

Utilization Activated Carbon from Bagasse in Processed of Laundry Waste

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Abstract—Research was carried out on the use of activated carbon from bagasse for processing laundry waste. The method used is the adsorption method with a variation of the length of contact between activated carbon and laundry waste. Laundry waste parameters analyzed included MBAS, phosphate, COD, BOD, TSS and pH. The ability of adsorption of laundry waste in the 120 minutes was reduced the concentration of MBAS up to 80.14%, phosphate up to 82.99%, COD up to 79.34%, BOD up to 77.28%, TSS up to 77.09% and pH 7.05.

Keywords— Bagasse, Activated Carbon, Laundry Waste, Adsorption.

I. INTRODUCTION

Laundry business is one type of home-based business that is currently developing throughout the city and rural areas. Laundry business in addition to providing positive benefits, also produces negative impacts, namely environmental pollution. The resulting environmental pollution comes from the rest of the laundry process that uses detergent. Detergents are generally composed of three main components consisting of surfactants (as a base for detergents), builders (phosphate compounds) and additives (bleach, deodorizers). Sodium tripolyphosphate (STTP) which is one of the ingredients in detergents which functions as a builder which is the second important element after surfactant, because of its ability to remove hardness minerals in water so that detergents can work optimally [1]. East Java Governor Regulation Number 72 of 2013 includes parameters of MBAS, Phosphate, COD, BOD, TSS, and pH [2]. Based on these parameters it can be an indicator to find out that laundry wastewater is still within the maximum allowed for each parameter.

In a laundry in Caruban East Java, the measurement of MBAS levels was 29,492 mg/L, Phosphate was 23.55 mg/L, COD was 1183.67 mg/L, BOD was 370,25 mg/L, TSS was 400 mg/L and pH 7.75. All conditions are above the maximum limit permitted according to the Governor of East Java Regulation so that processing is required before being discharged into the environment. Laundry wastewater treatment that can be done is adsorption. Adsorption

is an event of absorption of a substance on a solid surface. The adsorption phenomenon occurs due to the pulling force between the adsorbate molecules and the active sites on the surface of the adsorbent [3].

Adsorption is a more effective method for tackling liquid waste pollution, because in addition to being easy to do also has high effectiveness. Adsorption using activated carbon is one of the potential ways to overcome laundry liquid waste. The basic materials of activated carbon are organic materials with high carbon content and are activated using 5 M HCl.

Sugarcane bagasse is a residue from the process of grinding sugar cane after the squeeze process or the release is issued [4]. The supply of bagasse in Indonesia is quite abundant in line with the number of sugar cane sellers on the side of the road. Sugar cane produced in each sugar cane ice seller is burned, dumped in a trash or in an empty land [5]. Various utilization efforts have been made to minimize bagasse, but this effort has not been able to overcome the problem of bagasse. One of the basic considerations for making activated carbon is bagasse containing high levels of lignocellulose [6].

In ecotoxicology, a large number of tests find that LAS can cause acute and chronic toxicity to aquatic organisms. LAS with a concentration of 20-30% solution can cause tissue damage in mice after skin contact for more than 15 days. At a concentration of 25 mg/L LAS, the fish reacts with a pattern of increasing activity, inactivity and immobility, and if not removed from the system will cause death. Minimal effects related to biochemical changes and histopathology in the liver have been reported in subchronic toxicity tests for mice given a concentration of LAS 120 mg/kg body weight per day in food or drinking water [7].

This MBAS method is used to determine the concentration of surfactants in solution because the concentration of MBAS is proportional to the concentration of surfactants. The principle of phosphate testing is in an acidic atmosphere,

laundry in Carub

ammonium molybdate and potassium antimonyl tartrate react with orthophosphate to form phosphomolybdic acid compounds and then reduced by ascorbic acid to become a molybdenous blue complex. COD is the amount of oxygen needed to remodel organic matter into carbon dioxide, water and ammonia. The BOD value of an aquatic is influenced by the amount of organic matter and pollutants in these waters [8]. Total Suspended Solid (TSS) is suspended solids that are not dissolved and cannot settle directly, consisting of particles of smaller size and weight than sediment [9]. The pH value is a parameter that is used to measure the degree of acidity or concentration of H^+ values in water.

