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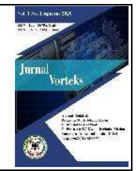

OPTIMIZATION OF THE TEMPERATURE OF COAGULATION WATER BATH ON PROCESSING OF THE POLYSULFONE MEMBRANES FOR THE WASTEWATER TREATMENT OF PALM OIL MILL EFFLUENT WITH ULTRAFILTRATION PROCESS

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Abstract

Ultrafiltration membranes include a type of porous membrane with a porous size order between 0.01 – 0.1 µm. The size of the small pores can be made phase inverse. Ultrafiltration is used to separate macromolecules and colloids from their solutions. The ultrafiltrated membrane has an asymmetrical structure with a denser upper layer (the porous size is smaller than the lower surface porosity), so the hydrodynamic retention will be larger. The objective of this study is to optimize the regular coagulation tub on the 19% PSf membrane manufacturing process with DMF solvent and to optimise the performance of the optimum PSF membrane in the processing of liquid waste of the PKS (palm coconut plant) with the ultrafiltration process. In the membrane performance testing process, the materials and tools used are polysulfonic polymers with dimethylformamide (DMF) solvents, whereas the instruments used are a set of ultrafiltration modules consisting of a centrifugal pump, ultra-filtration cell, pressure gauge, barrel, permeation tank, feed tank, and hose. This phase of the study starts with membrane preparation, SEM analysis, initial analysis of PCS liquid waste sample, 19% membrane operation performance test with coagulation bath temperature variable 40; 50; 60° C and adjusting pressure with variation 5; 10; 15; 20; 25 Psi, then determining membrane performance test which is permeability, flow, and rejection coefficients. The results obtained from this study show that a 19% PsfDMF membrane with a coagulation bath temperature of 50°C is the membrane that has the most optimum performance used for the POME wastewater treatment

Abstrak

Membran ultrafiltrasi termasuk jenis membran berpori dengan orde ukuran pori antara 0,01 – 0,1 µm. Ukuran pori kecil tersebut dapat dibuat secara inversi fasa. Ultrafiltrasi digunakan untuk memisahkan makromolekuler dan koloid dari larutannya. Membran ultrafiltrasi memiliki struktur yang asimetrik dengan lapisan atas yang lebih dense (ukuran pori lebih kecil dari porositas permukaan

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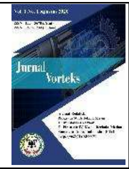

Kata Kunci :*Membran, Ultrafiltrasi, Polisulfon, POME*

lebih rendah), sehingga tahanan hidronamikanya akan lebih besar. Tujuan dari penelitian ini adalah mengoptimasi termperatur bak koagulasi pada proses pembuatan membran PSf 19% dengan pelarut DMF dan mengoptimasi kinerja membran PSf optimum dalam pengolahan limbah cair PKS (pabrik kelapa sawit) dengan proses ultrafiltrasi. Pada proses uji kinerja membran, bahan dan alat yang digunakan adalah polimer polysulfon dengan pelarutnya dimethylformamid (DMF), sedangkan alat yang digunakan yaitu seperangkat modul ultrafiltrasi yang terdiri dari pompa sentrifugal, cell ultrafiltrasi, pressure gauge, kerangan, tangki permeat, tangki umpan, dan selang. Sedangkan sampel yang digunakan adalah limbah cair PKS. Adapun tahapan penelitian ini dimulai dari preparasi membran, analisa SEM, analisa awal sampel limbah cair PKS, uji kinerja operasi membran 19% dengan variabel temperatur bak koagulasi 40; 50 ; 60 ^oC dan mengatur tekanan dengan variasi 5; 10; 15; 20; 25 Psi, kemudian menentukan uji kinerja membran yaitu berupa koefisien permeabilitas, fluks, dan rejeksi. Hasil yang diperoleh dari penelitian ini menunjukkan bahwa membran PsfDMF 19% dengan temperatur bak koagulasi 50 ^oC merupakan membran yang memiliki kinerja paling optimum digunakan untuk mengolah limbah cair PKS.

