Proceeding International Conference of Health Sciences
e-ISSN : 2827-9891 Vol. 2 Number 1
https://ocs.unism.ac.id/index.php/ICoHS Januari 2024

THE EFFECTIVENESS OF ACTIVATED CARBON JASMINE WATER *(Echinodorus polifolius)* IN REDUCING BOD *(Biological Oxygen Demand)* AND COD *(Chemical Oxygen Demand)* LEVELS IN SASIRANGAN FABRIC INDUSTRIAL WASTE

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Abstract

Dyeing sasirangan cloth in the sasirangan industry uses dyes made from harmful chemicals that can cause BOD and COD contamination. Reduction of BOD and COD levels can use adsorption from activated carbon jasmine water. Activated carbon can be taken from plants that contain cellulose such as water jasmine by 64.51%. To determine the effectiveness and differences in variations in the length of exposure to activated carbon jasmine water (*Echinodorus polifolius*) in reducing BOD and COD levels in sasirangan fabric industrial waste with variations in control time, time 30, 60, and 120 minutes. Activation for activated carbon by heating HCl 1M at 100ºC, then filtered while tested to obtain a neutral pH. After that, activated carbon is dried by oven. Activated carbon is treated with wastewater with different time variations and then measured for BOD and COD levels using the titration method. The results of measuring BOD and COD levels in samples before treatment were 102 mg L^{-1} and 1476.3 mg L^{-1}. Decreased levels of BOD and COD respectively is <0.28 mg L^{-1}, 9.4 mg L^{-1}, 2.2 mg L^{-1} and 506.2 mg L^{-1}, 646.8 mg L^{-1}, 534.3 mg L^{-1}. The percentage decrease in BOD and COD levels at 30, 60, and 120 minutes was 100%, 91%, 98% and 65.71%, 56.19%, 63,81%. The highest absorption with a contact time of 30 minutes was 100% at BOD levels and 65.71% at COD levels with a decrease of <0.28 mg L^{-1} or 0 (zero) and 506.2 mg L^{-1}.

Keywords: activated carbon, BOD, COD, industrial waste

Introduction

Sasirangan cloth is a typical cloth of the Banjar tribe that has been passed down for generations in Kalimantan and has become an industry. The stage of making Sasirangan fabric starts from cutting fabric, making patterns, sewing, dyeing, removing stitches, washing fabric, and drying and ironing Sasirangan fabric. At the staining stage using a variety of dyes, napthol, caustic soda and fixanol solution. The dyeing process carried out by the sasirangan industry in Sasirangan village still does not pay attention to health standards and environmental friendliness such as disposing of waste from dyeing directly into the river and removing the remaining dye on the fabric by washing directly into the river (Jumriani, 2018).

This clearly causes contamination in the river of Sasirangan village, according to the results of research by Darmansyah *et al*., (2017) in Sasirangan village that the concentration of BOD and COD contained in sasirangan liquid waste is very high, namely 3800 mg L^{-1} and 5192 mg L^{-1}. Based on quality standards for Business and/ or Industrial Activities in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.16/MENLHK/SETJEN/KUM.1/4/2019, namely 60 mg L^{-1} and 150 mg L^{-1} for BOD and COD (Kiptiah *et al*., 2022).

Activated carbon or often called activated charcoal is a product of the carbonization method whose main component is mostly carbon which is then reacted with chemicals, so that the pores owned by charcoal are open and able to become absorbent substances on the surface (adsorbent). The use of activated charcoal as an adsorbent is widely used to absorb toxic liquids, poisonous gases, foul odors, water purifiers, drinking water filters, and so on (Akhmad *et al*., 2012). In the health sector, activated charcoal is used to treat poisoning or digestive disorders, such as flatulence or diarrhea (Nenohai *et al*., 2023).

Activated carbon can be taken from plants containing cellulose. Plants containing cellulose such as hyacinths by 60% (Nuria *et al*., 2020), galam wood by 37% (Darmaji *et al*., 2020), and water jasmine by 64.51% (Kurniawati, 2018).

According to research from Aritonang, *et al*., (2022), BOD levels with a value of 480 mg L^{-1} above the quality standard after being given activated carbon that has not been activated can reduce levels to 120 mg L^{-1} and activated carbon that has been activated can reduce levels to 60 mg L^{-1}. While COD levels with a value of 650 mg L^{-1} above the quality standard after being given activated carbon that has not been activated can reduce levels to 150 mg L^{-1} and activated carbon that has been activated can reduce levels to 80 mg L^{-1}.