This studied seeks to provide an alternative use of bagasse from sugar cane sellers to activated carbon which can then be used to reduce the concentration of MBAS, phosphate, COD, BOD, TSS and pH in laundry waste.

II. RESEARCH METHOD

A. Equipments

The tools used in this research are erlenmeyer, magnetic stirrer, analytical balance of OHAUS Pioneer TM, oven, 50 ml volumetric flask, drop pipette, 100 ml beaker, known volume of winkler bottle, burette, aerator, BOD inclusator, universal indicator and pH meter. The instrument used in this study was the UV-Vis Shimadzu UV-165 OPC spectrophotometer.

B. Materials

The materials used in this study are activated carbon from bagasse, laundry waste, Aquades, H_2SO_4 , potassium antimonyl tartrate, ammonium molybdate, ascorbic acid, potassium anhydrous phosphate anhydrous, $NaHPO_4 \cdot 2H_2O$, Na_2CO_3 solution, starch / starch indicator solution, sodium thiosulfate solution 0.025N, $HgSO_4$, potassium dichromate, powder or Crystal Ag_2SO_4 , Potassium Hydrogen standard solution, phosphate buffer solution, magnesium sulfate solution, calcium chloride solution, ferric chloride solution, diluent solution, glucose-acid glutamate solution, manganese solution sulfate, azide iodide solution, H_2SO_4 1N solution, 1 N NaOH solution, pH 4 buffer and pH buffer

C. Procedure

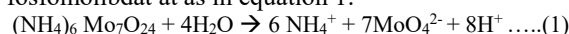
The adsorption process is carried out by inserting 0.2 grams of activated carbon in 100 ml of laundry waste then stirring with a magnetic stirrer for 30, 60, 90, 120 and 150 minutes. The method used for MBAS testing is SNI 06-6989.51-2005, Phosphate is Standard Methods 20th edition 1998, COD is SNI

6989.2-2009, BOD is SNI 6989.72: 2009, TSS is SNI 06-6989.3-2004, pH is SNI 06-69 6989.11-2004.

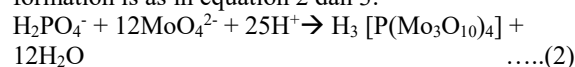
III. RESULTS AND DISCUSSION

A. Phosphate Test according to Standard Methods 20th edition 1998

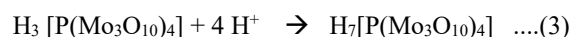
The principle of phosphate testing is in an acidic atmosphere, ammonium molybdate and potassium antimonyl tartrate react with orthophosphate to form phosphomolybdic acid compounds and then reduced by ascorbic acid to become a molybdenous blue complex. The reaction of acid formation fosfomolibdat at as in equation 1:



The reaction step for blue phosphomolybdenum formation is as in equation 2 dan 3:



Askorbat acid



Reduction

In Table 1 shows the average concentration of phosphate absorbed in the time variation, from the table it can be seen that the phosphate concentration decreases with increasing contact time. Based on Table 1, a graph is made by connecting the time as the X axis to the amount of phosphate concentration absorbed (mg / L) as the Y axis. The graph results can be seen in Figure 1.

Figure 1 shows that at the contact time of 120 minutes, the percentage of phosphate concentration absorbed experienced the largest decrease of 82.99%, whereas at the contact time of 30 minutes the percentage of phosphate concentration was the smallest at 69%, but at contact time of more than 120 minutes the percentage of phosphate concentration absorbed has decreased.