INTRODUCTION

With the widespread increase in palm coconut plantations in Indonesia, the waste from palm coke processing has also increased. In the process of processing fresh fruit doughnuts (TBS) into palm oil, production residues are produced as solid and liquid waste. (POME). The liquid waste produced by the CCS comes from the results of the production process in the rehabilitation activities, clarification and from the process of processing the core [1]. Therefore, it can be calculated that every day, a palm oil processing plant can produce 650 m^3 of liquid waste per day. (PPKS,2006). Waste characteristics consist of physical, chemical, and biological properties. Waste's characteristics based on physical properties include temperature, rottenness, smell, and taste, based on chemical characteristics including organic material content, protein, BOD (Biological Oxygen Demand), and COD (Chemical Oxygen Demand) [2]. According to the decision of the Minister of the State of the Environment, there are 7 (seven) main parameters that are used as reference for the raw quality of waste, namely:

Table 1 PKS Waste Quality Standard Reference Parameters

Parameter	Highest ratesi (mg/l)	Highest pollution load (kg/ton)
BOD	100	0,25
COD	350	0,88
TSS	250	0,63
Oils & Fats	25	0,063
Total nitrogen(partial N)	50	0,125
pH	6,0 – 9,0	
Highest waste discharge	2,5 m^2 per ton of CPO palm oil products	

One of the uses of membrane technology can be made to minimize the volume of liquid waste produced by industry by taking the water contained in the waste. The development of membrane technology that is also advanced in the environmental field allows it to do waste treatment in the form of direct application [3]. So it doesn't add the amount of waste that's thrown into the environment. Ultrafiltration membranes include a type of porous membrane with a porous size order between 0.01 – 0.1 μm. These small porous sizes can be made in phase inverse [4]. Ultrafiltration is used to separate macromolecules and colloids from their solutions. This membrane is similar to microfiltration, which is a porous membrane where the rejection of solute substances is strongly influenced by the size and weight of the solute substance relative to the size of the membrane pores [5]. The ultrafiltrated membrane has an asymmetrical structure with a denser upper layer (the porous size is smaller than the lower surface porosity), so the hydrodynamic retention will be larger.[6]. In this process, there are several highly influential variables, namely: a. polymer concentration, (sampling concentration compared to the morphological structure of membrane pores) b. solvent type, (the boiling point of a high solvent will produce a small membrane pore) c. Coagulation temperature The higher the temperature of the coagulation tub, the resulting membrane has smaller pores in diameter, this is because the higher the temperature of the coagulation tub (which contains non-solvents) the solvent on the membrane is more evaporated so that the polymer sulphonizes the evaporating pores, then the closer and more stable pores are produced [7] d. Time annealing, ((a process of improving the properties of membrane pores by heating the membrane at certain time intervals and then cooling). The evaporation time also greatly affects the morphological structure of the membrane, where the longer the evaporating time takes, the smaller the form of the resulting membrane pores. (non-porous).

3. Permeability is a measurement of the speed at which a particular species penetrates a membrane.
4. Rejection is the amount of solute retained on the membrane. Scanning Electron Microscopy (SEM) is one of the techniques used for membrane characteristics that shows a precise way and simple method to characterize and analyze the morphological structure of membrane pores formed.

RESEARCH METHODS

The membrane inverse technique used in this study is phase inverse. In this case, it is based on the process of making a membrane that includes two phases, namely a liquid phase that will be transformed into a solid phase [8]. The process of making a large asymmetrical membrane is as follows: 1) Dissolves the polymer in a solvent suitable to form a dope with a certain polymer composition. 2) The film printing of a certain thickness of such a dope is followed by the evaporation of the solvent within a certain time interval. In the membrane performance testing process, the materials and tools used are polysulfonic polymers with dimethylformamide (DMF) solvents, while the instruments used are a set of ultrafiltration modules consisting of centrifugal pumps, ultra-filtration cells, pressure gauges, containers, meat tanks, feed tanks and hose [9]. This phase of the study starts with membrane preparation, SEM analysis, initial analysis of PCS liquid waste samples, 19% membrane operation performance test with coagulation bath temperature variables of 40; 50; 60°C and adjusting pressure with variations of 5; 10; 15; 20; 25 Psi, then determining the membrane performance test is permeability, flow, and rejection coefficients [10]

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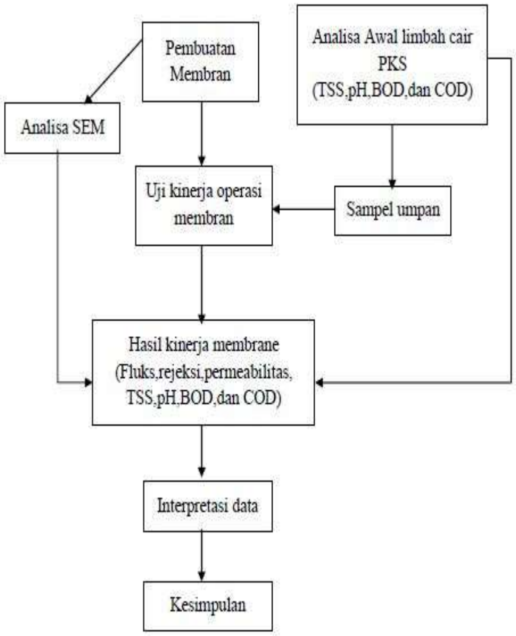

