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LAKE WATER TREATMENT OF PADENGAN PLOSO VILLAGE, LAMONGAN DISTRICT WITH FILTRATION AND ADSORPTION PROCESS

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ABSTRACT

The inhabitants of Pedengan Ploso Village, Lamongan Regency currently still use lake water that does not meet the requirements of clean water, especially for turbidity parameters. In this village, there are enough coconut trees whose shells are not used optimally. This study used adsorbent media of coconut shell charcoal by a batch and continuous process. To obtain optimal results of turbidity allowance, the filtration process was conducted using sand, which is also available quite a lot in this village. Then, the water adsorption process was carried out. In the batch process, size variations of the adsorbent used were: mesh of 8, 10, 20 and the adsorbent dose of 50 g/ 500 mL, 75 g/500 mL, 100 g/500 mL. The adsorption ability of batch process was measured from the value of x / m using Freundlich, Langmuir, and BET isotherms. In the continuous process, variations in media column height used were 7 cm, 14 cm and 21 cm. The adsorption ability of continuous process was measured by the kinetics constant (k1) and adsorption capacity (qo). From the results of the batch research, the maximum turbidity removal efficiency was 43.75% in the mesh of 10. From the results of continuous research, the maximum turbidity removal efficiency of 96.57% in the mesh of 10 and column height of 21 cm with kinetic constants value of k1 = 5.2474 lt / mg.hour and qo = 3.411 x 10-7 mg adsorbate/mg adsorbent.

KEY WORDS: Adsorption, Turbidity, Coconut shell, Kinetic constants

INTRODUCTION

The residents of Padengan Ploso Village in Lamongan Regency, East Java Province are still experiencing difficulties in obtaining clean water that meets the requirements of quality, quantity, continuity, and cheap water prices. A small number of more ableresidents use well-bore water from deep ground water to get clean water. While the less able residents still use surface water from the lake which the water quality does not meet the requirements of clean water, especially for turbidity parameters that are still above the standard of clean water requirements. This research intends to improve the quality of lake water turbidity so that it can be used properly by less able residents. Padengan Ploso Village in Lamongan Regency, East Java Province is a village in the coastal area, where sand and coconut trees are found. The filtration process using sand provides good results for decreasing water turbidity (Maryani *et al.*, 2014). Coconut shell has not been used to be charcoal as in theory,it has the ability to absorb turbidity, color, and odor from surface water as well as lake water. Previous studies have been carried out in connection with batch adsorption processes and continuously using residual coal adsorbent media (fly ash and bottom ash) and coconut shell charcoal. Kurniawan and Razif (2012) conducted adoption research on continuous columns using coal and produced the highest color removal efficiency of 71.14%. Muiz and Razif (2012) examined coal adsorption with horizontal columns and obtained the highest color removal efficiency of 72%. Pratama and Razif (2012) attempted to examine adsorption with continuous vertical columns using bottom ash

and obtained color removal efficiency of 88.79%. Mustafa and Razif (2012) also examined bottom ash with the continuous horizontal flow and obtained the highest removal efficiency of 70.05% for PV parameters (Permangnat Value). Razif (1992) attempted to examine adsorption of paper mill wastewater using coal adsorbents and it was also used for alcohol and spirits factory wastewater by Razif *et al*. (1994). Razif and Moesriati (2000) examined the detergent adsorption using coal in a continuous column and produced the kinetic (k1) and media capacity (qo) for detergents So Klin, Ronso, and Daia. Razif (2000) tested the configuration engineering of adsorption and biocycle systems for domestic wastewater treatment containing detergents, with a removal efficiency of surfactant levels ranging from 88.65 - 95.25%. Jannatin (2011) also examined the removal efficiency test of adsorbent media of coconut shell charcoal to reduce color and permanganate value from batik industrial waste. Karri (2017) utilized coconut shell for the phenol adsorption process by producing removal varying from 63% to 96% and revealing that coconut shell is a low-cost and feasible adsorbent for removing phenol from wastewater. Bujawati *et al.* (2013) used coconut shell charcoal for hardness removal. Coconut shell charcoal has also been used to treat industrial iodine mining wastewater in Alam and Razif (2018).

