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Pollution Load Assessment Of Batik Industry Wastewater Using Key Water Quality Parameters

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Abstract
The batik industry is one of the leading creative economy sectors in Indonesia that contributes significantly to the regional economy. However, the production process produces large amounts of liquid waste containing synthetic dyes, salts, surfactants, oxidizing agents, as well as alkaline and organic chemicals such as costic soda, sodium silicate, and wax. The purpose of the study was to analyze the quality of liquid waste in the batik industry based on Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), and Total Dissolved Solid (TDS) test data on seven samples (A-G) produced by the batik industry in Yogyakarta. The BOD test is carried out with the SNI 6989.72:2009 test method, the COD test is carried out with the SNI 6989.73:2019 test method, the TSS test is carried out with the SNI 6989.3:2019 test method, and the TDS test is carried out with the SNI 6989.27:2019 test method. The results showed that some samples (especially samples D and C) had a very high pollutant load that required multistage processing such as neutralization/pretreatment, coagulation-flocculation, advanced oxidation processes (AOPs) or a combination of biological and adsorption.
Keywords – *batik waste, BOD, COD, TSS, TDS, advanced oxidation, adsorption, coagulation-flocculation.*

I. INTRODUCTION

The batik industry is one of the leading creative economy sectors in Indonesia that contributes significantly to the regional economy. However, the production process produces large amounts of liquid waste containing synthetic dyes, salts, surfactants, oxidizing agents, as well as alkaline and organic chemicals such as costic soda, sodium silicate, and wax [1], [2]. This content causes a high load of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), as well as increases Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) in the receiving water body [1], [2], [3]. [4], [5], [6].

Batik liquid waste that is disposed of directly into the environment without treatment can cause serious pollution to the waters and soil. Synthetic dyes such as naptol, indigosol, and remasol are known to be toxic, carcinogenic, and persistent so they are difficult to break down biologically. The accumulation of dyes in water bodies inhibits light penetration, interferes with the photosynthesis of aquatic organisms, and results in a decrease in dissolved oxygen levels. In addition, high alkaline content can raise the pH of waters and affect aquatic biodiversity [7], [8].

Several international studies in the last five years have shown that the treatment of batik and textile waste requires a combination of physical, chemical, and biological methods to achieve optimal results. In general, there are four main approaches that are widely used, namely: coagulation–flocculation and electrocoagulation, aerobic–anaerobic biological processes, Advanced Oxidation Processes (AOPs), and adsorption using biomass and activated carbon materials.

Coagulation–flocculation and electrocoagulation methods are effective in reducing TSS and partial color through the formation of precipitating flocs, mainly using $FeCl_3$, $Al_2(SO_4)_3$, or aluminum/iron electrodes [9]. Aerobic–anaerobic biological processes including the Upflow Anaerobic Sludge Blanket (UASB) system, trickling filters, and constructed wetlands are used to significantly lower BOD and COD at low cost, suitable for batik SME scale [10]. Advanced Oxidation Processes (AOPs) in the form of technologies based on UV/H_2O_2, ozone, Fenton, and electrocatalytic can reduce complex organic compounds and colors that cannot be biodegradable [11]. The AOPs have been proven to reduce COD by 80–95% in textile waste containing azo dyes. Then adsorption using biomass and activated carbon materials such as the use of agricultural waste-based adsorbents (rice husks, fruit peels, bagasse, coconut shell charcoal) has been used to effectively absorb synthetic dyes. This approach is environmentally friendly and low-cost, suitable for applications at the SME level [12].

Various study results show that the combination of these methods, such as coagulation–AOP–adsorption or biological-adsorption, provides the most efficient results in reducing the burden of BOD, COD, TSS, and TDS to reach the quality standards set in the Regulation of the Minister of Environment No. 5 of 2014 [13]. Thus, the evaluation of these parameters (BOD, COD, TSS, TDS) is important to design an efficient, economical, and sustainable waste treatment system. This study uses laboratory test data from seven batik waste samples (A–G) as the basis for analysis, then compares it with the latest international studies (2020–2025) to formulate appropriate treatment recommendations for batik SMEs in Indonesia.

II. METHODOLOGY

The wastewater samples analyzed in this study were collected from various stages of the batik production process, each involving different chemical compounds and dyes. The synthetic dyes used included Indigosol, Blue Salt B, Blue BB, and Red B, which are commonly applied during the dyeing stage of batik making. In addition, Remasol, a reactive dye, was sampled before any treatment to determine the initial characteristics of the wastewater. The mixture of batik wax (malam) and caustic soda (NaOH) originated from the *pelorodan* process (wax removal), which typically contributes to high organic content and increased alkalinity in the effluent. Wastewater from the Naptol dyeing process and its rinse water was also included, as these contain residual azo dyes and color-binding agents that are resistant to biodegradation. Furthermore, a mixture of Naptol and caustic soda was collected to represent the combined wastewater from dyeing and wax removal stages. Each sample reflects different characteristics of batik wastewater, from the dyeing and washing steps to the wax removal process, collectively contributing to the high pollutant load typically found in liquid waste from the batik industry.

