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Optimization the annealling time of membrane PSF19%DMF for palm oil mill effluent treatment

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ABSTRACT

The membrane that produced is expected to be used for separation the particles that having size of 0.01 to 0.1 µm with MWCO range of 200-300 from the solution as industries wastewater. The objective of research is to study the influence of the annealling time in wastewater treatment processing especially for POME and explore the membrane PSf19%DMF with optimum performance for this case. The performance of membrane is defined by three parameter as flux, permeability, and rejection. Interest gained from this study is to examine the influence of membrane PSfDMF19% in the process of wastewater treatment with membrane module which have optimum performance in the Palm Oil Mill Effluent (POME) treatment. The first step of this research is constructing of membrane PSf19%DMF with annealing temperature of 70 ^{0}C and for variance time annealing 45 minutes, 90 minutes and 135 minutes. Then follow for testing the performance of membrane PSfDMF19% with the variation pressure of 0.5; 1.0; 1.5; 2.0 and 2.5 psia then feed POME is passed through the cell Membrane ultrafiltration/nanofiltration. Optimum membrane obtained from the POME treatment contained in the membrane PSf19%DMF with annealling time optimum 90 minutes. The optimum operating conditions of the treatment for POME contained in P = 2,5Psia with the flux of 1646.0250 x 10-5 cm3 / cm2.det, pure water permeability coefficient of 156.6 x 10-5 cm3 / cm2.det. psia, and rejection 97.2703%. while the optimum pressure at P=2,5 Psia with pH = 7.42; TSS = 123mg / L; BOD = 148mg / L; and COD = 305mg / L. The results obtained is quite effective, because it have been approached with the standard effluent for POME.

Keywords - *Membrane, Nanofiltration,Ultafiltrafiltration, POME, PSfDMF19%,*

INTRODUCTION

The extent of oil palm plantations in Indonesia, which reached 1.8 million hectares of oil palm plantations, production of 17.11 million tonnes (Food Security Agency, 2008) resulted in a sizeable liquid waste. Industrial wastewater produced is sometimes less handled with optimal treatment that leads to /environmental pollution. To answer this question, the research team tried to conduct a research

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sometimes less handled with optimal treatment that leads to /environmental pollution. To answer this question, the research team tried to conduct a research study on wastewater treatment using membrane technology is expected to be a new solution in liquid waste processing system for POME especially because the process is much more effective and time is relatively short. Membrane technology continues to grow because it has several features including the need for low energy use, the separation can be done in a steady state, and without the use of additives (chemicals). The problems that often arise among high selectivity is obtained membrane but have low permeability, also used high pressure then the physical strength of the membrane becomes very important.

The objectives of this research are following;

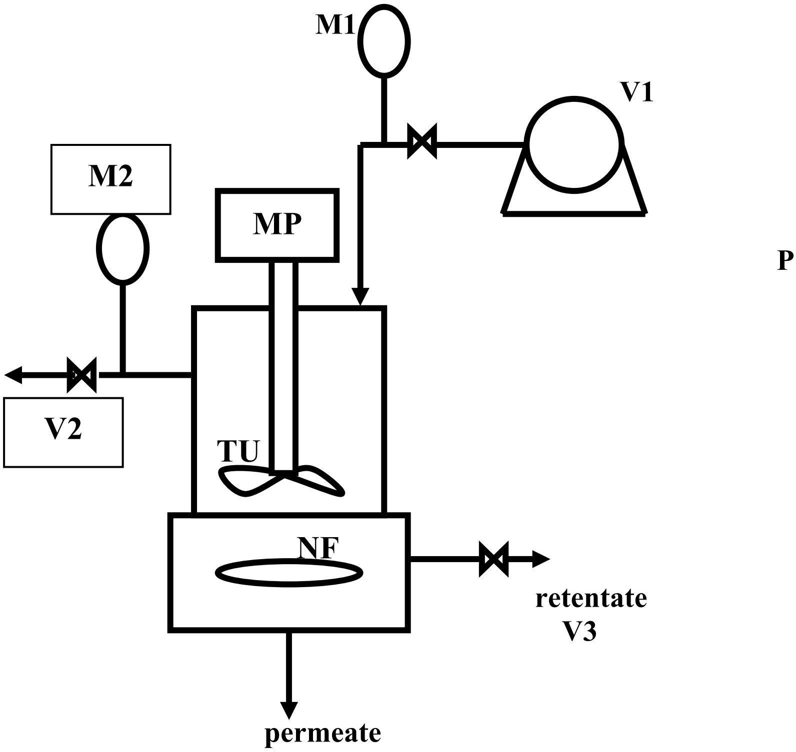
1. Optimizing the polymer PSf annealing time for processing palm oil mill effluent (POME); and 2. Determine the optimum PSF membrane performance for processing palm oil mill effluent (POME).