Figure 1. Flow Chart

RESULT AND DISCUSSION

The Influence of Coagulation Bath Temperature on the Morphological Structure of the Temperature Coagulating Bath plays an important role in the formation of the membrane morphological structure. It can be seen in Figures 1, 2, and 3 which are the results of SEM (Scanning Electron Microscopy). If these three membranes are compared, then the PSfDMF19% Temperature Coagulation Bak 40° C membrane in Figure 1 has the smallest porous size, whereas the membrane PSf DMF19 % Temperature Coagulation bak 50°C in Fig. 2 is a membrane with the largest porous dimensions. The following is the sequence of the membrane that has the smallest to largest pores, i.e. the PMFDM19% temperature coagulation bak 40°C membrane has an average porous diameter of 3.3543 µm and an average distance between pores of 1.0344 µm. This is not in line with the theory that the higher the temperature of the coagulation tub, the smaller the diameter of the membrane, the lower the temperature, the more the polymer of the polysulphone fills the room of the solvent that has evaporated, and the more tight and stable the pores are produced.

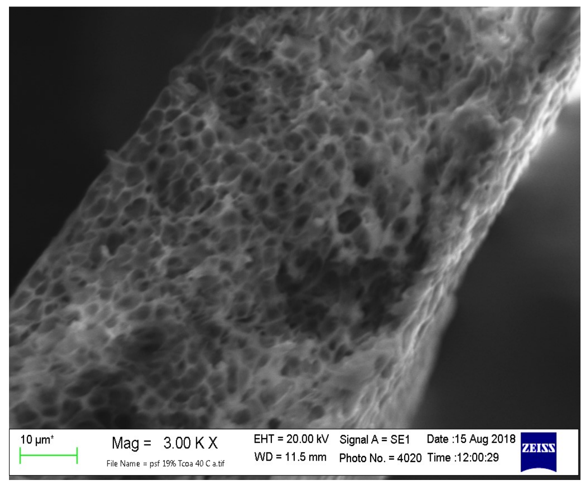

Figure 2. Photo SEM (Scanning Electron Microscopy) membrane PSfDMF19% Coagulation water bath temperature 40° C

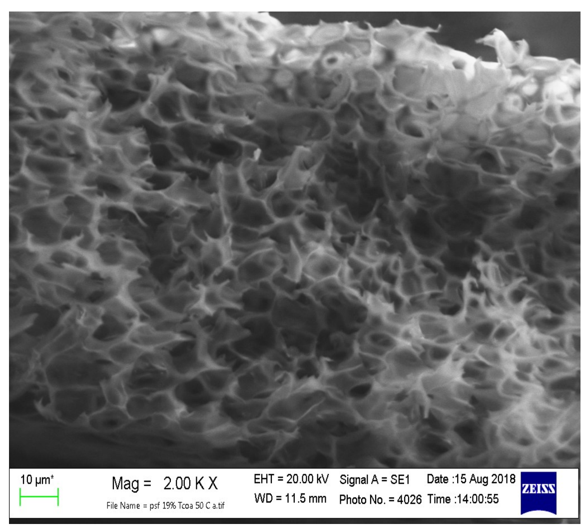

Figure 3. Photo SEM (Scanning Electron Microscopy) membrane PSfDMF19% Coagulation water bath temperature 50°C

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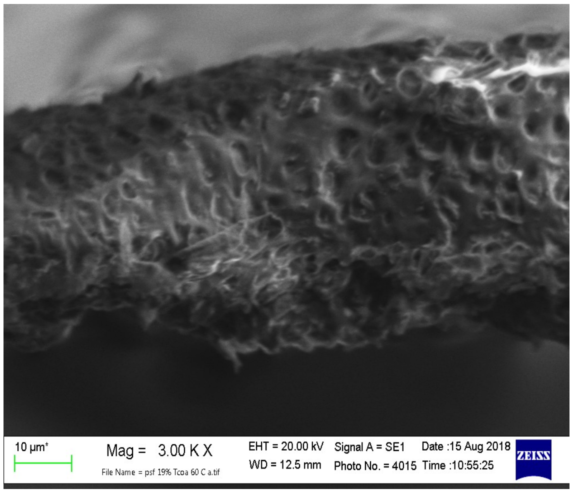

