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By Amrifan Saladin Mohruni

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Mechanical Properties membrane Polyethersulfone (PES) With Reinforcement Silver Nitrate

Ahmad Zamheri[1] , Syamsul Rijal[1], . Zainal Burlian[2], Amrifan Saladin Mohruni[2], Dewi Puspita Sari[2], Agung Mataram[2]

[1](*Department of Mechanical Engineering, Politeknik Negeri Sriwijaya, South Sumatera, Indonesia)*
[2.] *(Department Mechanical engineering, Universitas Sriwijaya, South Sumatera, Indonesia)*

Abstract:
This research will be used as raw material for the manufacture of polymer membrane of Polyethersulfone (PES). Properties of a membrane are known about the characteristics of the membrane which can figure out the effectiveness and efficiency of a membrane that is created by the presence of parameter testing. Study of the parameters used, namely tensile strength, microstructure, and permeability of the membrane. This membrane is created using three different aqueous concentrations of Polyethersulfone (PES) (20%, 22.5%, 25% by weight) with the addition of concentrations of silver nitrate (AgNO3) a 1% weight and N, N-Dimethylformamide (DMF) as a solvent.The membrane formation method was the phase inversion . The method used was the phase inversion, in which the polymer, reinforcement, and solvent were mixed homogeneously for approximately 2-3 hours, and the membrane was directly printed on a glass plate.Three tests were conducted for membrane formation: tensile test, microscopic test using scanning electron microscope, and flux value test using clean water permeability (CWP). This study concluded that membrane expansion by increasing the concentration of polyetherculphons at concentrations of 20 wt%, 22.5wt% and 25wt%, and 1wt% Silver nitrate could increase the tensile stress and pore density on the membrane surface.

Key Word*: membrane; Polyethersulfone; Silver Nitrate; N,N Dimethylformamide, Tensile Strength; SEM; Clean Water Permeability.*

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I. Introduction

Water is a very important requirement for humans. The rate of population growth is also directly proportional to water demand, but inversely proportional to the ability of land to provide a source of cleanwater[1]. Currently, the technology in water purification processes such as reverse osmosis is the most classy process as it can perform energy efficiency. One of the most widely used materials is composite membranes such as brackish water desalination applications, seawater, freshwater softening, organic matter removal, pure wastewater purification, and advanced wastewater purification[2]. In membrane development, fouling control is a competitive and challenging step in membrane development, as studies have shown that increasing membrane hydrophilicity reduces the hydrophobicity between foul in the feed and the membrane surface.

Although Polyethersulfone (PES) has good thermal and mechanical stability, PES has limitations in its hydrophobic properties that cause high water permeability and fouling[3]. In many studies, Polyethersulfone has proven its efficiency in nanofiltration, gas separation, and other wastewater purification. [3]. The development of membranes using polyethylene polymers with silver nitrate as reinforcement has been widely used. This is done by adding a reinforcing matrix, namely silver nitrate. Silver nitrate has the properties of a colorless, odorless, crystalline solid, and is one of the low costs in membrane formation [4].In the formation of membranes with polyethersulfone polymers with silver nitrate as reinforcement requires a solvent to dissolve the homogeneous bond between the two materials. Solvent N,N Dimethylformamide combines extraction, distillation and reverse osmosis.[5]

At concentrations of 20% by weight, 22.5% by weight, and 25% by weight. This membrane formation aims to determine the value of the maximum tensile strength of the membrane, the surface of the membrane produced in microscopic tests using a scanning electron microscope, and the value of the flux generated by the membrane. With several series of tests and concentration limits used, it is hoped that the results obtained are that the membrane has better mechanical and microscopic properties.

II. Material And Methods

When developing membranes, manufacturing and printing membranes, as well as testing the permeability of clean water, they were carried out at the Department of Mechanical Engineering Masters, Faculty of Engineering, Sriwijaya University, South Sumatra, Indonesia. The materials used during the test were Polyethersulfone polymer with a concentration of 20wt%, 22.5wt%, 25% wt, Silver nitrate with a concentration of 1wt%, and the solvent was N,N Dimethylformamide.