Table 1. Average Absorbed Phosphate Concentration in Contact Time Variations

No	Contact Time (minutes)	Phosphate Concentration (mg / L)			Percentage of phosphate concentration absorbed (%)
		Early	Average		
			End	Absorbed	
1	30	23.55	7.30	16.24	69.00
2	60		6.65	16.89	71.75
3	90		4.24	19.30	81.99
4	120		4.00	19.54	82.99
5	150		5.06	18.48	78.49

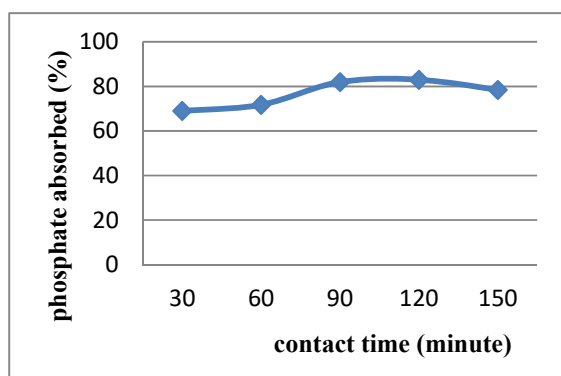


Figure 1. Graph of Phosphate Absorption in Time Variations

Activated carbon containing H^+ ions has a positively charged surface of the adsorbent particles, so that it can bind to negatively charged phosphate ions. Before the adsorption process, this H^+ ion on the surface binds to other anions. Negatively charged phosphate (PO_4^-) allows bonding with positively charged adsorbents (H^+ ions). In this adsorption process, phosphate anions will replace other anions that bind to the H^+ ion [10]. This is because the excessive contact time causes activated carbon to saturate and cause phosphate to escape the activated carbon pores (desorption occurs).

B. Methylene Blue Anionic Surfactant Test (MBAS) according to SNI 06-6989.51-2004

The MBAS method is useful for determining the content of anionic surfactants from wastewater. The core of the MBAS method are 3 sequentially, namely: Methylene blue extraction with anionic surfactant from the medium of water solution into chloroform ($CHCl_3$), then followed by the separation between the water and organic phases and the measurement of blue in $CHCl_3$ using spectrophotometry at 652 wavelengths. nm [11].

The following is a description of the reaction (ion association) that occurs between methylene blue and surfactant:

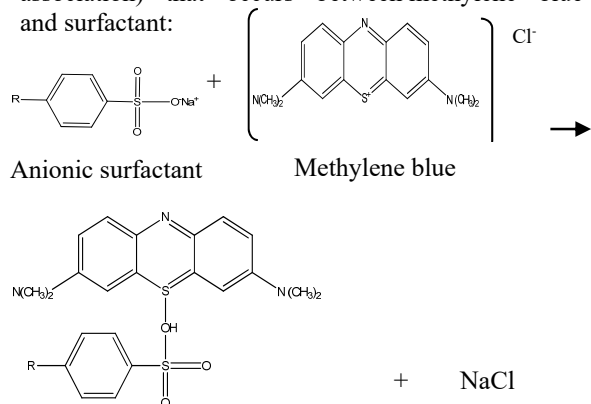


Figure 2 . The reaction between methylene blue and surfactant

N^+ ion can be seen from methylene blue interacting attack and bind with O^- ions of the surfactant by electrostatic forces to form neutral species that can be extracted into an organic solvent. Whereas Cl^- ions of methylene blue bind to Na^+ ions from surfactants and remain in the water phase. Anionic phosphatases react with methylene blue to form new ionic pairs dissolved in organic solvents, the intensity of the blue color formed is measured by spectrophotometer with a wavelength of 652 nm. The measured uptake is equivalent to the level of anionic surfactants.

In Table 2 shows the average concentration of MBAS absorbed in the time variation, from the table it can be seen that the concentration of MBAS has decreased with increasing contact time.

Table 2. Average Absorbed MBAS Concentration in contact Time Variations

No	Contact Time (minutes)	MBAS Concentration (mg / L)			Percentage of MBAS concentration absorbed (%)
		Early	Average		
			End	Absorbed	
1	30	29.49	6.30	23.19	78.63
2	60		6.11	23.37	79.26
3	90		5.96	23.52	79.77
4	120		5.85	23.63	80.14
5	150		6.05	23.43	79.47

Based on Table 2, a graph is made by relating the time as the X axis to the amount of MBAS concentration absorbed (mg / L) as the Y axis. The results can be seen in Figure 3.