Water jasmine is an aquatic plant that has the Latin name *Echinodorus polifolius*. Water jasmine in English is known as Mexican sword plant. The distribution of water jasmine is in Central America, the Mississippi basin and Venezuela (Baroroh & Irawanto, 2016). According to Rochyati in (Kurniawati, 2018) in fresh stalks of water jasmine plants have a chemical content of water 95.6%, ash 0.44%, crude fiber 2.09%, carbohydrates 0.17%, fat 0.35%, protein 0.16%, phosphor rus 0.52%, potassium 0.42%, chloride 0.26%, alkanoids 2.22%. While in dry state contains cellulose content of 64.51%, pentose 15.61%, silica 5.56%, ash 12% and lignin 7.69% (Kurniawati, 2018).

Titration is a type of volumetric. The reaction is carried out by titration, where a solution is added from the burette little by little until the exact amount of substances reacted becomes equivalent to each other. When the added titrant is equivalent, the addition of the titrant must be stopped; At this time it is called the "end point" of titration.

The titration method for the BOD test uses the iodometric method (azide modification), this method is a test of dissolved oxygen (DO) levels from waste or water samples (Nuraini *et al.*, 2019). Meanwhile, in determining COD using redox titration, namely dichromatometry which uses dichromate compounds as oxidizers.

Materials and Method

The materials used in this study include water jasmine, wastewater samples of the sasirangan fabric industry, aquadest, Potassium Dichromate ($K_2Cr_2O_7$), KIO_3, KI, Na_2CO_3, H_2SO_4 Concentrated, HCl 1M, Sodium Thiosulfate ($Na_2S_2O_3$), Ferro Ammonium Sulphate (FAS), Ferroin indicator, amylum indicator, $MnSO_4$. The tools used in this study include analytical balances, titration tools, ovens, furnaces, drip pipettes, measuring pipettes, erlenmeyer, measuring flasks, hot plates, beakers, horn spoons, stirring rods, winkler bottles, 60 mesh sieves.

The research method used in this study is a quantitative method by experimental design with Posttest design with control design. Sampling was carried out in the sasirangan fabric industry in Sasirangan Village, Banjarmasin. This research was conducted at the Chemical Laboratory of Sari Mulia University and the Laboratory of the Center for Environmental Health Engineering and Disease Control (BBTKLPP) Banjarbaru.

Procedure

Water Jasmine Leaf Carbonization Process

Water jasmine leaves are cut uniformly and then dried in the sun for 3-7 days, then carbon is made by heating in a furnace for 1 hour at a temperature of 500°C after which grinding and sieving are carried out until activated carbon with a sieve size of 60 mesh is obtained.

Chemical Activation of Activated Carbon

Weigh as much as 40 grams of carbon and then put into a beaker added with 1M HCl as much as 500 mL then stirred with a magnetic strirer for 10 minutes in a state of 100^{o}C after that let stand for 24 hours. After that, activated carbon is filtered using whatman 41 paper with 3-4 drops of NaOH added as neutralization so that it reaches neutral pH (pH 6-7).

Sample Preparation

Put the sample water into 3 (three) beaker glasses as much as 500 ml and add activated carbon charcoal from jasmine water of 3 grams each, let the three Erlenmeyers stand for 30 minutes, 60 minutes, and 120 minutes, then filter.

BOD Level Analysis

a) Prepare 2 bottles of DO, marking each bottle with A_1 and A_2 notation;
b) Put a sample solution of 2.0 mg L^{-1} into each bottle of DO, A_1 and A_2 until overflowing, then carefully close each bottle to avoid the formation of air bubbles;
c) Corner several times, then add mineral-free water around the mouth of the closed DO bottle;
d) Store A_2 bottles in incubator cabinets 20^{o}C ± 1^{o}C for 5 days;
e) Measure dissolved oxygen against the solution in the A_1 vial with the DO tool;
f) Take an A_1 vial, then add 1 mL of $MnSO_4$ and 1mL of alkaline iodide azide with a pipette tip just above the surface of the solution;
g) Close immediately and homogenize until a complete lump forms;
h) Let the clot settle for 5-10 minutes;
i) Add 1 mL of concentrated H_2SO_4, cover and homogenize until precipitate completely dissolves;
j) Take 50 mL and put in Erlenmeyer 150 mL;
k) Titration with $Na_2S_2O_3$ with amylum indicator until the right blue color disappears;
l) Perform the same treatment as the A_1 bottle on the A_2 bottle after 5 days;

m) Calculation of BOD levels and Efficiency of decrease with formulas:

$$\text{Dissolved oxygen (DO) (mg L}^{-1}\text{)} = \frac{V \times N \times 8000 \times F}{\text{mL sample}}$$

$$BOD = ((A1 - A2) - (B1 - B2)) \times P$$

$$De = \frac{C_0 - C_1}{C_0} \times 100\%$$

Keterangan:

V = mL $Na_2S_2O_3$

N = Normality $Na_2S_2O_3$

8000= Weight of milli oxygen equivalent x 1000 ml L^{-1}

F = Factor (bottle volume divided by bottle volume minus volume of $MnSO_4$ reagent and alkaline iodide azide)

A_1 = Sample DO levels before incubation (0 days)

A_2 = Sample DO levels after incubation (5 days)

B_1 = Blank DO content before incubation (0 days)

B_2 = Blank DO content after incubation (5 days)

P = Comparison of test sample volume (V_1) per total volume (V_2).

COD Level Analysis

a) Pipette the sample volume of 2.5 ml, add 1.5 ml digestion solution and add 3.5 ml of sulfuric acid reagent solution to the tube or ampoule,

b) Close the jar and shake gently until homogeneous;

c) Put the tube on a heater that has been heated at 150^{o}C, do digestion for 2 hours;

d) Slowly cool the refluxed sample to room temperature during occasional cooling, the sample cap is opened to prevent gas pressure from occurring;

e) Quantitatively transfer the sample from the tube or ampoule into the Erlenmeyer for titration;

f) Add 0.05-0.1 mL ferroin indicator or 1-2 drops and stir with a magnetic stirrer while titrating with 0.05 M FAS raw solution until a clear color change from green-blue to reddish-brown occurs;

g) Perform steps a) to f) against organic-free water as blanks;

h) Calculate COD levels and their decreasing efficiency with formulas:

$$COD\ (mg\ O_2\ L^{-1}) = \frac{(A\text{-}B) \times M \times 8000}{mL\ sample}$$

$$De = \frac{C_0 - C_1}{C_0} \times 100\%$$

Keterangan:

A = Volume of FAS solution required for blanks (mL)

B = Volume of FAS solution (ml)

M = Molarity of FAS solution

8000= Weight of milli oxygen equivalent x 1000 ml L^{-1}

De= Decrease efficiency

C_0 = Levels before treatment

C_1 = Levels after treatment

Result and Discussion

The results of testing BOD levels in sasirangan fabric industrial waste are as follows:

Table 1. BOD Test Results

Time	BOD (mg L^{-1})
0 Minute	102
30 Minute	<0,28 (0)
60 Minute	9,4
120 Minute	2,2

Source: Mandiri, 2023

The efficiency of reducing BOD levels is as follows:

Table 2. BOD Reduction Efficiency

Time	% Efficiency of Decreasing BOD Levels
30 Minute	100%
60 Minute	91%
120 Minute	98%

Source: Mandiri, 2023

Furthermore, the One Way Anova test was carried out, the following results were obtained:

Table 3. One Way Anova Test Results

ANOVA					
Decrease Efficiency					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1185.315	2	593.415	2.360	.175
Within Groups	1505.697	6	251.400		
Total	2691.012	8			

Source: Mandiri, 2023

The results of testing COD levels in sasirangan fabric industrial waste are as follows:

Table 4. COD Test Results

Time	COD (mg L^{-1})
0 Minute	1476,3
30 Minute	506,2
60 Minute	646,8
120 Minute	534,3

Source: Mandiri, 2023

The efficiency of reducing COD levels is as follows:

Table 5. COD Reduction Efficiency

Time	% COD Reduction Efficiency
30 Minute	65,71%
60 Minute	56,19%
120 Minute	63,81%

Source: Mandiri, 2023

Furthermore, the One Way Anova test was carried out, the following results were obtained:

Table 6. One Way Anova Test Results

ANOVA					
Decrease Efficiency					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	151.705	2	75.853	8.581	.017
Within Groups	53.035	6	8.839		
Total	204.740	8			

Source: Mandiri, 2023

Quantitative testing to measure BOD levels is carried out by the Winkler titration method, namely iodometric titration (azide modification) using sodium thiosulfate solution ($Na_2S_2O_3$) which has been standardized first. DO (Dissolved Oxygen) testing was carried out first to see 0 (zero) days dissolved oxygen and 5 (five) days dissolved oxygen from variations in samples without treatment and with 30 minutes, 60 minutes, and 120 minutes treatment.

