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Characterization of Batik Industrial Wastewater in Bogor City

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Abstract

Wastewater from the batik industry in Bogor City is the most waste produced from the dyeing process. The batik industry produces waste with concentrated color due to the high concentration of color content from the dyeing process. This affects water bodies as a direct disposal site for waste. Batik waste also has the potential to contain heavy metal compounds derived from the composition of dyes. This will have an impact on the disruption of the balance in the environment around the industry. Therefore, it is necessary to characterize batik wastewater to determine the pollutant content. This research aims to characterize the batik industry wastewater in the city of Bogor by measuring the levels of COD, BOD, TSS, pH, temperature, total chromium content, total phenol content, and sulfide content according to the parameters P.16/MENLKH/SETJEN /KUM.1/4/2019. The results showed the characteristics of the wastewater from the batik industry in Bogor City with levels of COD in dyeing waste at 797 mg/L and total waste at 52463 mg/L, BOD levels in dyeing waste at 431 mg/L, and total waste at 238 mg/L. TSS in the dyeing waste is 706.5 mg/L and the total waste is 3679 mg/L, the temperature in the dyeing waste is 26.9 °C and the total waste is 26.3°C, pH in staining waste at 1.62 and total waste at 6.82; the total chromium content in the staining waste was 2.62 mg/L and the total waste was 940.2 mg/L, the total phenol content and sulfide content in the dyeing waste and total waste was not detected. The characteristics of batik waste are not by the established quality standards, so there is a need for processing before the waste is discharged into the environment.

Keywords: Batik industry; Characterization; Wastewater

1. INTRODUCTION

Development increasingly industry increase from time to time, no exception the batik industry which is a creative art culture the Indonesian people have hereditary. Even UNESCO has confirmed batik as an inheritance culture belonging to Indonesia since October 2, 2009 [1]. Confession this awarded by UNESCO with seeing various efforts made by Indonesia, especially evaluation to the full variety of batik motifs meaning profound philosopher. Deployment batik production in Indonesia according to Ministry Coordinator Field the People's Welfare of the Republic of Indonesia is spread over 20 provinces, including: of them that is West Java in particular Bogor city. Bogor Batik in general carries a characteristic batik motif typical of Bogor City as promoted by one of the batik industries famous in Bogor, namely as cleaver, deer, rain, carcass flower (*Amorphophallus titanium*), flower lotus, taro leaves, etc [2]. The Cleaver-Deer motif is a mainstay motif that reflects the peace and security of Bogor because facing four ready corners secures the city of Bogor. Bogor called the City of Rain is also a mainstay motif in rain-drizzling batik [2]. In research Naimah (2014) found waste test parameter results industry textiles in Bogor City is enough high and over standard raw quality already set. Parameters tested include TSS, TDS, BOD, COD, and fats/oils [3].

Data from the Ministry of Industry shows productivity batik industry, registered from 2011 to 2015 experienced an increase of 14.7%. Enhancement of the batik industry in Indonesia turns out to cause problem negative related to the environment, especially in environmental waters. The batik industry process produces waste containing substance color from the dyeing and washing process of batik cloth [4]. Common dyes used in the batik industry are dye synthetic, because the synthetic color is easy to get, generates colors bright, and is not easy to fade. For example, that is indigosol, naphthol, and indanthrene [5]. But on the other hand, the use of synthetic dye could be fatal to health. If accumulated and eaten through chain food, can cause many disturbances in health. Using substance synthesis dye could accumulate in the body of humans and a carcinogenic period long cause abnormality in human organs. When swallowed could result in irritation of the digestion channel, nausea, vomiting, pain of the stomach, disturbance of function of the liver, heart cancer, and biological urinary cancer [6]. The substance of color used is a combination of substance synthetic dye with substance shaper working color for bringing up as well as strengthening color [7]. As for the substance of shaper, the usual colors used are diazonium salt, NaOH, sulfate acid, hydro salt, caustic soda, etc. The substance of synthetic color is combined with unsaturated organic substance, chromophore, and auxochrome. Chromophores have a role as the one that produces color whereas auxochrome is the one that gives nature to fiber cloth. Important chromophore that is azo groups (–N=N–), vinyl (–C=C–), nitro ($–NO_2$), and carbonyl (–C=O) groups. Whereas several group important auxochrome is $–NH_2$, –COOH, $–SO_3H$, and –OH [8]. Unsaturated organic substance used in the formation of