Based on research that has been done before by S. Irfan and S. Agus, 2009 entitled "Optimization of Coagulation container Temperature on Poly Sulphate Membrane For Process in Palm Oil Using Ultra filtration". From the title of the research, which focused on the treatment of wastewater POME gained some variable optimizations such as Time Evaporation 2 minutes, Coagulation temperature 60 ^{o}C, Annealing Temperature 70 ° C, Time Annealing 90 minutes and therefore need to be given the influence of time annealing is used for the treatment of wastewater POME on ultrafiltration membranes, and it is expected that the manufacture of the membrane with optimum performance in the process of POME wastewater treatment can achieve effluent standards for palm oil mill (the content of PH, TSS, BOD and COD) are has been set (can be seen in Table 2.3). From the above explanation it is necessary to do research on "Optimization of Annealing Time In polysulfone membrane (PSF) for POME wastewater Treatment with Ultrafiltration/Nanofiltration Process.

RESEARCH METHODOLOGY

The materials used in this study are polymers polysulfone (PSf) as a polymeric material solution mixture dope, DMF (Dimethyl formamid) as a solvent, Aquadest as a non-solvent, dope solution polysulfone (PSf) as a casting solution, POME liquid waste that comes from fat fit effluent as feed samples.

Operating equipment consists of a cell membrane Nanofiltration The series of experimental tools in the test phase membrane performance can be seen in Figure 1 below. Other equipment used are glass equipment commonly used in laboratories which in this case is used for the making the membranes, a set of analytical tools COD, BOD, TSS, pH, and SEM.



P	:	pump
TU	:	feed tank
V1, V2, V3	:	control valve
M1, M2	:	pressure gauge
NF	:	cell Nanofiltration
MP	:	mixer motor

Figure 1: The Scheme of Membrane Module

The variables process on the research are consist of the fixed variables and the unchanged variables. The fixed variables were among polymer concentration: 19%; Coagulation bath temperature: 70 ^{0}C; Evaporation time: 2 minutes;and Annealing temperature: 70 ^{0}C while the unchanged variables were consist of Annealing time: 45; 90; 135 Minutes and operation pressure: 0.5; 1.0; 1.5; 2.0; 2.5 bar. Analysis performance of the membrane produced as followed;

a. Analysis of the morphology and structure and pore size distribution using Scanning Electron Microscopy (SEM)
b. Initial analyzes on samples of POME (pH content, TSS, BOD and COD)

c. Analysis of the performance of the membrane with ultrafiltration/nanofiltration modules (flux, rejection, and the coefficient permibiltas pure water)
d. Analysis permeate liquid waste (pH content, TSS, BOD and COD)

RESULTS AND DISCUSSION

Morphology of Membrane Structures

This can be seen in the picture below is the analysis of structure morphology using Scanning Electron Microscopy (SEM)

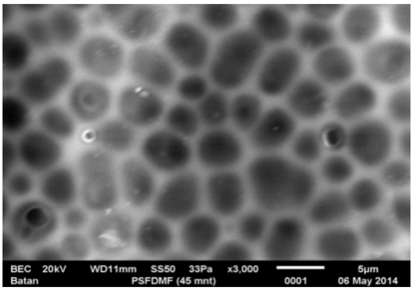


Figure 2: SEM photos membrane PSfDMF19% 45 minutes

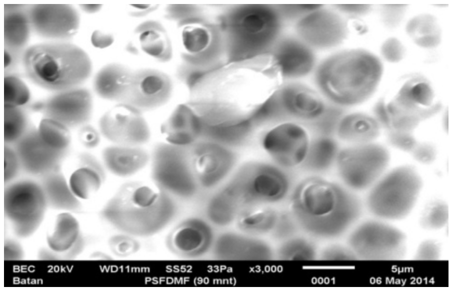


Figure 3: SEM photos membrane PSfDMF19% 90 minutes

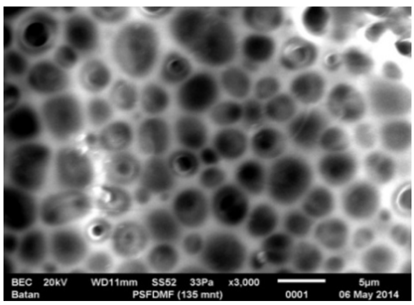


Figure 4: SEM photos membrane PSfDMF19% 135 minutes

Can be seen in the table below that the pore size of the membrane by using Scanning Electron Microscopy (SEM)