A total of seven samples of liquid waste (A–G) were collected from the following various batik SMEs:

A. Indigosol – Batik Jumputan Batikan
B. Blue salt b, blue bb, red b – Batik Berkah Lestari
C. Remasol before processing – Batik Aisyah
D. Mixture of waste with wax and kostic – Berkah Lestari
E. Mixture of naptol and rinsing water – Pak Sukamli
F. Mixture of naptol, ASL-B, AS-G, ASBR, kostic – Berkah Lestari
G. Soil filtration results – Sri Kuncoro

Wastewater samples were collected from several batik production sites located in Yogyakarta, Indonesia. The samples represented different stages of the batik process, including dyeing, rinsing, and wax removal (*pelorodan*). Each sample was collected in 1-liter polyethylene bottles, labeled according to its source (e.g., Indigosol, Blue Salt B, Remasol, Wax Mix with Caustic, Naptol, and Naptol–Caustic mixture), and stored at 4 °C prior to analysis to prevent biological degradation. All samples were analyzed within 24 hours of collection.

Physicochemical parameters, including pH, BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), TSS (Total Suspended Solids), and TDS (Total Dissolved Solids), were measured according to the Standard Methods for the Examination of Water and Wastewater. The BOD was determined using the 5-day incubation method at 20 °C, while COD was measured by the closed reflux dichromate method. TSS was analyzed by filtering samples through pre-weighed glass fiber filters (Whatman GF/C, 0.45 µm) followed by drying at 105 °C to constant weight. TDS was determined gravimetrically after filtration and evaporation of the filtrate at 180 °C.

All analyses were conducted in triplicate to ensure accuracy and reproducibility. The results were compared against the Indonesian National Standard for Industrial Textile Effluent Quality [6], which specifies maximum permissible limits of BOD ≤ 150 mg/L and COD ≤ 300 mg/L. The comparison provided insight into the degree of pollution and compliance of batik wastewater with national environmental standards.

The BOD level test is carried out by preparing 2 DO bottle fruit, mark each bottle with the notation A1; A2; put the test sample solution into each bottle of DO A1 and A2; until it overflows, then close each bottle carefully to avoid the formation of air bubbles; shake several times, then add mineral-free water around the mouth of the closed DO bottle; store the A2 bottle in a 20°C ± 1°C C incubator cabinet for 5 days; Measure dissolved oxygen against the solution in the A1 bottle with the DO meter tool calibrated according to *Standard Methods for the Examination of Water and Wastewater 21st Edition, 2005: Membrane electrode method (4500-O G)* or by iodometric titration method (Azida modification) in accordance with SNI 06- 6989.14-2004.

The measurement results are the value of dissolved oxygen of zero days (A1). Dissolved oxygen measurements at zero days should be taken no later than 30 minutes after dilution; repeat the process for the incubated A2 bottle for 5 days ± 6 hours. The measurement results obtained were 5-day dissolved oxygen values (A2); Perform the work for the determination of the blank using a diluent solution without a test sample. The measurement results obtained were zero days dissolved oxygen value (B1) and 5 days dissolved oxygen value (B2); Perform work for the standard control setting using a glucose-glutamic acid solution. The measurement results obtained were the value of dissolved oxygen of zero days (C1) and the value of dissolved oxygen of 5 days (C2); Rework on several types of dilution test samples. To prevent the nitrification process from occurring, a nitrification inhibitor solution of 1 mL per 1 L of diluting solution can be added. Dissolved oxygen in diluting water consumed by microbes for 5 days ranges from 0.6 mg/L – 1.0 mg/L. The frequency of work for blank determination and standard control with glucose-glutamate acid is 5% - 10% per *Batch* (one series of measurements) or at least 1 time for the number of test samples less than 20.

The COD level determination test is carried out by preparingand preserving the test sample, a test sample until it is homogeneous and immediately conducting an analysis. The test sample is preserved by adding H_2SO_4 until the pH is less than 2.0 and the test sample is stored in a 4°C cooler with a shelf life of 7 days.