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color is aromatic compounds, like hydrocarbon aromatics and their derivatives, phenols and their derivatives, and hydrocarbons containing nitrogen [9]. An organic compound at color substance with high concentration causes wastewater to contain poisonous substances, so wastewater should experience processing more formerly before being thrown away in the environment.

Batik waste also has the potential to contain compound chromium hexavalent (Cr^{6+}) [10]. Chrome hexavalent waste is more dangerous and toxic if compared with chromium trivalent (Cr^{3+}). The process of making batik, from the beginning until refinement, indicated the use of chemicals ingredient with the content of heavy metals. Puspita et al [11] stated that the content of heavy metals on waste originated from dye substances. The batik production also requires water with high volume, produces waste with high color substance, contains reactive residue dye, and contains chemistry material [12]. Besides high content color substance, waste of the batik industry and textile industries also contain synthetic materials which are late or hard degradated. In the production, Batik is needed a water source, as well as chemical ingredients in the form of organic and inorganic substances, which causes several parameters of batik wastewater quality such as BOD, COD, TDS, TSS, sulfide, total phenol, and total Cr becomes high [13] [14], so the level of this parameters exceed the quality of standard.

Minister of Environment Regulation Life and the Forestry Republic of Indonesia Number P.16/MENLKH/SETJEN/KUM.1/4/2019 concerning change second on Minister of Environment Regulation Life Number 5 of 2014 concerning wastewater quality by physical and chemical properties. The quality standard of wastewater for business and/ or activity industry textile is BOD of 45 mg/L, COD of 125 mg/L, TSS of 40 mg/L, levels of total phenol of 0.5 mg/L, levels of total chromium of 1 mg/L, the content of sulfide of 0.3 mg/L, pH is in the range of 6-9, and temperature is the temperature of the air around (with deviation 2) [15]. Because of this, a goal of the study is for determining the characteristics of physical and chemical wastewater of industrial batik in Bogor City by measuring the levels of BOD, COD, temperature, TSS, pH, sulfide, total phenol, and total chromium.

2. METHODS

The sample used is wastewater from Batik Industry in Bogor City. Parameters were analyzed according to procedure standard analysis of the quality of wastewater contained in the Regulation of the Minister of the Environment Life and The Forestry Republic of Indonesia Number P.16/MENLKH/SETJEN/KUM.1/4/2019. The test method refers to the Indonesian National Standard. Analysis of COD measured by closed reflux method, BOD levels are measured by Winkler method, TSS measured by gravimetry method, pH and temperature measured by pH meter, total chromium measured by AAS (Atomic Absorption Spectrophotometry) method, total phenol as well as sulfide measured by Spectrodirect Spectrophotometry.

2.1. Tools

Tools used in a study i.e scale analytical, cuvette, burette, glass cup, Erlenmeyer, volume pipette, measuring glass, dropper, measuring flask, watch glass, the crucible, strain paper, funnel, desiccator, oven, UV-VIS spectrophotometer, AAS, Spectrodirect Spectrophotometry, BOD meter, vial, and magnetic stirrer.

2.2. Ingredients

Ingredients used in the study i.e wastewater of batik industry from staining wastewater and wastewater from total production batik, distilled water, potassium dichromate solution, concentrated sulfuric acid, concentrated nitric acid, potassium hydrogen phthalate standard solution, chromium solution standard, sulfide tablets No. 1 and 2 (Lovibond brand); phenol tablets no. 1 and 2 (Lovibond brand); HCl 1 M, NaOH 1 M, Allyl Thiourea, and KOH 45% (w/w) (Merck).