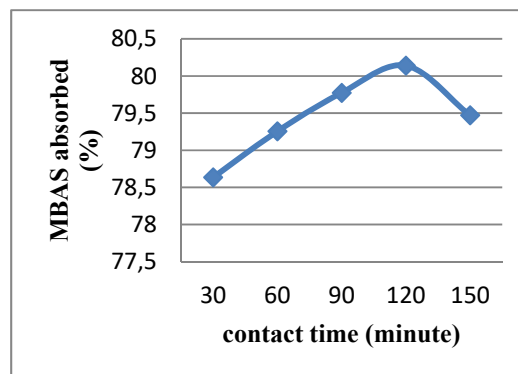


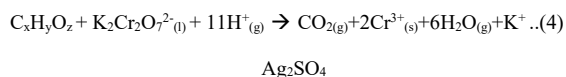
Figure 3. MBAS Absorption Chart on Time Variations

Figure 3 shows that at the contact time of 120 minutes, the percentage of MBAS concentration absorbed experienced the largest decrease of 80.14%, while at the contact time of 30 minutes showed the lowest percentage of 78.63%, but at contact time of more than 120 minutes the percentage of MBAS

concentration absorbed has decreased. This is because the excessive contact time causes activated carbon to pass saturated and causes MBAS to be released from the pores of activated carbon (desorption occurs).

C. Chemical Oxygen Demand (COD) According to SNI 6989.2-2009

COD test principle are organic and inorganic compounds, especially organic in the test sample is oxidized by $\text{Cr}_2\text{O}_7^{2-}$ in the closed reflux produce Cr^{3+} . The amount of oxidant needed is expressed in oxygen equivalents ($\text{O}_2 \text{ mg / L}$) measured by visible light spectrophotometry. $\text{Cr}_2\text{O}_7^{2-}$ strongly absorbs at a wavelength of 420 nm and Cr^{6+} strongly absorbs at a wavelength of 600 nm. For COD values of 100 mg / L up to 900 mg / L the increase in Cr^{6+} determined at a wavelength of 600 nm. In the test sample with a higher COD value, dilution is performed before testing. For COD values, it is smaller or equal to 90 mg/L, the decrease in $\text{Cr}_2\text{O}_7^{2-}$ concentration is determined at a wavelength of 420 nm. There action steps are as in equation (4):



This reaction takes place ± 2 hours, refluxed with a steam condenser apparatus, so that no volatile substances evaporate organic out. Then added silver sulfate which is useful to accelerate the reaction and mercury sulfate to eliminate chloride disturbances which are generally present in wastewater.

Table 3 shows the average COD concentration absorbed in the time variation. Figure 3 shows that the contact time from the 30 to the 120 minutes has increased graph and at 120 minutes the optimum time for adsorbent to absorb adsorbate and the concentration decreases. At 120 minutes contact time, the percentage of COD concentration absorbed is 79.34%, while at 30 minutes contact time the percentage of COD concentration absorbed is 78.25%. At contact time of more than 120 minutes the percentage of COD concentration absorbed has decreased. This shows that the contact time affects the decrease in COD concentration after addition of activated carbon.

The longer the contact time of the waste with activated carbon, the higher the average concentration of COD absorbed. Higher average concentration of COD was absorbed with increasing contact time allegedly because of active carbon which has been saturated to absorb organic matter in the waste involved desorbed after 120 minutes so add organic material to the sample resulting COD concentration rises.

Table 3. Average Absorbed COD Concentration in Contact Time Variations

No	Contact Time (minutes)	COD concentration (mg / L)			Percentage of absorbed COD concentration (%)
		Early	Average		
			End	End	
1	30	1183.67	257.5	926,17	78.25
2	60		247	936.67	79.13
3	90		245.5	938,17	79.26
4	120		244.5	939,17	79.34
5	150		246	937.67	79.22

Based on Table 3, a graph is made by connecting the time as the X axis to the amount of COD concentration absorbed (mg / L) as the Y axis. The results can be seen in Figure 4 .