The procedure is carried out by Pipette 10 mL test sample, put it into a 250 mL erlenmeyer, Add 0.2 g of $HgSO_4$ powder and some boiling stones. Add 5 mL of potassium dichromate solution, $K_2Cr_2O_7$ 0.25 N. Add 15 mL of sulfuric acid reagent – silver sulfate slowly while cooling in cooling water. Connect with *a Liebig* cooler and simmer on *a hot plate* for 2 hours. Cool and wash the inside of the cooler with distilled water until the test sample volume is approximately 70 mL. Cool to room temperature, add 2 to 3 drops of ferroin indicator, titration with FAS solution 0.1 N until reddish-brown, note the need for FAS solution. Do steps for distilled water as a blank. Note the need for FAS solutions. This blank analysis also carried out the standardization of the FAS solution and carried out each COD determination.

The TDS level test is carried out by stirring the test sample until it is homogeneous; take a quantitative test sample with a certain volume, put it into a filter that has been equipped with a suction pump and filter medium; operate the filter device; Rinse the filter medium 3 times with 10 ml of mineral-free water each, continue the filtration with the vacuum system until drained; transfer the filtrate into a vaporizer cup that has a fixed weight; Steam the filtrate present in the evaporator cup with a water bath up to the side.

Evaporation can also be done using an oven or *hot plate* with a temperature below the boiling point of water so that the filtrate in the cup does not splash out. Place the evaporative cup filled with the crushed dissolved solids in the oven at 180 ^{0}C ± 2 ^{0}C for at least 1 hour. During the drying process, the oven should not be opened and closed. Remove the evaporative cup from the oven with tongs and cool in the decifier. After cooling, immediately weigh in on the analytical balance. Repeat the experiment until a fixed weight is obtained (recorded as W1 mg), then calculate the TDS value.
The TSS level test is carried out with vacuum equipment. Moisten the colander with a small amount of distilled water. Stir the test sample with a magnetic stirrer to obtain a more homogeneous test sample. The test sample pipette with a specific volume, at the time of the sample is stirred with a magnetic stirrer. Wash the filter paper or colander with 3 x 10 mL of distilled water, allow it to dry completely, and continue straining in a vacuum for 3 minutes to obtain a perfect filter. Test examples with high dissolved solids require additional washing. Carefully remove the filter paper from the screening equipment and transfer it to an aluminum weighing container as a support. If using a Gooch cup, move the cup from the appliance assembly. Dry in the oven for at least 1 hour at 103^{o}C to 105^{o}C, cool in a desiccant to balance temperature and weight. Repeat the stages of drying, cooling in the decifier, and weighing until a constant weight is obtained or until the weight change is less than 4% from the previous weighing or less than 0.5 mg. If the filtration is perfect takes more than 10 minutes, increase the diameter of the filter paper or reduce the volume of the test sample. Measure the volume of the test sample that produces a residual dry weight of 2.5 mg to 200 mg. If the filtered volume does not meet the minimum result, increase the volume of the test sample to 1000 mL.

Data Analysis Techniques
The BOD value of the sample test is calculated as follows:

$$\mathbf{BOD_5} = \frac{(\mathbf{A_1} - \mathbf{A_2}) - (\frac{\mathbf{B_1} - \mathbf{B_2}}{\mathbf{V_B}})\mathbf{V_C}}{\mathbf{P}}$$

Where:

BOD is the BOD5 value of the sample test (mg/L);
A1 is the dissolved oxygen level of the sample test before incubation (0 days) (mg/L);
A2 is the dissolved oxygen level of the sample test after 5 days of incubation (mg/L);
B1 is the level of dissolved oxygen of the blank before incubation (0 days) (mg/L);
B2 is the level of dissolved oxygen of the blank after 5 days of incubation (mg/L);
VB is the volume of microbial suspension (mL) in a blank DO bottle;
Vc is the volume of microbial suspensions in the sample test bottle (mL);
P is the ratio of sample test volume (V1) to total volume (V2).
If the test sample is not added microbial seeds, VB = 0.

COD up to (mg/L O_2) = $\frac{(A-B)(N)(8000)}{mL\ sample-test}$
where:
A is the volume of FAS solution required for the blank, mL;
B is the volume of FAS solution required for example, mL;
N is the normality of FAS solution.
TSS Up:
mg TSS per liter = $\frac{(A-B)\times 1000}{test\ sample\ volume, mL}$
Where:
A is the weight of filter paper + dry residue, mg;
B is the weight of the filter paper, mg.

Calculate TDS according to the following formula.

TDS (total dissolved solid) level calculated by the formula
(mg/L): $\frac{(W_1 - W_0) \times 1000}{V}$
Description:
W0 is the fixed weight of the empty cup after heating 180°C ± 2°C, (mg);
W1 is the fixed weight of the cup containing the total dissolved solids after heating 180°C ± 2°C, (mg);
V is the volume of the sample test in ml units; 1000 is the conversion from milliliters to liters.