2.3. Procedure Analysis

2.3.1 COD analysis with reflux closed method by spectrophotometry

COD test is done by the method of SNI 6989.2:2009, namely through the digestion process. Stage this conducted with pipetted the sample or working solution then added digestion solution and sulphuric acid solution in a tube closed, then shaken so that homogeneous. Next, the tube was heated in heating at 150°C and carried out reflux for 2 hours. Then measured sample that has been heated, left until temperature room for preventing formation sediment. Let suspension settle down and make sure the part to be measured is truly clear. Absorption of the sample is measured at the 600 nm wavelength and a calibration curve is made as area quantification. COD was determined with Duplo repetition [16].

2.3.2 TSS (Total Suspended Solid)

TSS test is done by the method of SNI 6989.3:2019, namely sample that has been homogeneously filtered with filter media that has been weighed before. Residue retained on the filter media dried in the range temperature 103°C to 105°C to reach constantly. Ascension of filter weighing represents Total Suspended Solid (TSS) [17].

2.3.3 pH and Temperature

pH and temperature test conducted by the method of SNI 6989.11:2019, namely electrode rinsed with mineral-free water, next dried with paper tissue. Then electrode was dipped in the sample until the pH meter shows stable reading. Reading result of scale or numbers on display noted. After measurement, the electrode was rinsed and soaked return with mineral-free water [18].

2.3.4 Analysis of Total Chromium

Analysis of total chromium was performed by the method of SNI 6989.17:2009, the namely standard solution made from chromium solution with pipette 10 mL, parent solution then entered in measuring flask 10 mL. Standard solution diluted until sign boundary and homogenized then

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analyzed with AAS. Standard calibration curve made for area quantification. Sample solution destruction with concentrated nitric acid and heated until the solution becomes clear. Then diluted with added aqua dest water until the sign border on a 50 mL measuring flask. Absorption of sample solution measured using AAS on 357.9 nm wavelength [19].

2.3.5 Analysis of Sulfide

Sulfide analysis conducted with Spectro Direct has conducted calibration with use sample solution as much as 10 mL into the vial then closed and entered into place in Spectrodirect and measured. Sulfide tablets No. 1 were added to in vial containing the sample and crushed until homogeneous. Then added one sulfide tablet No. 2 into the same vial and homogenized it. Vial closed then homogenized and placed in sample place at spectrodirect. Then on the Spectrodirect pressed the knob and wait for the reaction process for 10 minutes. After the reaction process is done, measurement is started by automatic. Results were determined in mg/L Sulfide.

2.3.6 Analysis of Total Phenol

Analysis of total Phenol was carried out with Spectrodirect method, which is conducted calibrated with use sample solution as much as 10 mL into the vial then closed and entered to in the sample place at spectrodirect. One phenol tablet No. 1 was added to in vial containing the sample and crushed until homogeneous. Then added one phenol tablet No. 2 to the same vial and homogenized it. Vial closed then shaken and placed in sample place at Spectrodirect with ensuring that position parallel. Then on the Spectrodirect pressed the knob test and wait for the reaction process for 5 minutes. After the reaction process is done, measurement is started by automatic. Results were determined in mg/L Phenol.

2.3.7 BOD Analysis

Analysis of BOD is done with the wrinkle method i.e pH of the sample is determined the first time, and the optimum pH for biochemistry oxidation is 6.5-7.5. If the pH is high added HCl 1 M or H_2SO_4 1 M. If the pH is low NaOH 1 M was added. Next, the sample is filtered with strain paper. Then the sample volume varied by the BOD range (Table 1). The sample was entered into a bottle and then added a few drops of nitrification inhibitor B (Allyl Thiourea or ATH) according to the sample volume used. Then the solution was stirred with a magnetic stirring rod in each bottle and added 3-4 drops of 45% (w/w) KOH, to seal the gasket then entered the seal gasket into the mouth bottle. After that mounted the BOD head/sensor on the bottle and tightened with be careful, make sure the system does not leak. BOD bottle with the built-in sensor placed on the shelf of the BOD meter unit. Then BOD measurement system is in a stirrer that has been prepared and incubated in an incubator at 20 °C ± 1°C. BOD measurement is carried out for 5 days with to-do recording results every day.