Table 1:. Results of Analysis of Membrane Preparation

Jenis Membran	Analysis Parameter	
	Average of Pore Diameter (µm)	Spacing Pore Average (µm)
PSfDMF19% 45	0,1653	0,0500
PSfDMF19% 90	0,1600	0,0420
PSfDMF19% 135	0,1300	0,0400

Testing for Performance of Membrane

Table 2: Permeability Coefficient of Membrane for Pure Water (Lp)

No	Types of Membrane	Permeability (cm^3/cm^2.det.Psia) x 10^{-5}
1	PSfDMF19% 45	97,67
2	PSfDMF19% 90	156,6
3	PSfDMF19% 135	112

Characteristic of Permeat from POME treatment

Table 3: pH, TSS, BOD, and COD from POME sample

Types of Membrane	POME Wastewater Sample			
	pH	TSS	BOD	COD
PSfDMF19% 45 PSfDMF19% 90 PSfDMF19% 135	3,6	13.670	4.214	8.427

Table 4: pH, TSS, BOD, and COD Permeate from POME treatment

Types of Membrane	Permeate from POME treatment			
	pH	TSS	BOD	COD
PSfDMF19% 45	7,56	153	157	339
PSfDMF19% 90	7,42	123	148	305
PSfDMF19% 135	7,34	144	125	234

Table 5: Limitation of POME Wastewater Before Discharge to the River

Types of Membrane	Limitation of POME Wastewater Before Discharge			
	pH	TSS	BOD	COD
PSfDMF19% 45 PSfDMF19% 90 PSfDMF19% 135	6-9	Max. 250	Max. 250	Max. 500

Effect of Annealing Time against Morphological Structure

Annealing time has an important role in shaping the structure of membrane morphology. It can be seen in Figures 2, 3 and 4 which is the result of SEM (Scanning Electron Microscopy). If the three membranes are compared, then the membrane PSfDMF19% 135 minutes in Figure 4 has the smallest pore size of the membrane others.

The reason is the longer the annealing time with annealing temperature of 70° C is more stable pores are formed, in which the function of annealing to make changes to the size of the average diameter of the pore membrane is stable and prevent swelling (swelling of the membrane pores) that can occur when the solution diffuses pass through the membrane.

Influence the Operation Pressure of Flux and Permeability

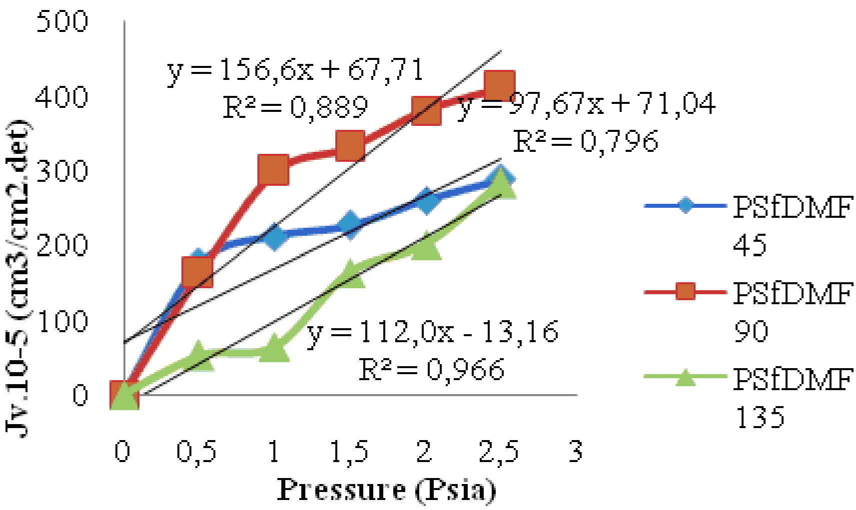


Figure 5: Influence of the operation pressure of flux on pure water feed

In the Figure. 5 above can be seen the influence of the flux to the operating pressure of each membrane using pure water feed. On the table it can be seen tendency of price increase flux. In the figure 5 above can be seen the influence of the flux to the operating pressure of each membrane using pure water feed. On the table it can be seen tendency of price increase flux along with increasing operating pressure.

