CEJOTER: Chelo Journal of Technology Development f Engineering
Vol. 1, No. 2, March, 2024, pp. 88 – 95
ISSN (print) 3026-5223 ; ISSN (online) 3026-3395

MANUFACTURING CERAMIC MEMBRANES FROM A MIXTURE OF ZEOLITE AND KAOLIN USING RICE HUSK CHARCOAL ADDITIVES

Muhammad Fikra Andeswan[1]*, Elfiana[1], Pardi[1]
[1]Department of Chemical Engineering, Lhokseumawe State Polytechnic, Lhokseumawe City Punteut, Blang Mangat, Lhokseumawe City, Aceh 24301, Indonesia
*E-mail: andesmuhammad13@gmail.com

ABSTRACT

One of the easy-to-apply ways to solve water purification problems is by making filters. Currently, clean water treatment with membrane technology is a very promising treatment process with excellent quality and suitable for many advantages. The purpose of this study is to determine the effect of variations in the composition of materials, namely zeolite, clay, and rice husk charcoal. At the stage of making membranes, zeolite and kaolin variations were carried out. For zeolite: kaolin variations are 75: 10, 55 : 25, 35 : 35, 25 : 55, and 10: The results of the study obtained quality that meets the SNI 01-3553-2006 requirements such as an average pH of 7.48, an average TDS of 98 mg/L, and an average turbidity of 0.914 NTU. The best comparison is 35% Zeolite: 35% Clay with the addition of 15% rice husk charcoal.
Keywords: Ceramic Membrane, Sintering, Swamp Water, Water Filter

INTRODUCTION

Separation technology using membranes has now become widespread in various circles, both academic and industrial. The success of the membrane separation process also depends on the quality of the membrane. The need for clean water is increasing, making it necessary for some people to try and look for other alternatives to fulfill their need for clean water. Currently, clean water treatment with membrane technology is a very promising treatment process with excellent quality and is also suitable for drinking water treatment in developing countries because it has many advantages. Among the advantages of membrane technology is that the quality of the water produced is very good, uses fewer chemicals, is able to remove pollutants and also does not require a large area.

Swamp water is a land of standing water, scientifically speaking, which occurs continuously or seasonally due to obstructed drainage and has special physical, chemical and biological characteristics. There is also another opinion which says that swamps are all kinds of muddy land made naturally or man-made by

mixing fresh water and sea water, including sea areas where the water is less than 6 meters deep at low tide, namely swamps and tidal land. [2]

Membranes based on their material source can be grouped into natural membranes and synthetic membranes. One of the membrane technologies that is starting to be developed is a porous membrane whose material is ceramic. Ceramic materials have small cavities that are able to pass fluids, so that ceramic materials can be formed into membranes as water filter media, known as ceramic membranes.

Research conducted by Saifuddin (2018) has utilized a mixture of zeolite and clay as an organic membrane to simulate river water samples. The total weight of the membrane is 700 grams. The variation in this research is the mass ratio of clay: natural zeolite, namely, 90%: 10%, 80%:
20%, 70%: 30%, 60%: 40%, & 50%: 50%.

The results for the pH parameters with the filtration membrane showed that the pH was in accordance with the standard qualifications for class A drinking water, after filtering it increased. For the parameters TDS, Turbidity, Fe & Mn levels, which were analyzed experienced a decrease in concentration.

Elfiana, et al (2019) conducted research on the Characterization of Inorganic Hybrid Membranes Mixed Zeolite and Activated Clay with PVA Adhesive using the sintering method for colorless peat water. The research results show that the higher the sintering temperature, the smaller the density, the greater the membrane porosity, and the smaller the membrane pore size. The research results obtained by the inorganic hybrid membrane (MHA-ZC) were classified as a microfiltration (MF) membrane with a pore size of 1.2μm, density of 0.811 gr/cm3, porosity of 45%, membrane permeability of 313.57 L/m².h, water color rejection coefficient peat of 90.59%. This research was carried out to make ceramic membranes using zeolite, kaolin, rice husk charcoal, white Portland cement, and PVA using the sintering method. It is hoped that the results of this research will reveal the characteristics of the resulting membrane based on morphology testing with a Scanning Electron Microscope (SEM) so that it can be continued to test the quality of membrane performance in water treatment.