Table 1. Addition of ATH

BOD range measured (mg/L)	Sample volume (mL)	Number of drops of ATH
0-40	428	10
0-80	360	10
0-200	244	5
0-400	157	5
0-800	94	3
0-2000	56	3
0-4000	24.7	1

3. RESULT AND DISCUSSION

Research results show that the parameters of BOD, COD, TSS, and total chromium analyzed higher than threshold quality wastewater for industrial textiles, based on Minister of Environment Regulation Life and the Forestry Republic of Indonesia Number P.16 /MENLKH/SETJEN/KUM.1/4/ 2019, as shown in Table 2.

Table 2. Characteristics of wastewater of batik industry in Bogor City

Parameters	**Unit**	**Results**		**Quality Standards**
		Coloring Waste	**Total Waste**	
pH	-	1.62	6.82	6.0-9.0
Temperature	°C	26.9	26.3	Temperature around (deviation 2)
COD	mg/L	797	52463	125
BOD	mg/L	431	238	45
TSS	mg/L	706.5	3679	40
Total Phenol	mg/L	Not detected	Not detected	0.5
Total Cr (Cr^{6+})	mg/L	2.62	940.2	1.0
Sulfide	mg/L	Not detected	Not detected	0.3

According to Indrayani [20], pH and temperature parameters i.e important supporting parameters for conducted analysis, because two parameters are an indicator for the continuity of the decomposition process by microorganisms in the something system reactor. At the time of conducted analysis, the pH in coloring waste was not fulfilled the quality standard, where the pH value of 1.62 is acid. Meanwhile, the pH of total waste has fulfilled the quality standard with a range of 6-9. Whereas the temperature of coloring waste and total waste is no different, the temperature value is still in the range of optimum temperature for growth bacteria, namely ranging from 24-35 °C. The temperature of waste is needed in processing waste.

The height levels of BOD and COD were caused by the existence abundant of organics substrate in wastewater. Parameters of BOD used to measure the activity of microorganisms in usage much oxygen purposeful dissolved for degrading ingredient abundant organic in the substrate, so that could cause happening deletion indicated oxygen through low DO value. A decreased rate of oxygen will impact the survival of aquatic life. Wirosarjono in Salmin

[21] stated that the level of water pollution could be rated from BOD and DO values as shown in Table 3.

Table 3. The level of water pollution based on DO and BOD Value

Pollution Level	Parameters	
	DO (mg/L)	BOD (mg/L)
Low	>5	0-10
Medium	0-5	10-20
High	0	25

Based on the level of water pollution served in table 3 above, can conclude that the quality wastewater of batik belongs to high-level pollution, so needed effort in processing wastewater before being thrown away into the environment.

In scientific research, COD parameters show a lot of oxygen chemicals needed by microorganisms for oxidizing organic ingredients in the wastewater. The increase in BOD will be comparable with an increase in COD. The increase in COD can also be influenced lack of dissolved oxygen in waters [22]. COD value for coloring water nor total waste is very high above the quality standard of 125 mg/L. Where is the COD value for coloring waste which is 797 mg/L, and for total waste which is 52463 mg/L.

TSS is a parameter that shows a lot of substance solid, which can be in the form of organic or inorganic ingredients [22]. TSS of coloring waste and total waste is classified as high because of a lot of material in the form of particles smooth on both sample wastewater. TSS testing on coloring waste and total waste gives a very high yield compared to the quality standard P.16/MENLKH/SETJEN/KUM.1/4/2019, namely of 40 mg/L. Where is the TSS value on the coloring waste of 706.5 mg/L, while total waste has higher than coloring waste is 3679 mg/L. In this research, the level of TSS is higher than the industry wastewater in Yogyakarta which is 530 mg/L [20].

