large porosity and pore distribution because diffusion of DMF into the water coagulation bath more faster. Analysis of SEM can be shown in Figure 1, Figure 2, and Figure 3.

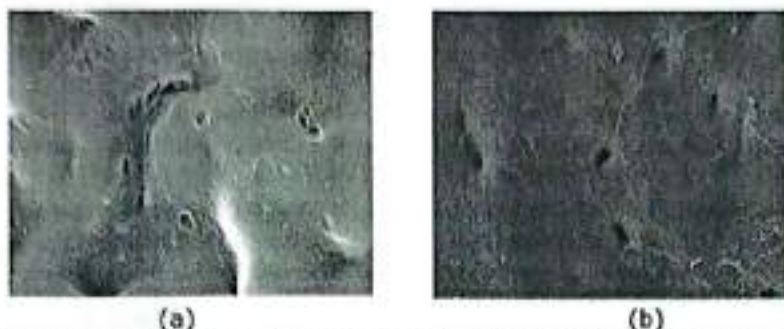


Figure 1. Asymmetrical structure of membrane: (a) dense top-layer (2000x); (b) porous sub-layer (500x, room temperature of coagulation bath).

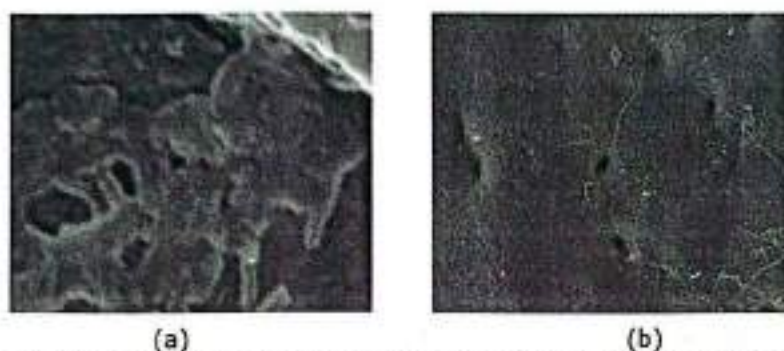


Figure 2. Structure of membrane (500x, room temperature): (a) without PEG; (b) addition PEG.



Figure 3. Structure of membrane respect to temperature of water coagulation bath (500x): (a) 15°C; (b) room temperature.

Higher temperature would strongly affect the flux performance of CA membrane because affinity between solvent of DMF and nonsolvent of water very strong. Higher PEG content would lead to higher flux because PEG is a pore-forming that creates pore in the polymer matrix of CA so that size of micropores increased. Conservally, rejection of all membranes would lead to lower with increased the content of PEG (Chou et al., 2007). High flux with low rejection obtained from the membrane with greater porosity and pore distribution. The result of flux and rejection for all membranes as shown in Table 1.

Characterization of membrane can be obtained by the pore size or molecular weight cut-off (MWCO) value which is obtained by measuring the retention of macromolecules with molecular weight. Cellulose acetate membranes in presence and absence PEG had the MWCO of 67 kDa although there was found the different of the rejection value. While the MWCO is based on 80% of solute rejection, so that all the membranes had the same MWCO and still categorized as ultrafiltration membrane.

Table 1. Effect of various content on the membrane performance

PEG (MW)	Coagulation bath temperature (°C)	Flux of water (L/m ² .jam)	Flux of Dekstran (L/m ² .jam)	Flux of BSA (L/m ² .jam)	Rejection of Dextran (12.000 Da) (%)	Rejection of BSA (67.000 Da) (%)
Murni	15	53 ± 4	49 ± 4	43 ± 2	56.54 ± 4,3	84.2 ± 6.4
SA	30	74 ± 6	59 ± 4	58 ± 4	54.8 ± 4.1	78.7 ± 5.9
	50	96 ± 7	81 ± 6	65 ± 5	53.5 ± 4,04	74.7 ± 5.6
1450	15	96 ± 10	83 ± 6	74 ± 6	60,9 ± 4.6	85.6 ± 6.5
Da	30	121 ± 13	95 ± 7	83 ± 6	55.9 ± 4.2	79.9 ± 5.8
	50	129 ± 14	119 ± 9	103 ± 8	50.9 ± 3.9	75.7 ± 5.7

Conclusions

Cellulose acetate of acetyl content of 39.66% and number average molecular weight 130,221 Da used for preparing of membranes with ratio of CA respect to DMF is 1:6. Membranes with the addition of PEG produced a thicker layer and suppress the formation of macrovoid. SEM analysis shows a denser structure of membrane morphology with better regularity of pore shape, so has a better pore density (porosity) distribution of large and visible pores. Coagulation at higher temperatures produced a thinner layer. The structure of membrane morphology is more tenuous with a bigger pore size and greater number of pores so large porosity and pore distribution. High flux with low rejection obtained from the membrane with greater porosity and pore distribution. MWCO determination was based on the value of 80% rejection of dextran and BSA standard solution and the obtained pore size ranges obtained ≤ 67 kDa, and is still categorized as ultrafiltration membrane.

Acknowledgements

The authors thank the Directorate General of Higher Education National Education Departments of The Republic Indonesia and Government of Nangroe Aceh Darussalam through Syliah Kuala University for their financial support. The authors also thank to Prof. H. A. Aziz Darwis, M.Sc; Prof. Hj. Erliza Noor; and Dr. Kaseno, M.Eng as leader in my research at Department of Agriculture Industry Technology - Bogor Agricultural Institute.

References

- Chou, W. L., Yu, D. G., Chien, M. dan Yang, C. H. J. 2007. Effect of molecular weight and concentration of PEG additives on morphology and permeation performance of cellulose acetate. Sciencedirect Separation and Purification Technology.
- Coutinho, C.A.; Chiu, M.C.; Basso, R.C.; Ribeiro, A.I.B; Goncalves, L.A.g; Viotto, L.A. State of art of the application of membrane technology to vegetables oils: A review. Food Research International 42: 536-550.
- Javiya, S., Yogesh, Gupta, S., Singh, K dan Bhattacharya, A. 2008. Porometry studies of the polysulfone membranes on addition of poly(ethylene glycol) in gelation bath during preparation. Journal of Mex. Chem. Soc. 52(2): 140-144, Sociedad Química de México ISSN 1870-249X.
- Mahendran, R., Malaisamy, R., dan Mohan, D. R. 2004. Cellulose acetate and polyethersulfone blend ultrafiltration membranes. Part I: Preparation and characterizations. Polymer Advanced Technologies 15: 149-157.

- Mulder, M. 1996. Basic Principles of Membrane Technology. Kluwer Academic Publisher, Netherland.
- Rosnelly, C.M., Darwis, A.A., Noor, E., and Kaseno. 2009. Preparation of cellulose acetate from pulp of sengon wood (*Paraserianthes falcataria*). Agri-Tek, Vol.10 (1).
- Rosnelly, C.M., Darwis, A.A., Noor, E., and Kaseno. 2010. The effect of acetate anhydride ration in the process of cellulose acetylation of pulp from Sengon (*Paraserianthes falcataria*). Warta Industri hasil Pertanian, Vol.27 (1).
- Shibata, T. 2004. Cellulose acetate in separation technology. Macromol. Symp. 208: 353-369.
- Strathmann, H. 1990. Synthetic membranes and their preparation. In M.C. Porter (Ed), Handbook of industrial membrane technology. New Jersey: Noyes Publication.