Figure 4. Photo SEM (Scanning Electron Microscopy) membrane PSfDMF19% Coagulation baking temperature 60°C

The Influence of coagulation water bath temperature on membrane performance

Permeability of each membrane Based on the experimental results obtained PSFDMf permeability values 5 minutes 10.7 (cm3/cm2.det.Psia) x10-5 and permeability values PSFDmf 10 minutes 198,1 (cm3/cm2.Det.Psia) x 10-5 and PSF DMf 15 minutes 70,4 (cm3/cm3.det.Psya) X 10-5 of the three results permeation coefficients above have increased and decreased due to the presence of leakage in the membrane and porous obstruction there is polarization [11]

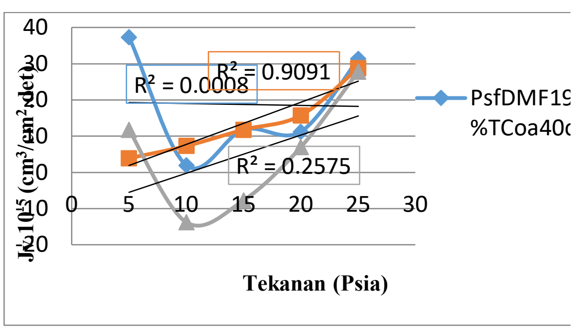

Figure 5. Relationship between operating pressure and flow on pure water supply

In Figure 5, you can see the influence of flux on the operating pressure on each membrane using pure water supply. In Figure, you can also see the trend of the increase in the price of the flux as the operational pressure increases, while in Figure 5, you can view the effect of the flow on the operation pressure on the individual membrane by using the liquid waste supply of PKS. It can be explained that pressure is a driving force for the Ultrafiltration process (UF) so with an increase in the operating pressure, the total flow increases as described in the following equation.

Jtot = LP (ΔP – σ Δπ)(Mulder, 1996)

The high total flow is due to the increasing operating pressure and flow rate and causes the dissolved substance to be carried. The samples taken in this experiment were PSfDMF PSf DMF19% Temperature Coagulation Bak 40°C, PSfDMF19 % Temperature coagulation bak 50°C and PSfDF19% Coagulation Bak Temperature 60°C with the lowest operating pressure condition of 5 Psia and the highest 25 Psia. For membrane water supply PSfDMF19% Temperature Coagulation Bat 40oC has the lowest flow value at 10 Psia pressure is 1,9639 x 10-5 cm3/cm2.det, whereas the highest flux value at 5 Psia is 37,3496 x 10 - 5 cm3/ cm2.det. For pure water input PSf DMF19 % Temperature coagulation bat 50°C has a lowest flow value at a pressure of 5 psi is 3,9337 x 10 to 5 cm^3 / cm^2.de, where the highest flow value on a pressure from 25 psia was 28,8335 x 10 and 5 cm^3.det.

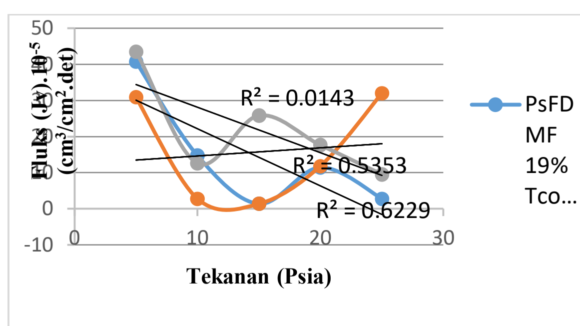

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Figure 6. Relationship Between Operating Pressure and Flux on Wastewater POME Feed

On the liquid waste feed PKS took a membrane sample At PSfDMF19% Temperature Coagulation Bak 40 oC has the lowest flow value at pressure 15 Psia is 1,4036 x 10-5 cm3/cm^2. det, whereas the highest flux value at 5 Psia pressure is 40,7230 x 10 - 5 cm3/ cm2.det. For liquid waste input PKS at PSf DMF19 % Temperature coagulation bak 50°C had the lowest flow value on pressure 15 psia is 1.4036 × 10 - 55 cm^3/CM^2. det while the highest flow rate at pressure 25 Psia was 32,0181 x 10 5 cm33/cm^{2}de**t.**:

CONCLUSION

The optimal operating conditions obtained from the wastewater treatment of the POME is the membrane PSfDMF19% 50oC at P = 25 psia with flow value (Jv) = 53,8452 x 10-5 cm^3/cm^2.det, permeability (Lp) = 2,708 x10-5 cm^3 / cm^2.det.psia, and rejection (R) = 96,2722%.

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