Phenol compound content in wastewater is harmful pollutants at the level of high toxicity even with low concentrations, in the quality standard have 0.5 mg/L [20]. In batik wastewater existence phenol is caused by alcohol mixed with wax in the scraping process in batik [16]. The table above shows that the test results on the phenol parameters are very low than the quality standard. This is declared with data on Spectrodirect that is under range on spectrodirect.

There is one heavy metal necessary to notice existence in batik wastewater, that is total chromium. Total chromium in the production of batik is usually obtained from synthetic dyes [20]. Total chromium in coloring waste and total waste is 2.62 mg/L and 940.2 mg/L, respectively, this value is higher than the quality standard i.e 1.0 mg/L. This is caused height use of the color substance in the batik processing. In this research, total chromium is higher than the batik industry in Yogyakarta [20].

Sulfide compound is an inorganic anion from sulfur, this is not affecting the color of the sulfide salt, therefore that sulfide is classified as a strong base, a salt solution such as sodium sulfide (Na_2S) which is corrosive and can attack skin (irritant). Sulfide is also the simplest sulfur anion. The mixture of sulphuric acid (H_2SO_4) and sulfide salt is often used as a servant substance in batik making with the use of synthetic dye [20]. The quality standard of sulfide is <0.3 mg/L, based on the results obtained shown in the table above that the test results on the sulfide parameters are very lower than the quality standard allowed. Therefore, sulfide content from the activity of batik coloring in Bogor City is not pollution for the area around because the rate of sulfide is under the threshold limit of quality standards [15].

4. CONCLUSION

Based on the results of the study conclude coloring waste and total waste exceeds the quality standard allowed by the Minister of Environment Regulation Life and the Forestry Republic of Indonesia Number P.16/MENLKH/SETJEN/KUM.1/4/2019. Therefore, wastewater of the batik industry needs to process before being thrown away into the environment.

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REFERENCES

[1] UNESCO, Nomination for Inscription on Representative List in 2009, reference No. 00170, Intergovernmental Committee for The Safeguarding of the Intangible Culture Heritage, Law no. 24 of 2000 concerning Agreement International.

[2] Wijayanto, E. 2013. Bogor Batik My Tradition: Structuralism Study Genetics and Memetics. *Crossing*, 29, 210–225.

[3] Naimah, S., Ardhanie, SA, Nugroho Jati, B., Nur Aidha and Agustina Arianita. 2014. Degradation Substance Color on Waste Liquid Industry Textile with Method Photocatalytic Use Nanocomposite Tio 2-Zeolite (Color Degradation In Textile Industrial Wastewater With Photocatalytic Method Using Nanocomposite Tio2-Zeolite). *Packaging Chemistry*. Vol 36. 225-236.

[4] Tangahu, Bieby Voijant; Dwi Agustina Ningsih. 2016. Drop Test Content of COD, BOD in Waste Liquid Batik dye using Scirpus grossus and Iris pseudacorus with System Intermittent Exposure. *Journal Science and Technology Environment*. 8(2), 121-130.

[5] Casta and Taruna. 2007. *Cirebon Batik: An Introduction Appreciation, Motive, and Meaning Symbolic*. Cirebon: Communication, Culture and Tourism Agency Cirebon Regency.