The method in question is mixing materials to produce a membrane with a homogeneous mixture of materials. The membrane formation method used is polyetherculfon, silver nitrate and DMF solvent, mixing is done by stirring the mixture without a specified time limit. In this study, stirring lasted about 4-6 hours, so that the membrane formed and mixed evenly. Then the membrane is printed using the phase inversion method and then immersed in water. The resulting membrane is a flat sheet of printedmembrane.

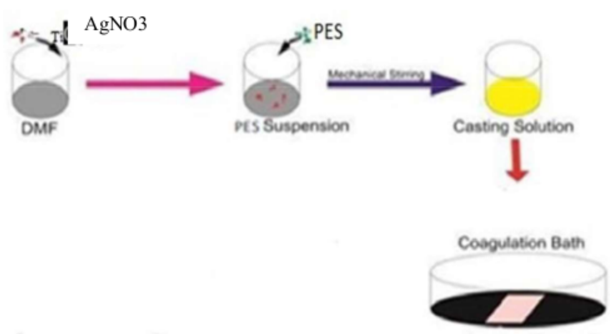

Figure 1 membrane manufacturing process.

After the forming process is carried out, the membrane that has been formed on a flat sheet is made by forming a membrane sample according to the tests carried out. In this study there were three tests carried out. They are tensile test, microscopic test, and clean water permeability test.

Tensile test:

This tensile test was carried out to determine the mechanical properties of the membrane. Prior to membrane testing, the test sample was first measured according to the standard. The test equipment used is a tensile testing machine WP 310 Gunt Hamburg Material Testing Machine. The sample used in this tensile test consists of 9 samples. There were three samples for each concentration of polyethylene polymer which had been mixed with silver nitrate and DMF. Each concentration used in the test was 20wt% with three samples, a concentration of 22.5wt% with three samples, and a concentration of 25wt% with three samples.

Figure 2. Tensile Testing Equipment Model WP 310 Gunt Hamburg Material Testing Machine

Test Scanning Electron Microscope

SEM is an electron microscope designed to observe and analyze the surface of materials directly. An instrument for analyzing the surface of a material. The SEM test was carried out at one of the campuses in Bandar Lampung, namely the University of Lampung. The sample taken is 1 sample for each concentration. The device used is the Zeiss EVO 10 I Scanning Electron Microscope (SEM). The results can be seen in Figure 4-2. 4-3 and 4-4 with 5000x . magnification

Figure 3. Scanning electron microscope test equipment

Clean Water Permeability Test:

This test aims to measure the flux parameters for the formation of fouling membranes. This test was conducted in Mechanical Engineering, Faculty of Engineering, Sriwijaya University, Palembang. The tool used is a clean water permeability device that uses a 1 bar pressure pump. The membrane sample used in this test is 56.2 cm in diameter or with a circular radius of 28.1 m, where the collected water will flow through pipes. The water passes through the faucet for 0.694 hours and will record how much water is discharged from the pipe into the measuring cup. This test uses 1 sample for each polymer concentration of polyethersulfone and silver nitrate.

Figure 4. Clean Water Permeability

III. Result

Tension Test

Table 1 Membrane PES 20wt%, $AgNO_3$1wt%, and DMF

Specimen	Material Composition (% by weight)			Area (mm2)	Max Load (kN)	Tensile Stress (kN/mm2)
	PES (gr)	DMF	$AgNO_3$(gr)			
A1	10.00	39.90	0.10	1.2	0.011	0.0092
A2	10.00	39.90	0.10	1.2	0.011	0.0092
A3	10.00	39.90	0.10	1.2	0.012	0.0100
Average Maximum Tensile Stress					0.011	0.00946667