METHOD

Materials used include; natural zeolite, clay/kaolin, portland cement, polyvinyl alcohol, rice husk charcoal, swamp water, distilled water.

The tools used include; analytical balance, 100 ml balance, oven, 100 ml beaker glass, basin, spoon, stopwatch, sample bottle, furnace, pH meter, stirrer, module mold, crusher, set of prototype tools.

CEJOTER: Chelo Journal of Technology Development f Engineering
Vol. 1, No. 2, March, 2024, pp. 88 – 95
ISSN (print) 3026-5223 ; ISSN (online) 3026-3395

Membrane Mold Making

Stainless steel was prepared to make a tube-shaped membrane mold casing with a height of 250 mm, an outer diameter of
69.83 mm and an inner diameter of 27.5
mm. Efforts are made to make the mold as well as possible and as neatly as possible during welding, so that during the printing process the membrane is not damaged so that the appropriate size is obtained.

Production of Bacterial Cellulose

Put 2 liters of old coconut water, 10 grams of urea and 20 grams of glucose into the Jartest tool. Add 10 ml of glacial acetic acid. Next, 200 grams of Acetobacter xylinum starter was added. Then oxygen flows into the Jartest device. Then fermented for 7 days. The medium was rotated in a Jartest tool with a rotation speed of 100 rpm.

Preparation of Membrane Mixtures

Zeolite, kaolin, rice husk charcoal, white portland cement, and PVA are crushed using a crusher and sifted using a vibrating screen to obtain a uniform size of 100/120 mesh.After obtaining a uniform particle size, the ingredients are weighed using a digital balance according to the composition variations that have been determined.

Making Membranes Using the Sintering Method

A mixture of zeolite + kaolin + rice husk charcoal + portland cement + PVA, weighed according to the specified composition. Put all the mixed ingredients into a container, then stir the mixture by adding water little by little until a paste forms. Membrane molding is done by pouring the mixture into a tube-shaped membrane mold. Then remove the membrane from the mold and dry it using sunlight at a temperature of 30oC for 3 x 24 hours, a temperature of 70oC for 4 hours, and sintering in a furnace at a temperature of 800oC for 4 hours which aims to improve the quality of the ceramic membrane as a filter. Then the membrane is removed from the furnace and cooled to room temperature.

Operating Procedures for Swamp Water Treatment with Ceramic Membranes

The membrane tube is inserted into the housing and installed into the equipment circuit. Check that the valve is completely closed. Swamp water that has been

CEJOTER: Chelo Journal of Technology Development f Engineering
Vol. 1, No. 2, March, 2024, pp. 88 – 95
ISSN (print) 3026-5223 ; ISSN (online) 3026-3395

characterized is put into the feed water tank up to the 21 L mark and the water level is maintained above the effluent pipe. The pump is turned on, and open tap V1, leave it until the pump is stable. Set the pressure at PG1 (membrane feed pressure) at 0.5 bar by adjusting the openings of V2 (membrane feed valve) and V3 (retented valve), and leave V4 (permeate valve) open at 45 degrees. The flow process was carried out continuously for 15 minutes. Repeat stage 5 for pressure 1.0 to 2.5.

TDS (Total Dissolved Solid) Test Using a TDS Meter

Turn on the device (press the ON/OFF button). Calibrate the tool first before use. Place the sample in a 200 ml beaker glass. Dip the TDS meter into the beaker containing the sample. Read the value that appears on the TDS meter.

Test the Degree of Acidity (pH) Using a pH Meter

Prepare the sample to be analyzed. Calibrate the tool first before use. Place the sample in a 200 ml beaker glass.Dip the pH meter into the beaker containing the sample.Read the value that appears on the pH meter.

Turbidity Test Using a Turbidity Meter

Prepare the sample to be analyzed. Calibrate first before use. The sample is put into a turbidity analysis bottle. Turn on the turbidity meter. The bottle containing the sample is inserted into the turbidity meter. Look at the value read, note it down.