This can be explained that the pressure is the thrust (driving force) for process Ultrafiltration (UF) so that the increase in operating pressure causes an increase in the total flux. The total flux due to the high operating pressure and flow rate, which grow and cause solute carried away as well.

Influence The Operating Pressure of Flux and Rejection In the Membrane

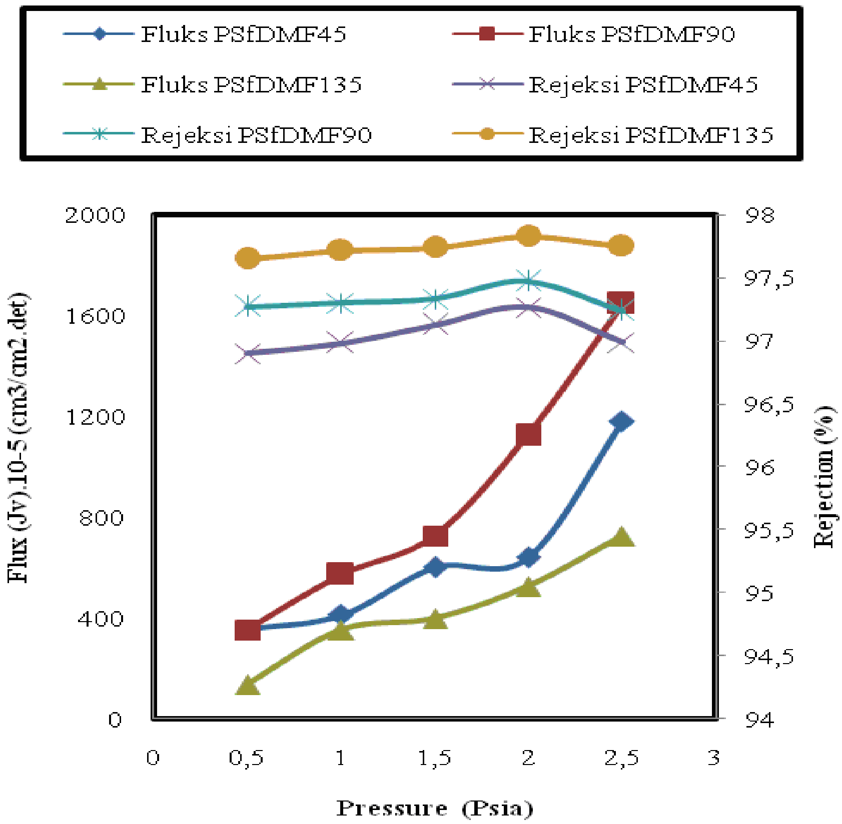


Figure 6: Influence of the operation pressure of flux and rejection

Based on the images that can be observed the ties 5. Above the flux is proportional to the operating pressure and rejection is inversely proportional to the operating pressure on each membrane. Can also be seen linear line of each membrane. The highest linear line is a linear line of membrane PSfDMF19% of 90 minutes, this indicates that the membrane PSfDMF19% 90 minutes is the most optimum membrane compared with other membranes. Where the optimum state is obtained at a pressure of 2.5 psia with flux value is 1646.0250 x 10-5 cm3 / cm2.det and rejection value that is 97.2703%. While the value of the average flux membranes PSfDMF19% 90 minutes 2.5 psia is 885.1143 x 10-5 cm3 / cm2.det and rejection average value is 97.3209%.

CONCLUSION

1. The most optimum membrane obtained was PSf9%DMF with the annealing time optimum on 90 minutes which has an average pore diameter of 0.1600 μm and the distance between the average pore 0.0420 μm.
2. The optimum operating conditions of the wastewater treatment membrane PSf19%DMF90 are in P = 2.5 psia with flux (Jv) = 1646.0250 x10^{-5} cm3 / cm2.det; permeability (Lp) = 156.6 x10-5 cm3 / cm2.det.psia ; rejection (R) = 97.2703%. While the condition of permeate generated in wastewater treatment with membrane PSf19%DMF90 , namely at P = 2.5 psia; pH = 7.42; and TSS = 123 mg / L, BOD = 148 mg / L, and COD = 305 mg / L
3. Waste water treatment POME using a polysulfone membrane in this study is quite effective, because the results are in accordance with the specified quality standards for POME.

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