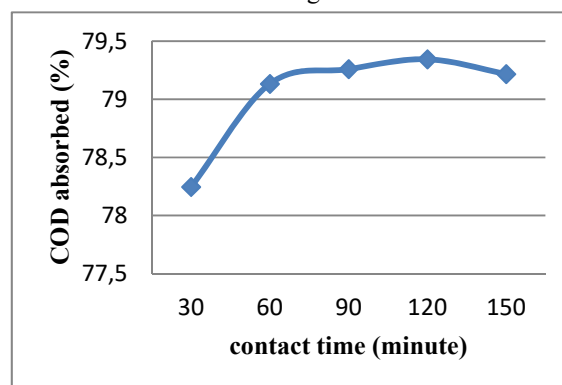


Figure 4. Graph of COD Absorption in Contact Time Variations

D. Biochemical Oxygen Demand (BOD) test according to SNI 6989.72 :2009

BOD testing generally uses the Winkler-Alkali iodide azide method to determine dissolved oxygen levels. The principle is that oxygen in the sample will oxidize MnSO_4 which is added to the solution in an alkaline state, so that MnO_2 deposits occur. Addition of sulfuric acid and potassium iodide will be released iodine which is equivalent to dissolved oxygen. The released iodine was then analyzed by iodometric titration method with standard thiosulfate solution with starch indicator. The following is the reaction in the Winkler titration method:

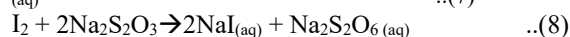
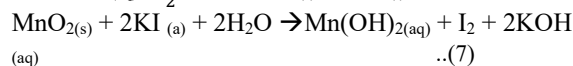
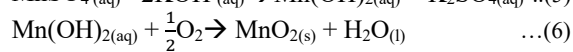
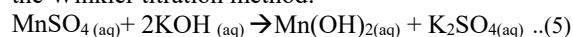


Table 4 shows the average concentration of BOD absorbed in the time variation. Figure 5 shows that the contact time from the 30 to the 120 minutes has increased graph and at 120 minutes the optimum time for adsorbent to absorb adsorbate and the concentration decreases. At 120 minutes contact time, the percentage of BOD concentration absorbed is 77.28%, while at 30 minutes contact time the percentage of BOD concentration absorbed is 74.26%. At contact time of more than 120 minutes, the percentage of BOD concentration absorbed has decreased. The decrease in BOD concentration coincides with the increase in contact time. This shows that the contact time affects the concentration of BOD waste after the addition of activated carbon.

Table 4. Average Absorbed BOD Concentration in Contact Time Variations

No	Contact Time (minutes)	BOD concentration (mg / L)			Percentage of absorbed BOD concentration (%)
		Early	Average		
			End	Absorbed	
1	30	370.25	95.32	274.93	74.26
2	60		92.58	277.67	75.00
3	90		90.52	279.73	75.55
4	120		84.12	286.13	77.28
5	150		88.84	281.41	76.01

Based on Table 4, a graph is made by connecting the time as the X axis to the amount of BOD concentration absorbed (mg / L) as the Y axis. The results of the graph can be seen in Figure 5.

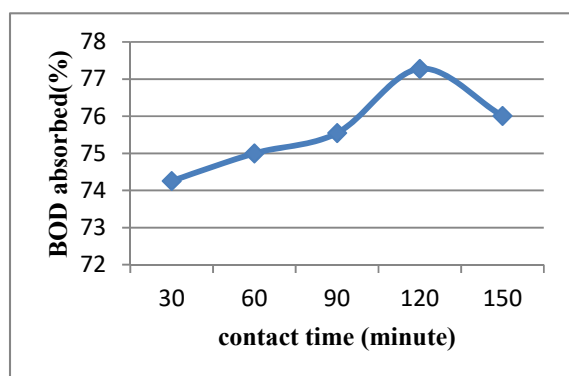


Figure 5. Graph of BOD Absorption in Time Variations

E. Total Suspended Solid Test (TSS) According to SNI 06-6989.3-2004

Testing of TSS concentration values aims to determine the total dissolved solids in wastewater. TSS comes from organic and inorganic compounds found in laundry wastes. Organic materials come from surfactants and additives, inorganic materials derived from detergent builders. At this stage laundry waste samples will be adsorbed with bagasse activated carbon which acts as an adsorbent. In table 5 shows the average concentration of TSS absorbed in the time variation.