Volume 02, Number 01, June 2022, Page 20 - 24
e-ISSN: 2776-4508; p-ISSN: 2776-1711
Publisher : Universitas Pakuan

[6] Masthura. 2019. Identification of rhodamine b and methanyl yellow on sweets fruit circulating in the city of Banda Aceh qualitative. *AMINE* 1(1): 39-44.
[7] Nurbidayah., Suarsini, E., and Hastuti, US. 2014. Biodegradation with Isolate Indigenous Bacteria in Waste Textile Sasirangan in Banjarmasin. *Proceedings of the Synergy National Seminar Food Feed and Energy Renewable*. 21-23 October 2014. Yogyakarta: 233.
[8] Haryono, Muhammad Faizal D, Christi Liamita N and Atiek Rostika. 2018. Processing Waste Substance Color Textile Dispersed with Method Electroflotation. *Journal of Chemistry and Education.* Vol 3 (1); 95-96.
[9] Manurung, R., Rusdanelli H, Irvan. 2004. *Overhaul Substance Azo Reactive Color by Anaerobes-Aerobes.* E-USU Repository. Faculty of Engineering, Department of Chemical Engineering, University of North Sumatra.
[10] Sasongko, Dwi; Wildan Panji Tresna. 2010. Identification Elements and Metal Content Weight on Waste Batik Dye with Method Analysis Neutron Activation. *Journal Knowledge Knowledge and Technology REVIEW*. Volume 27. Accessed from.
[11] Puspita U, Siregar A, Hidayati N. 2011. Ability Aquatic Plants as Agent Phytoremediator Metal Heavy Chromium (Cr) is found in Waste Liquid Batik Industry. *Journal The Worst*. 39(1), 58-64.
[12] Ramesh, et al. 2007. *Cotton Textile Processing:* Waste Generation and Effluent Treatment. *Journal of Cotton Science*, 11:141–153.
[13] Subki, NS and Rohasliney, H. 2011. A Preliminary Study on Batik Effluent in Kelantan State: A Water Quality Perspective. *International Conference on Chemical, Biological and Environmental Sciences (ICCEBS'2011).* Bangkok December 2011.
[14] Kurniawan, WM, Purwanto, P., and Sudarno, S. 2013. Wastewater Management Strategy for Sustainable Batik MSME Centers in the District Sukoharjo. *Journal Knowledge Neighborhood*, 11(2): 62 -72.
[15] Minister of Environment Regulation Life and The Forestry Republic of Indonesia Number P.16/MENLKH/SETJEN/KUM.1/4/ 2019 concerning Wastewater Quality Standards.
[16] Badan Standarisasi Nasional. 2009. *SNI 6989.2:2009. Water and wastewater – Part 2: How to test Needs Oxygen Chemical (Chemical Oxygen Demand/COD) with reflux closed by spectrophotometry.* BSN: Jakarta.
[17] Badan Standarisasi Nasional. 2019. *SNI 6989.3:2019. Water and wastewater – Part 3: Solids test method total suspended solids (TSS) gravimetry*. BSN: Jakarta.
[18] Badan Standarisasi Nasional. 2019. *SNI 6989.11:2019. Water and wastewater – Part 11: How to test degrees acidity (pH) using a pH meter*. BSN: Jakarta.
[19] Badan Standarisasi Nasional. 2009. *SNI 6989.17:2009. Water and wastewater – Part 17: Method of testing total chromium (Cr-T) Spectrophotometry Atomic Absorption (AAS).* BSN: Jakarta.
[20] Indrayani, Lilin. 2019. Technology Processing Waste Liquid Batik with WWTP BBKB as an alternative pilot for Batik Industry. Proceedings of the National Seminar on Chemical Engineering "Struggle" Development Chemical Technology for Processing Source Power Indonesian Nature. Yogyakarta. ISSN 1693-4393.
[21] Salmin. 2005. Oxygen dissolved (DO) and need oxygen biology (BOD) as one of the indicators for determining the quality of water. *Oceana*. Volume XXX, Numbers 3, 21-26.
[22] Fidiastuti, Hasminar Rachman and Anis Samrotul Latifah. 2018. *Characteristic Test Waste Liquid Tulungagung Batik Industry: Research Introduction*. Faculty Educational Sciences: Tribhuwana University Tunggadewi. Poor. National Seminar on Biology and Science and Technology Education III (2018). ISSN: 2527-533x.