Poll Res. 40 (2) : 646-650 (2021)

ISSN 0257–8050

THE COMBINATION OF BAGASSE AND CHITOSAN AS A MEMBRANE IN ELIMINATION OF CROSSFLOW BATIK WASTE POLLUTANT PARAMETERS

FIRRA ROSARIAWARI[1]*, FATIA HEDIANA[1] AND WAHID DIANBUDIYANTO[2]*

[1]Department of Environmental Engineering, Faculty of Technology UPN "Veteran" Jawa Timur, Surabaya, Indonesia

[2]Department of Biology, Program Study of Environmental Engineering, Faculty of Science and Technology, Universitas Airlangga, Surabaya, Indonesia

(Received 30 August, 2020; Accepted 9 November, 2020)

ABSTRACT

Batik waste is an industry that produces liquid waste that has levels of chemical oxygen demand (COD), total suspended solids (TSS) and colors that require treatment first so as not to cause pollution to surface water. Processing using a filtration membrane is one of the selected treatments. The advantages of filtration processing using membranes are low energy consumption, do not require a large area, and the process is easy to combine with other separation processes as well as various raw materials for making membranes. The membranes used in this research were chitosan and bagasse. The crossflow flow is chosen because it reduces the fouling that occurs. Previously, the coagulation-flocculation process was carried out as a pretreatment process for effectiveness in processing this home industry batik waste. Scanning electron microscope (SEM), Energy dispersive x-ray (EDX) was carried out to determine the morphology and elements contained in the membrane. Analysis of research parameters namely COD, TSS and color. Based on the research results the best COD rejection value was 42.67% and the value rejection to TSS removal was 64.29% and the best rejection value for color removal was 71.6% with a membrane of chitosan: PVA ratio 75%: 25% with a contact time of 20 minutes because the longer the filtration time, the greater the rejection value obtained.

KEY WORDS : Membranes, Bagasse, Chitosan, Colour, Crossflow

INTRODUCTION

The city of Sidoarjo is famous for its written batik industry. The high concentration of organic matter and synthetic dyes causes pollution, especially pollution in rivers, if treatment is not done first. Membrane technology is one of the processing methods used in treating batik liquid waste.

In this study, the aim of this research is to carry out batik waste treatment to reduce COD, TSS and color parameters and to determine the best combination of variations with membranes with bagasse and chitosan. In making this membrane using supporting materials, namely Poly Vinyl Alcohol (PVA), Polyethylene Glycol (PEG) to form a good membrane. According to research results (Sjamsiah, 2017) that the silica content contained in bagasse is ± 73.40%. Chitosan is one of the ingredients in the manufacture of filtration membranes. The chitosan-PVA-PEG combination is a mixture that has a high absorption capacity so that it can be used as a membrane in filtration. In this study, a membrane filtration technique was carried out using the pores of the membrane. After the filtration process the pores are getting smaller, the membrane is able to filter out the pollutants found in batik waste. Prior to the filtration process using the membrane, the coagulation flocculation process was carried out as a pretreatment. It is hoped that this process will provide effectiveness in overcoming the pollution problem caused by this batik waste.

MATERIALS AND METHODS

This research was conducted in a laboratory. One of the effective methods to reduce the pollutant parameters of batik waste before being disposed of into water bodies. Starting with the synthesis of the raw material into silica powder (SiO2) then added with PVA and PEG. Print the finished membrane. After the membrane is successfully formed, the filtration process with the membrane is continued to reduce the parameters. This filtration process uses waste that has gone through the pre-treatment process. Scanning Electron Microscope (SEM) - EDX is performed to determine the morphology and content of the membrane, UV-Visible spectrophotometer to determine the results of decreasing light intensity, gravimetric to determine the results of TSS reduction and Titrimetric to determine the results of COD reduction.

MATERIALS AND METHODS

Some of the materials used in this study. Bagasse, shrimp chitosan, Polyvinyl alcohol (PVA), Polyethylene glycol (PEG), NH_4Cl, NaOH, HCL, PAC. Equipment used in this study: 200 mesh sieve, furnace, magnetic stirrer, loops and mortals, analytical scales, oven, SEM-EDX and crossflow instruments.