Table 5. Average Concentration of TSS Absorbed in Contact Time Variations

No	Contact Time (minutes)	TSS concentration (mg / L)			Percentage of TSS concentration absorbed (%)
		Early	Average		
			End	Absorbed	
1	30	400	93.95	306.05	76.51
2	60		92.75	307.25	76.81
3	90		92.05	307.95	76.99
4	120		91.65	308.35	77.09
5	150		91.85	308.15	77.04

Based on Table 5, a graph is made by connecting the time as the X axis to the amount of TSS concentration absorbed (mg / L) as the Y axis. The graph results can be seen in Figure 6.

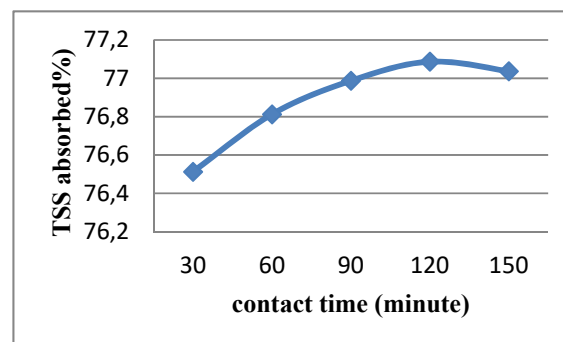


Figure 6. Graph of TSS Absorption in Time Variations

Figure 6 shows that the contact time from the 30 to the 120 minutes has increased graph and at 120 minutes the optimum time for adsorbent to absorb adsorbate and the concentration decreases. At 120 minutes contact time, the percentage of TSS concentration absorbed is 77.09%, while at 30 minutes contact time the percentage of TSS concentration absorbed is 76.51%. At contact time of more than 120 minutes the percentage of TSS concentration absorbed has decreased. Activated carbon absorbs the impurity component by binding it to the porous structure of activated carbon.

F. pH Change Test According to SNI 06-6989.11-2004

The pH value is a parameter used to measure the acidity or concentration of H^+ values in water. pH values that are too acidic or too alkaline are not good for the waters because only extreme organisms can live in these waters. The pH value of laundry waste after the addition of activated carbon is presented in table 6.

Table 6. pH data on various Contact time variations

No	Contact Time (minutes)	Initial pH	Final pH
1	30	7.75	7.52
2	60		7.46
3	90		7.28
4	120		7.05
5	150		7.19

Table 6 shows that the contact time from the 30 to the 120 minutes has decreased graph and at 120 minutes the optimum time for adsorbent has the lowest pH. At the contact time of 120 minutes the lowest pH was 7.05, while at 30 minutes contact time the highest pH was 7.52. At contact time of more than 120 minutes pH has increased. These results indicate that the contact time affects the pH value of laundry waste.

The pH value of laundry waste has decreased with longer contact time. Laundry waste contains alkaline detergents. Base absorption is carried out by activated carbon which contains groups of H^+ ions, which causes pH to fall.

The final results obtained from each parameter include MBAS which is 5.85 mg/L, Phosphate of 4.00 mg/L, COD of 244.5 mg/L, BOD of 84.12 mg/L, TSS of 91.65 mg/L, and pH 7.05 and the final result has met the maximum limit specified by the East Java Governor Regulation No. 72 of 2013.

IV. CONCLUSION

The results showed that the 120 minutes contact time between activated carbon from bagasse and laundry waste showed the best results seen from the percentage of phosphate concentration decrease of 82.99%, MBAS of 80.14%, COD of 79.34%, BOD of 77, 28%, TSS amounted to 77.09% and showed a pH of 7.05.

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