RESULTS AND DISCUSSION

Code	Pressure	TDS	pH	Turbidity	Temperature
	bar	Mg/L		NTU	°C
M1	0.5	100	7.7	1,118	28.5
	1.0	101	7.7	1,115	28.4
	1.5	102	7.8	1,155	29.1
	2.0	102	7.9	1,174	28.4
	2.5	103	8.0	1,191	28.5
M2	0.5	98	7.6	1,022	29.1
	1.0	99	7.6	1,030	28.6
	1.5	99	7.7	1,063	29.5
	2.0	101	7.7	1,062	29.4
	2.5	101	7.9	1,081	29.5
M3	0.5	96	7.3	0.859	29.3
	1.0	98	7.4	0.891	28.3
	1.5	98	7.4	0.901	28.7

CEJOTER: Chelo Journal of Technology Development f Engineering
Vol. 1, No. 2, March, 2024, pp. 88 – 95
ISSN (print) 3026-5223 ; ISSN (online) 3026-3395

	2.0	99	7.6	0.945	29.3
	2.5	99	7.7	0.975	28.5
	0.5	102	7.9	1,208	28.8
	1.0	104	7.9	1,233	28.3
M4	1.5	105	8.0	1,255	28.3
	2.0	106	8.0	1,259	29.2
	2.5	107	8.1	1,276	28.5
	0.5	103	8.2	1,243	28.5
	1.0	105	8.4	1,248	28.4
M5	1.5	106	8.6	1,251	29.1
	2.0	106	8.5	1,273	29.2
	2.5	108	8.7	1,301	28.3

Ceramic membranes are a filtering medium with a separation principle based on differences in molecular size and shape. In this research, the ceramic membrane was based on zeolite, kaolin, rice husk charcoal and the addition of Portland cement and PVA as adhesive. In this ceramic membrane, the process used is a filtration process. The filtration process is a separation method for separating solid substances from liquids using porous media. During the combustion process, the membrane will shrink and the pores in the membrane will open. In this research, kaolin functions as a material builder, where the longer the firing process, the stronger the clay will be. Rice husk charcoal is an alternative material used to absorb a number of impurities in water.

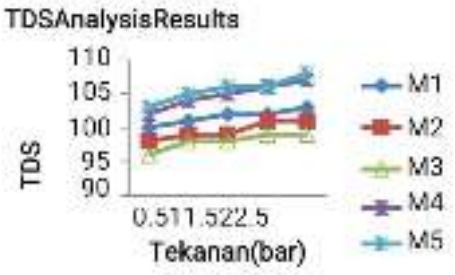

Figure 1. TDS Analysis Graph

On the effect of the composition of clay, zeolite and rice husk charcoal on TDS, the results showed a decrease in water content, where the total dissolved solids for the initial sample was 369 mg/L. Then, after filtration with various membranes, a decrease occurred. For the first membrane (M1) the average result was 101.6 mg/L. Then testing for the second membrane (M2) the average result was 99.6 mg/L. For the third membrane (M3) the average result was 98 mg/L. On the fourth membrane (M4) the average result was 104.8 mg/L. Finally, for the fifth membrane test (M5), the average result was 105.6 mg/L. The TDS analysis results obtained did not exceed the quality requirements of SNI 01- 3553-2006, namely 500 mg/l.

CEJOTER: Chelo Journal of Technology Development f Engineering
Vol. 1, No. 2, March, 2024, pp. 88 – 95
ISSN (print) 3026-5223 ; ISSN (online) 3026-3395

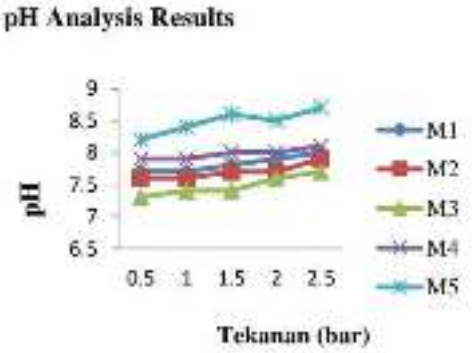

Figure 2. pH analysis graph

The initial sample of swamp water before simple filtration had a pH of 3.2. Then, after filtration and adsorption, the swamp water experienced an increase in pH from acid to a pH standard suitable for use in accordance with the decree of PERMENKESNo.492/Menkes/Per/IV/2010 where clean water standards for group A range from 6.5 – 8.5. The pH of this membrane is able to change the atmosphere of the water so that it becomes suitable for use. The degree of acidity increased in the material with the first membrane number (M1) with an average result of 7.82. Then on the second membrane (M2) the average result was 7.7. Followed by the third membrane assessment (M3) with an average result of 7.48. Then the fourth membrane (M4) obtained an average result of 7.98. Then for the fifth membrane composition (M5), the average result was 8.48. The pH analysis results obtained are in accordance with the quality requirements of SNI 01-2553-2006, namely 6.5 – 8.5.