Membrane Material Preparation

The bagasse is dried in the sun. After that, the bagasse is put into the oven to remove the moisture content. Then put the bagasse into the furnace at 275°C for 2 hours. Then the bagasse ash is pounded with a mortal and then sifted using a 200 mesh sieve. Then soak NaOH. The next process is the mixture in a magnetic stirrer with a speed of 110 rpm, add HCL to precipitate the silica then wash it using deionized water and silica in the oven so that the silica is completely dry

Solution manufacturing and membrane printing

Weighing silica powder and PVA with predetermined variables. Add 35 Ml 2-propanol then wait 30 minutes for a precipitate to form. Then, the liquid phase is discarded and the solid phase is poured into a beaker glass and then add 3.5 g of NH_4Cl which has been dissolved with deionized water. Then homogenized using a magnetic stirrer and allowed to stand until a precipitate is formed. At this printing stage, the separated sludge is mixed with PVA which has been weighed according to the variation and then adds PEG. Furthermore, the solution is applied to a magnetic stirrer to make it homogeneous. Then the mixture was printed and allowed to stand until completely dry at room temperature for ± 48 hours.

Crossflow Flow Membrane Testing

Waste that has gone through the pre-treatment process is flowed using a series of PVC pipes equipped with a pump and manometer that functions to regulate pressure. In this study, membrane testing was carried out for 20 minutes, i.e. every 5 minutes the resulting permeate was taken. In this study using cross flow because this flow can prevent fouling.

RESULTS AND DISCUSSION

Effect of Membrane Composition on COD Removal

After testing the membrane with crossflow flow, COD was analyzed. Chemical Oxygen Demand (COD) is the amount of oxygen needed to oxidize organic compounds that are chemically oxidized. This batik dyeing waste has high COD levels which can cause pollution in water bodies if it is not treated first.

Based on Figure 1, it can be seen that the largest rejection value is 42.67% with a chitosan: PVA ratio of 75%: 25% and a contact time of 20 minutes. The addition of chitosan in the membrane composition had an effect on the rejection value. The longer the filtration time, the greater the reaction value. The COD rejection value tends to increase with the

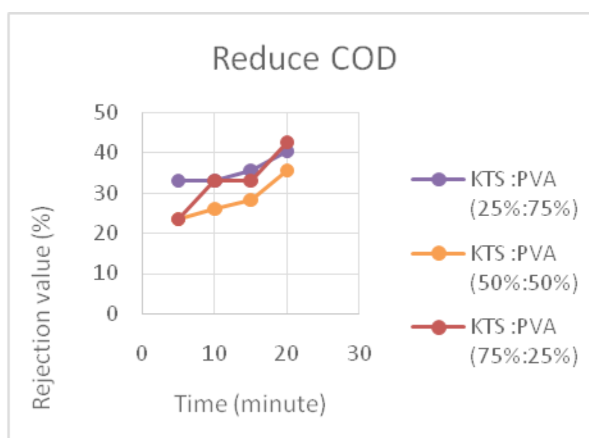


Fig. 1. Relationship between membrane variation and contact time on% COD removal

length of the filtration contact time. This is due to membraneblockage by the entry of waste pollutants into the membrane. The particles trapped in the membrane surface will reduce the pore size. The smaller membrane pores cause an increase in rejection value. This is supported by research (Pramitasari, 2017) which states that if the pores of the membrane are closed by the cake on the membrane surface, the membrane pores will be smaller so that it is more effective in increasing the COD rejection value.

The increase in chitosan composition reached the best composition with a chitosan: PVA ratio of 75%: 25% because the increase in the composition of more PVA would increase the membrane density and did not form pores which resulted in decreased COD rejection value. This is supported by research (Julian *et al.*, 2016) which states that the more PVA added will reduce the quality of the membrane so that the mass percentage of PVA must be truly stable, that is, it should not be less and no more than the mass of silica to produce an optimal membrane.

The optimum value of percent COD removal reached a COD concentration of 1996.8 mg/l, with the initial COD level after the pretreatment process of 3214.8 mg/l. However, this value still does not meet the quality standard for batik waste parameters according to the Governor of East Java Number 72 of 2013 where the maximum limit for COD parameters is 150 mg/l.