RESEARCH METHOD

Research on the batch process was carried out using a stirrer on the beaker of Jar-Test equipment which was filled with tested water as much as 500 mL, carried out with a stirring speed of 60 RPM, stirring time of 60 minutes, sedimentation time of 30 minutes and carried out for all variables. The research variables included three media mesh size variables (8, 10, 20), three media mass variables (50 g, 75 g, 100 g), and three variable concentrations of lake water turbidity. The first concentration variable was the original water from the lake with a turbidity of 7.82 NTU. The second variable was the concentration of lake water that had been filtered with a sand filter with 1.6 NTU turbidity. The third variable was the concentration of lake water that had been filtered with a sand filter and palm fiber with turbidity 3.5 NTU. After the sedimentation process was complete, the supernatant on the surface of the beaker was measured for turbidity and compared to the initial turbidity before the adsorption process. Then, the calculation of removal efficiency in units of percent was carried out, that is the result of the initial turbidity difference subtracted the final turbidity divided by the initial turbidity and multiplied by 100%. Afterward, the calculation of isotherm used formulas from Freundlich, Langmuir, and BET with the help of regression charts.Research on the continuous process was carried out by using continuous columns, with three variable column heights (7 cm, 14 cm, 21 cm). The continuous flow was from the inlet at the top of the adsorption column with the appropriate inlet and outlet rate settings. From the outlet at the bottom of the adsorption column, the water was collected, and the turbidity concentration was measured periodically until the continuous process reached a breakthrough, which was characterized by deteriorating turbidity quality at the outlet. Then, the measurement results were transferred to the graph to facilitate the calculation of removal efficiency, kinetic constants (k1) and adsorption ability (qo).

RESULTS AND DISCUSSION

Based on the results of laboratory analysis, the comparison between the data of lake water characteristics in Padengan Ploso Village, Lamongan Regency and the requirements for drinking water quality according to Minister of Health (2010) is shown in Table 1. Based on the water characteristics in Table 1, turbidity, TDS, and *E-coli* do not meet the requirements. Whereas for BOD, it does not meet the class I of surface water quality standards of 2 mg/L and class II of 3 mg / L in accordance with PP 82 of 2001. To meet the requirements of drinking water, the lake water is filtered first using a sand filter. The sand filter is expected to reduce TDS and *E. coli*. While BOD and turbidity can be reduced by adsorption based on the results of previous studies.The results of removal efficiency calculation for batch process was 43.75% as the highest value, mesh of 10, and final turbidity meets the standard of clean water quality of 5 NTU. From the calculation, the adsorption mechanism is more likely to follow Freundlich's Isotherm with a regression coefficient (R2) which is higher than Langmuir and BET. Hallajiqomi (2017) in his research found that Isotherm Freundlich is better than Isotherm Langmuir for manganese ion removal. If the Freundlich model better than the Langmuir model, thus indicating the presence of

Table 1. Characteristics of lake water in Padengan Ploso Village, Lamongan Regency

No.	TEST PARAMETERS	RESULT	Requirements for Drinking Water Quality
1	pH	8,4	6.5 – 8.5
2	Temperature (° C)	31	Air temperature (+/- 3)
3	Turbidity (NTU)	7,82	5
4	TS/Total Solid (mg/L)	1151	
5	TSS/Total Suspended Solid (mg/L)	175	
6	TDS/Total Disolved Solids (mg/L)	976	500
7	Color (TCU)	7	15
8	E-Coli (Amount per 100 mL sample)	72000	0
9	BOD (mg/L)	4,43	

Table 2. Comparison of adsorption results in continuous columns

Height of column	Removal efficiency at 3 hours position	Duration of breakthrough
7 cm	87 %	13 hours
14 cm	85 %	16 hours
21 cm	90 %	17 hours

heterogeneous adsorption sites(Kalaruban *et al.*, 2019). Kong (2017) in his study also found that the Freundlich isotherm equation (R2 = 0.9912), shows multilayer adsorption. The results of the study with adsorption with continuous columns were carried out for column height of 7 cm, 14 cm and 21 cm with the media size was the most optimum mesh granules from the batch process, mesh 10. The adsorption rate is influenced by the molecular size of the micropollutant as well as the granular activated carbon pore size (Piai *et al.*, 2019) .The comparison of adsorption results from these three columns is shown in Table 2.

Based on Table 2 above, the best adsorption results in the continuous column are at 21 cm column height. It is very reasonable because the mass of the adsorbent in the column is 21 cm more than the 14 cm and 7 cm columns. The complete calculation of turbidity removal efficiency for column 21 cm is shown in Table 3. Regarding the calculation of removal efficiency for continuous process of 21 cm columns (Table 3), the highest value of 96.57% with a cumulative time of 10 hours was obtained. The calculation of the kinetic constants for continuous process of column 21 cm is

Table 3. Turbidity removal efficiency with continuous column 21 cm

No	Time (hour)	Cumulative Time (hour)	Initial Turbidity NTU	Final Turbidity NTU	Removal Efficiency Percentage (%)
1	0	0	30.3	30.3	
2	0,5	0,5	30.3	6.97	77.00
3	0,5	1	30.3	4.59	84.85
4	1	2	30.3	4.44	85.35
5	1	3	30.3	2.86	90.56
6	1	4	30.3	3.68	87.85
7	1	5	30.3	3.45	88.61
8	1	6	30.3	1.87	93.83
9	1	7	30.3	3.35	88.94
10	1	8	30.3	3.23	89.34
11	1	9	30.3	4.08	86.53
12	1	10	30.3	1.04	96.57
13	1	11	30.3	2.99	90.13
14	1	12	30.3	2.47	91.85
15	1	13	30.3	4.22	86.07
16	1	14	30.3	6.47	78.65
17	1	15	30.3	7.57	75.02
18	1	16	30.3	3.85	87.29
19	1	17	30.3	3.67	87.89
20	1	18	30.3	13.67	54.88

Table 4. Calculation results of kinetic constants of 21 cm column turbidity

Cumulative Time (hour)	Turbidity Concentration		Volume processed	Co/Ce-1	ln (Co/Ce-1)
	Initial (mg/L)	Final (mg/L)	(L)		
0	3.939	0	0		
13	3.939	0.5486	9.42	6.18	1.821
15	3.939	0.9841	12.15	3.00	1.099
18	3.939	1.7771	16.38	1.22	0.196

shown in Table 4 and the graph of the regression equation is shown in Figure 1.