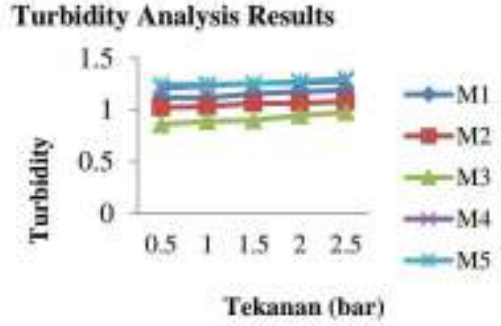

Figure 3. Turbidity Analysis Graph

The next physical parameter tested is the effect of material composition on turbidity. The effect of material composition on turbidity is that the results decrease. In the initial sample the test result was 7.054 NTU. Then, after going through the filtration and adsorption process on the membrane, the results for the first membrane (M1) were an average of 1,150 NTU. Then for the second membrane (M2) the average value was 1.051 NTU. For the third membrane (M3) the average result was 0.914 NTU. Then the fourth membrane (M4) with an average of 1,246 NTU. Finally, the fifth membrane (M5) obtained an average

result of 1.263 NTU. The turbidity analysis results obtained do not exceed the quality requirements of SNI 01- 3553-2006, namely 5 NTU.

CONCLUSION

1. The smaller the size of the clay compared to the zeolite, the better the reduction in turbidity, TDS (Total Dissolved Solid) and pH parameters.
2. The best ceramic membrane performance was obtained at a pressure of 0.5 bar with an M3 membrane composition (with the addition of 150 grams of rice husk charcoal) with an average pH value of 7.48, an average turbidity value of 0.914 NTU, and an average TDS value of 98 mg/L.

ACKNOWLEDGEMENTS

The author would like to thank all parties involved in writing this article, both directly and indirectly.

REFERENCES

[1] Afrianty, et al. 2012. Acid Mine Waste Water Treatment Using Ceramic Membrane Technology Journal of Chemical Engineering, 18 (3).
[2] Agmalini, S., Lingga, N. 2013. Improving the Quality of Swamp Water Using Ceramic Membranes Made from Clay and Coal Fly Ash. Journal of Chemical Engineering.
[3] Anwar Ma'ruf, et al. 2019. Making Ceramic Membranes from Natural Zeolite and Clay and Their Applications. UM Purwokerto Press.
[4] Elfiana, E., Fuadi, A. 2019. Characterization and Selectivity Study of Acid-Base Activated Clay- Zeolite Based Microfilter Membranes Based on Peat Water Organic Compound Parameters. In Proceedings of the Lhokseumawe State Polytechnic National Seminar (Vol. 3, No. 1, p. 129).
[5] Elfiana E, et al. 2019. Characterization Study of Inorganic Hybrid Membrane of Mixed Activated Zeolite and Clay with PVA Adhesives using Sintering Method for Coloress Peat Water. IOP Conference Series: Materials Science and Engineering.
[6] Elfiana.E, Sariadi., Jannah Raudhatul, 2018. Making an Inorganic Membrane Mixture of Natural Zeolite and Clay with the Addition of White Portland Cement and PVA Using the Sintering Method. Proceedings of the Lhokseumawe State Polytechnic National Seminar.
[7] Hidayat, 2006. Manufacturing and Characterization of Nanofiltration Membranes for Water Treatment. Chemical Engineering, Diponerogo University, Semarang.
[8] Kurniawan Mochammad, Setyo Budi Agus, Budi Susili Anggoro, 2018. Making Clay-Based Porous Ceramic Membranes with Variations of Zeolite

and Adding Coconut Shell Activated Charcoal and Polyvinyl Alcohol. State University of Jakarta. Pages 279 - 282.

[9] Mohtor, NH, et al (2017). Investigation on the effect of sintering temperature on kaolin hollow fiber membrane for dye filtration. Environmental Science and Pollution Research, 24(19), 15905–15917.