Effect of Membrane Composition on TSS Removal

The high and low TSS (Total Suspended Solid) value is useful for analyzing water bodies that are polluted due to waste and is very useful for evaluating water quality, as well as determining the efficiency of the

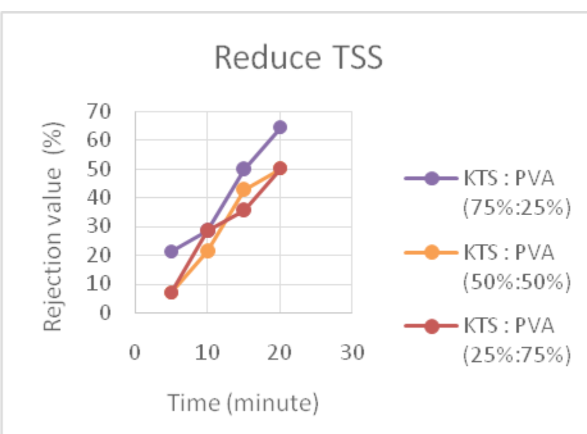


Fig. 2. Relationship between membrane variation and contact time on% TSS removal

treatment unit (Hidayat *et al.*, 2016).

The highest rejection value for TSS removal, namely 64.29%, was obtained from the variation of the chitosan: PVA membrane with a ratio of 75%: 25%. The increase in chitosan composition reached the best composition with a chitosan: PVA ratio of 75%: 25% because the increase in the composition of more PVA would increase the membrane density and did not form pores which resulted in decreased TSS rejection value. This is supported by research (Julian *et al.*, 2016) which states that the more PVA added will reduce the quality of the membrane so that the mass percentage of PVA must be truly stable, that is, no less and no more silica mass to produce optimal membranes.

This decrease in concentration indicates that the membrane has succeeded in eliminating a particle. The larger particle size, this is what allows a particle to be stuck on the membrane surface so that the TSS concentration decreases after passing through the membrane.One of the membranes with a mass ratio of bagasse with PVA 50%: 50% was torn at the 10th minute test so that no permeate was produced. This is supported by research (Julian *et al.*, 2016) also the composition of PVA should not be more or not by less to produce optimal membranes.The optimum value of TSS removal percent reached a TSS concentration of 50 mg/l, with the initial TSS level after the pretreatment process that was 140 mg/l. However, this value still does not meet thequality standard for batik waste parameters according to the East Java Governor Regulation number 72 of 2013 where the maximum limit for TSS 50 parameters is mg/l.

Effect of Membrane Composition on Color Removal

The perm-selectivity value of the membrane to the dye in batik waste was seen from the changes using a spectrophotometer of the resulting permeate. Perm-selectivity in holding a species in this case is the dye. The membrane is proven to be able to filter out the dark blue dye used in the batik coloring process. In this study, various combinations of membrane-forming materials were carried out on contact time. The percentage of color removal in a filtration membrane test can be referred to as the color rejection value. The percentage value of color reduction in batik wastewater through the membrane is as follows:

The process of reducing the color intensity of batik liquid waste after pretreatment was carried out

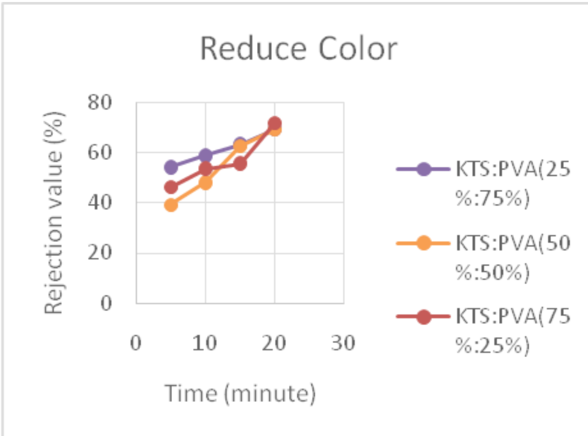


Fig. 3. Relationship between membrane variation and contact time for% color removal

using the membrane filtration method. The process of reducing this intensity is by flowing the waste through the membrane which has been placed in such a way with the adjustment of the tools then the waste that has passed through this membrane is collected and analyzed for its color intensity. The longer the contact time, the dye concentration decreases and causes rejection to increase. The highest rejection value for color removal, namely 71.6%, was obtained from the variation of the chitosan: PVA membrane with a ratio of 75%: 25%.