Table 2 Membran PES 22.5wt%, $AgNO_3$ 1wt%, dan DMF

Specimen	Material Composition (% by weight)			Area (mm2)	Max Load (kN)	Tensile Stress (kN/mm2)
	PES (gr)	DMF	$AgNO_3$(gr)			
A1	11.25	38.64	0.11	1.2	0.012	0.0100
A2	11.25	38.64	0.11	1.2	0.014	0.0116
A3	11.25	38.64	0.11	1.2	0.015	0.0125
Average Maximum Tensile Stress					0.013667	0.01136667

Table 3 Membran PES 25 wt%, $AgNO_3$ 1wt%, dan DMF

Specimen	Material Composition (% by weight)			Area (mm2)	Max Load (kN)	Tensile Stress (kN/mm2)
	PES (gr)	DMF	$AgNO_3$(gr)			
A1	12.50	37.38	0.12	1.2	0.012	0.0100
A2	12.50	37.38	0.12	1.2	0.016	0.0133
A3	12.50	37.38	0.12	1.2	0.015	0.0125

Average Maximum Tensile Stress	0.014333	0.01193333

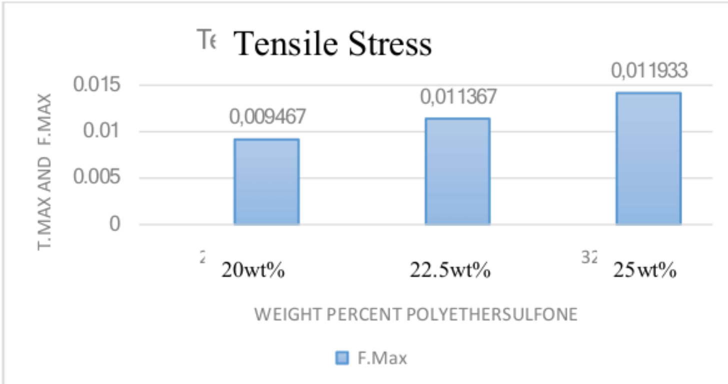

Figure 5-Graph of Tensile Stress Increase of Polyehersulfone

Microscopic Test

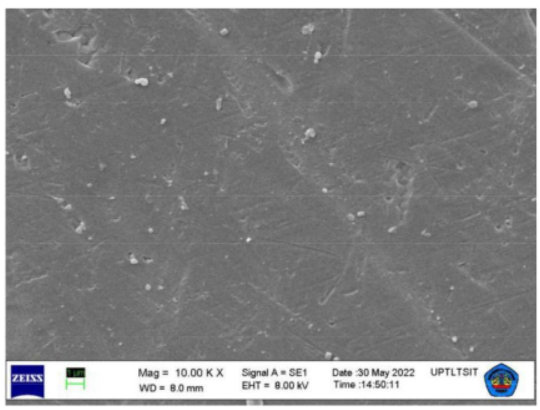

Figure 6. SEM results for PES 20wt%, NN-dimethylformamide and $AgNO_3$ for Magnification 5000x

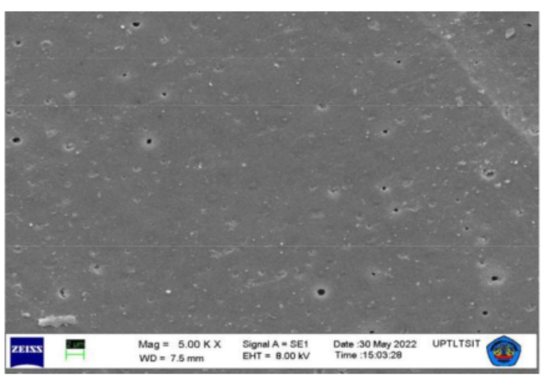

Figure 7 SEM results for PES 22.5wt% , NN-dimethylformamide, and $AgNO_3$ for Magnification 5000x