Based on Figure 1, the values obtained are;

Slope = -0,2318

$-K_1$ x Co /Q = -0,2318

K_1 = -(-0,78/Q)xCo

If Q = 2, 9 mL/second = 0,174 lt / hour

Then the value of K_1 = -(-0,2318/0,174) x 3,939 = 5,2474 lt /mg.hour

To get the values of qo

Intersep = 3,9713

$(K_1$ x qo x M) / Q = 3,9713

qo = (3,9713 x Q) / (K_1x M)

If M = Density x Volume

= 0.59 gr /ml x (¼ x 3,14 x $6,3^2$ x 21) cm^3

= 386,03 gram

qo = (3,9713 x 0,174/1000) / (5,2474 x 386,03)

= 0,000691 / 2025.65

= 0,00000034112 mg adsorbat/mg adsorban

= 3,411 x 10^{-7}mg adsorbat / mg adsorban

CONCLUSION

1. From the results of batch research, the maximum turbidity removal efficiency is 43.75% on mesh of 10
2. From the results of continuous research, the maximum turbidity removal efficiency of 96.57% on mesh of 10 and column height of 21 cm with kinetic constants value k1 of 5.2474 lt / mg. hour and qoof 3.411 x 10-7 mg adsorbate/ mg adsorbent.

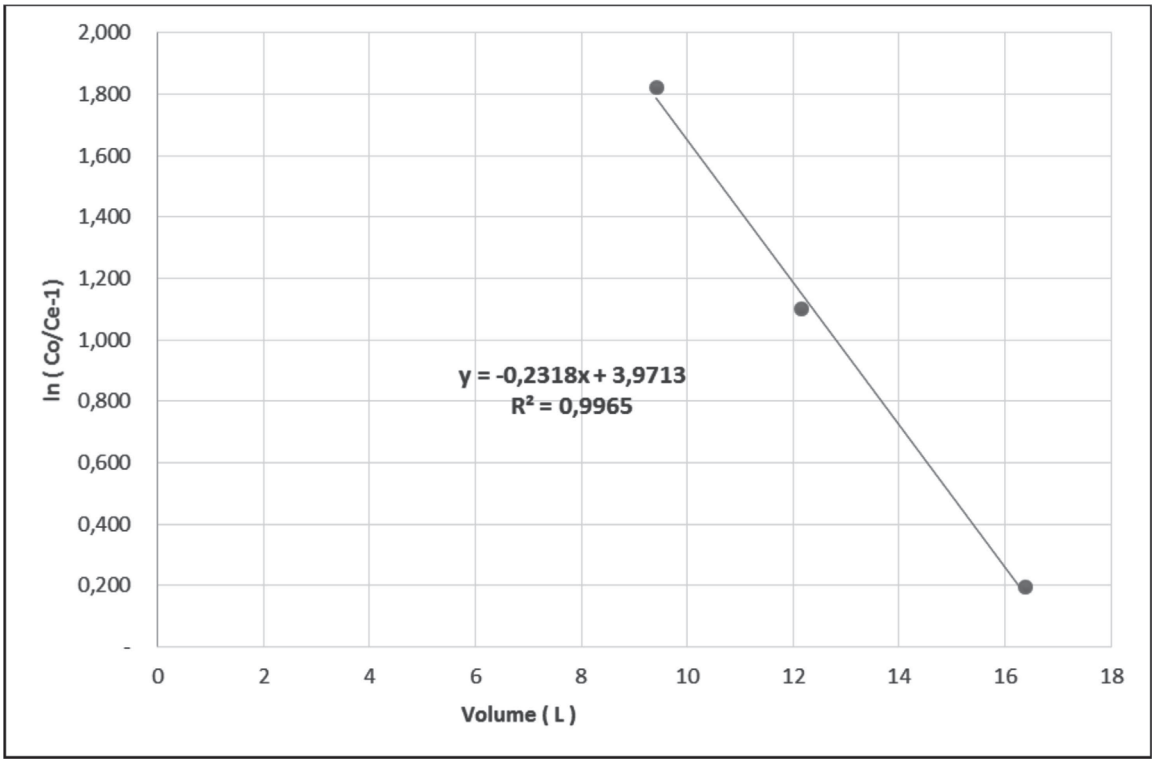

Fig. 1. Kinetic Constants(k1) Graph of Column 21 cm

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