In general, membranes based on chitosan have high hydrolytic properties. This is possible because of the active functional groups present in chitosan such as OH^- and NH_3^+ groups which can form bonds with H_2O molecules. Chitosan consists of NH_2 and OH- groups which are alkaline groups, so that when the chitosan is in contact with the dye it has a tendency to bond. Meanwhile, the –Si-O-Si and –Si-O-R groups of chitosan have a tendency to bind to the active groups both owned by chitosan and dyes (Chatterjee *et al.*, 2010). The color used in the batik industry is synthetic color, namely naphtol.

The decrease in color intensity before and after going through the filtration process shows that the membrane has succeeded in reducing the color intensity of batik waste. However, in this study, the color intensity of batik wastewater was not completely clear, colorless, this indicates that the color of batik wastewater was originally dark gray to light gray.

Effect of Crossflow Flow on Membrane Performance

In this crossflow flow, only a portion of the water passes through the membrane which is called permeate, because the direction of flow in this crossflow is parallel to the membrane, so the formation of cake (accumulation of contaminants on the membrane) is relatively small compared to the dead end flow because the entire flow passes through the membrane which causes the membrane to receive a load. Which is heavy because the membrane functions as a filtration medium and the membrane is also passed by all water flows. In this study using a pressure of 1 bar because if the flow rate through the membrane is low, it makes the fluid more stable so that more contaminants are filtered into the membrane than if the flow pressure is large, the faster the flow will flow, the less chance the contaminants will be filtered into the membrane, the pressure applied to the feed stream that passes through the membrane will cause deformation to the membrane which causes the pore size of the membrane to widen and the resulting flux is even greater.

Membrane Morphological Analysis

Membrane morphological analysis was carried out by SEM. Before doing the analysis, make sure the membrane is dry. One way to find out the surface structure.

Figure 4 shows the SEM analysis result of the membrane before it is applied to batik waste with a magnification of 100x and the membrane after it is applied to batik waste. From the results of the SEM test above, it shows that there is a closure of the pores on the membrane that has been used, this may come from the batik waste sample after the pretreatment process.

EDX (Energy Dispersive Analysis X-Ray) analysis was also carried out to determine the component elements filtered on the membrane. Table 1 shows the element content after filtration. The composition of the elements contained in the membrane after filtration can be seen in Table 1

Table 1. Elemental content before filtration

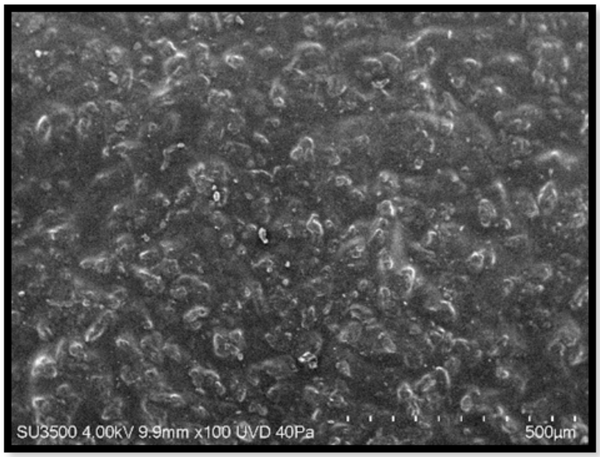
C	O	Al	Si	Cl
32.51	57.24	0.73	0.68	8.83

Table 2 shows the EDX results where the table shows that the constituent materials of the membrane contain elements such as O, Si, Al, C and Cl and the addition of Ca and Na elements to the membrane after filtration.