The results of the measurement of samples without treatment obtained are 102 mg L^{-1}, the level exceeds the quality standard for Business and/ or Industrial Activities in the regulation of the Minister of Environment and the Ministry of the Republic of Indonesia Number P.16/MENLHK/SETJEN/KUM.1/4/2019 for the value of BOD levels is 60 mg L^{-1}.

In table 1 can be seen the levels of BOD respectively, namely <0.28 or 0 (zero) mg L^{-1}, 9.4 mg L^{-1}, and 2.2 mg L^{-1}. The results stated that BOD levels decreased far below the quality standard, which is 60 mg L^{-1}. After knowing the BOD levels of each time variation, then the percentage of activated carbon absorption efficiency of the sample is calculated, that is, with results of 100%, 91%, and 98%, respectively. In this study with time variations of 30, 60, and 120 minutes, it can be seen from the results, that the optimal time exposed by activated carbon to reduce BOD levels, which is within 30 minutes.

These results are in line with research from Aritonang, *et al*., (2022), BOD levels with a value of 480 mg L^{-1} above the quality standard after being given activated carbon that has not been activated can reduce levels to 120 mg L^{-1} and activated carbon that has been activated can reduce levels to 60 mg L^{-1}.

After testing the decrease in BOD content, we want to see the effect of different variations on decreasing BOD content, namely with the One Way ANOVA statistical test obtained a significant value of 0.175 which means that the H_0 value >0.05, there is no significant difference between the variation in the time of giving activated carbon to reducing BOD levels in sasirangan fabric industrial waste.

Quantitative testing to measure COD levels is carried out dichromatometric titration method with Ferro Ammonium Sulphate (FAS) solution using ferroin indicators. This test was carried out on sasirangan industrial liquid waste to see COD levels with variations in samples without treatment and treatment of 30, 60, and 120 minutes.

The results of the measurement of samples without treatment obtained were 1476.3 mg L^{-1}, the level exceeds the quality standard for Business and/ or Industrial Activities in the regulation of the Minister of Environment and the Ministry of the Republic of Indonesia Number P.16/MENLHK/SETJEN/KUM.1/4/2019 for the value of COD levels is 150 mg L^{-1}.

In table 4 can be seen COD levels consecutively, namely 506.2 mg L^{-1}, 646.8 mg L^{-1}, and 534.3 mg L^{-1}. the results state that COD levels are still above the quality standard standard, which is 150 mg L^{-1}. After knowing the COD levels of each time variation, then the calculation of the percentage of activated carbon absorption efficiency of the sample, which is 65.71% respectively, 56.19%, and 63.81%.

In this study with time variations of 30, 60, and 120 minutes, it can be seen from the results, that the optimal time exposed by activated carbon to reduce COD levels, which is within 30 minutes. At a contact time of 60 minutes indicates that activated carbon has been saturated so the adsorption is very low. However, the bond that occurs between the surface of activated carbon and the substrate is weak, so this bond becomes detached again so that the surface of activated carbon that was previously bound to the substrate becomes empty.

The longer the contact time given to activated carbon and liquid waste, the greater the chance for the substrate to be bonded again so that the adsorption ability of activated carbon increases. In accordance with the statement of Suyata (2009) which states that the adsorption event in activated charcoal occurs due to the Van Der Waals Force, which is the intermolecular attraction between solid molecules and the adsorbed solute is greater than the attraction of fellow solute itself in solution, the solute will be contrasted on the surface of the solid (Setyaningrum, *et al*., 2019).

This result is in line with research from Aritonang, et al (2022), COD levels with a value of 650 mg L^{-1} above the quality standard after being given activated carbon that has not been activated can reduce levels to 150 mg L^{-1} and activated carbon that has been activated can reduce levels to 80 mg L^{-1}.

After testing the decrease in COD content, we want to see the effect of different variations on decreasing COD content, namely with the One Way ANOVA statistical test obtained a significant value of 0.017 which means that the H_a value <0.05, there is a significant difference between the variation in the time of giving activated carbon to reducing COD levels in sasirangan fabric industrial waste.

Conclusion

Based on the results of the study, it was found that the optimal time for reducing BOD levels at 30 minutes by 100%, while the **most** optimal time for decreasing COD levels at 30 minutes was 65.71%. In the BOD test, there was no significant effect on the decrease, while in the COD test, a significant effect on the decrease was obtained.

Acknowledgments

The author would like to thank apt. Tuti Alawiyah, S.Farm., MM and Nur Hidayah, MT for providing direction and guidance in completing this research.

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