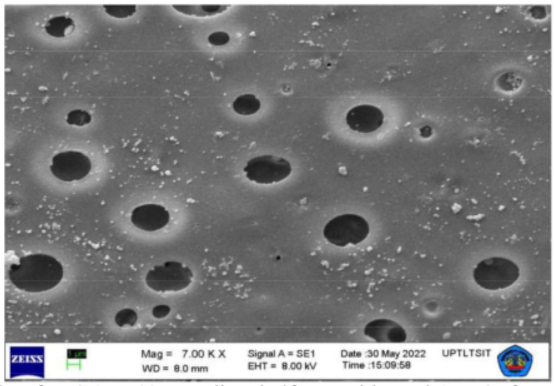

Figure 8. SEM results of PES 25wt%, NN-dimethylformamide, and $AgNO_3$ for Magnification 5000x

Clean Water Permeability Test

Membranes were tested at a pressure of 1 bar per hour and ambient temperature. The test was conducted at the Department of Mechanical Engineering, Sriwijaya University. Each sample was tested using a clean water permeability device, with the aim of finding out the flux value of each polymer concentration produced for 0.5 h. To analyze the results as in table 4-4. With the provision of a dead-end system with an effective membrane area of 18.08 cm^2 was used to analyze the performance of the prepared membrane. the following test results:

Table 4 Tire Test Results using CWP

No	Membrane	Volume Permeat (L)	Membrane area (m^2)	Time (h)	Pressure (Bar)	Flux L/m^2.h.bar
1	PES 20wt%	1	0.0025	0.694	1	3.2266
2	PES 22.5%	1	0.0025	0.694	1	2.5813
3	PES 25%	2	0.0025	0.694	1	2.3393

IV. Discussion

Based on the table 1, table 2, table 3 and figure 5, the results obtained are at a PES concentration of 20 wt%, and the average tensile stress value is 0.00946 kN/mm2. In membranes with a PES concentration of 22.5wt%, the average maximum tensile stress was 0.011366 kN/mm2, while the average maximum tensile stress at a concentration of 25wt% was 0.011933 kN/mm2. Based on the data, it is concluded that the average value of the highest maximum tensile stress is at a concentration of 20wt%, which is 0.00946kN/mm2. 0.00946 kN/mm2, while the lowest maximum load value and maximum stress value were at 20% concentration at 0.011 kN and 0.00946 kN/mm2.

Microscopic test results (Figure 6-8) PES membranes, NN-dimethylformamide, and $AgNO_3$ has as a pore shape with a homogeneous size. Based on concentrations of 20wt%, 22.5wt%, and 25wt%, it was shown that membranes with concentrations of 20 wt% had less homogeneous pore surface sizes than membranes at concentrations of 25wt%. The higher the concentration of Polyethersulfone contained in the membrane, the greater the pore density formed on the membrane. Increased porosity causes increased membrane hydrocitivity [6].

At clean water permeability test shown that the greater the concentration of PES polymer added, the more pore density will occur, which causes the flux value or water flow rate to decrease. According supported by research conducted by Eryildiz and colleagues that membranes with high hydrophilicity have higher membrane stability. When hydrophobic membranes are tested for water filtration, the mass water transfer will be significantly reduced, and consequently, the flux permeability of the membrane will be reduced[7]

V. Conclusion

Based on the results of tests conducted on Polyetersulfon Membrane Formation (PES) with the addition of the addictive substance Silver Nitrate ($AgNO_3$), it is concluded that development of membrane formation with polyethersulfone polymers with 20 wt%, 22.5wt%, and 25 wt% and silver nitrate with concentrations of 1wt% can be carried out. In the tensile test, Polyethersulfone and silver nitrate membranes showed a higher 4 maximum tensile stress value with a value of 0.00100 kN/mm2 at a concentration of 25wt%, and the lowest maximum tensile stress value occurred at a concentration of 20wt% with a value of 0.011 kN/mm2. In testing the maximum water flow rate value on the membrane, which is at a concentration of 20 wt% of 3.2266 L/ m2.h.bar, while the lowest water flow rate value is at a concentration of 25wt% which is 2.3393 L/ m2.h.bar

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