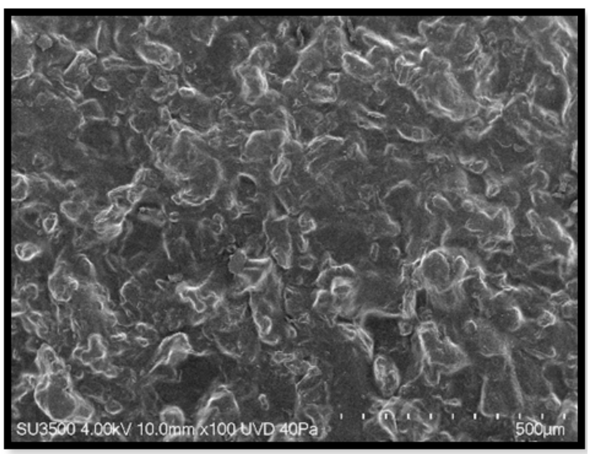
In Table 2 shooting was carried out at one point /

Table 2. Elemental content after filtration (%)

C	O	Al	Si	Cl	Ca	Na
33.42	57.37	0.81	0.64	5.5	1.37	0.88



(a)



(b)

Fig. 4. Membrane Morphology (a) Before and Membranes (b) After Filtration

spot from the test, it was obtained an indication of the presence of Na and Ca. There is sodium, which means that there are still impurities that are possible when washing silica in the silica synthesis process with less clean distilled water (less evenly) so that it still does not get pure silica. The addition of the element Ca to the membrane comes from waste pollutants inside the membrane.

CONCLUSION

Chitosan membrane can reduce COD by 42.67%, 64.29% for TSS reduction and 71.6% for reduction in color parameters. The effect of this crossflow flow causes relatively small cake formation because the direction of flow is parallel to the membrane so that the pressure obtained by the membrane is not too large which causes the membrane to tear quickly. The ratio of chitosan and PVA 75%: 25% is the best combination ratio for this study because the membrane is the most optimal in reducing batik waste pollutants.

REFERENCES

Chatterjee, S., Lee, M. W. and Wooa, S. H. 2010. Adsorption of congo red by chitosan hydrogel beads impregnated with carbon nanotubes. *Bioresour. Technol.* 101(6) : 1800-1806. https://doi.org/10.1016/j.biortech.2009.10.051

D. Hidayat, Rinawati, R. Suprianto, and P. Sari Dewi. 2016. Penentuan Kandungan Zat Padat (Total Dissolve Solid Dan Total Suspended Solid) Di Perairan Teluk Lampung | wati | Analit: Analytical and Environmental Chemistry. *Anal. Environ. Chem.* 1(1) : 36-46. https://jurnal.fmipa.unila.ac.id/analit/article/view/1236

E. B. S. and M. A. Nova Shintia Bokau. 2014. Sintesis Membran Kitosan Termodifikasi Silika Abu Sekam Padi Untuk Proses Dekolorisasi. *IJCS - Indones. J. Chem. Sci.* 3: 1. https://journal.unnes.ac.id/sju/index.php/ijcs/article/view/2866

Julian, J. 2016. Pengaruh Komposisi PVA / Kitosanterhadap Perilaku Membran Komposit PVA /Kitosan/Grafin Oksida yang Terikat Silang Asam Sulfat. 5(1) : 37-43. http://dx.doi.org/10.12962/j23373520.v5i1.15932

Pramitasari, N. 2017. Pemanfaatan Zeolit Dan Silika Sebagai Material Warna Limbah Cair Batik Zeolite and Silica as Material for Filter Membrane To Remove Color From Batik Wastewater. *J. Purifikasi.* 17(1) : 11-21. https://doi.org/10.12962/j25983806.v17.i1.45

Siswanto, A., Damayanti and Wahyuni, S. 2016. Penggunaanmembrankitosanuntukpenurunan COD dan BOD limbahcairkelapasawit. *Menara Perkeb.* 84(1) : 22-28. http://dx.doi.org/10.22302/iribb.jur.mp.v84i1.213

Sjamsiah, 2017. Sintesis Membran Silika Kitosandari Abu Ampas Tebu (Bagasse) *Al-Kimia.* 5(1) : 81-88. https://doi.org/10.24252/al-kimia.v5i1.2857.