III. RESULTS AND DISCUSSION

Organic Load (BOD and COD Analysis)

The BOD and COD values of the batik wastewater samples varied significantly depending on the production stage. The highest organic load was observed in Sample D, which contained a mixture of wax (*malam*) and caustic soda (NaOH). This sample exhibited extremely high BOD and COD values, indicating a large amount of organic and chemical content. The high BOD reflects the presence of biodegradable organic matter, while the elevated COD indicates both biodegradable and non-biodegradable compounds that require chemical oxidation [14].
According to the Indonesian Standard for Textile Industry Effluent (BOD ≤ 150 mg/L; COD ≤ 300 mg/L), almost all samples—except Sample G—exceeded the permissible limits. The excessive BOD and COD suggest that most batik effluents contain high concentrations of wax, dyes, surfactants, and other organic substances. The wax and caustic mixture in Sample D releases fatty acids, paraffin, and resin compounds that are difficult to decompose, leading to high oxygen demand in receiving waters [15].
High COD values were also recorded in Sample C, which corresponded to the use of Remasol reactive dyes. These dyes are characterized by their complex aromatic structures and sulfonate groups, making them resistant to biodegradation [16]. Such compounds contribute to the persistence of color and organic load in wastewater, indicating that conventional biological treatment alone may be insufficient for effective removal.
The results of the research on the levels of BOD, COD, TSS, and TDS of batik dye waste are shown in Table 1.

Table 1. Rates of BOD, COD, TSS, and TDS of batik dye waste

Sample	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	TDS (mg/L)	Information
A	665.5	2,621.0	36.0	15,675.0	Indigosol
B	1,405.9	1,951.6	32.0	6,595.0	Blue salt b, blue bb, red b
C	1,515.2	9,112.9	1,343.8	13,340.0	Remasol before processing
D	19,038.7	34,442.3	8,983.3	105,900.0	Wax mix, kostik
E	1,120.3	1,225.8	580.0	1,520	Naptol and rinse water
F	550.9	3,758.1	200.0	6,030.0	A mixture of naptol and kostic
G	6.5	39.1	5.0	401.0	Soil filtration results

Based on Table 1, it can be explained that all dye waste samples produced by the batik industry show BOD levels above 150 mg/L, all of which exceed the standard quality threshold for liquid waste in the textile industry, except for sample G showing a BOD level of 6.5 mg/L. This means that samples G have received dye waste filtration treatment with soil, has met/in accordance with the quality standards of liquid waste in the textile industry. Likewise, COD levels, produced by the batik industry show COD levels above 300 mg/L, all of which exceed the standard threshold for the quality of liquid waste in the textile industry, except for sample G showing a COD level of 39.1 mg/L. This means that sample G that has received a treatment for filtering dye waste with soil, has met/complied with the quality standards of liquid waste in the textile industry.

BOD and COD values showed high organic matter content, especially in sample D which contained a mixture of wax and costic waste. According to the quality standard of liquid waste for the textile industry (BOD ≤ 150 mg/L; COD ≤ 300 mg/L), all samples except G exceeded the threshold. This shows that most batik waste contains very high organic and chemical substances. BOD and COD values are the main indicators of the level of organic pollution in wastewater. A high BOD value indicates the amount of organic matter that microorganisms can biodegrade, while a COD value indicates the total content of organic matter (both biodegradable and non-biodegradable) that requires chemical oxidizers to decompose [14].

In the test results, sample D had the highest BOD and COD values among all samples. This sample comes from a mixture of batik (batik wax) and kostic (NaOH) wax waste used in the process of palorodan or wax removal from fabrics. Both materials contribute greatly to the increase in organic and chemical load because batik wax candles contain complex organic compounds such as paraffin, resin, and resins that are difficult to biodegrade. Costic soda (NaOH) is a strong alkaline that can dissolve fats and proteins, produce dissolved organic compounds and increase the alkalinity of wastewater [15].

According to the Regulation of the Minister of Environment and Forestry No. 5 of 2014 concerning Wastewater Quality Standards, for the textile industry, the maximum value of BOD is 150 mg/L and COD is 300 mg/L. Based on the test results, all batik waste samples except sample G exceeded the threshold. This indicates that most batik liquid waste contains a high pollutant load and has the potential to reduce the quality of the receiving water body.

The high content of organic and chemical substances in batik waste can cause a decrease in dissolved oxygen (DO) levels in waters, disrupt aquatic life, and trigger the eutrophication process [17]. In addition, synthetic dyes and chemical compounds such as surfactants, heavy metal salts, and alkalis can be toxic to aquatic organisms and cause long-term effects on the environment [18].

Thus, a pre-treatment process is required before batik liquid waste is disposed of into the environment, for example through coagulation-flocculation, adsorption using biomaterials (such as cellulose powder or activated charcoal), or biological systems such as aerobic/anaerobic reactors.

Suspended and Dissolved Solids (TSS and TDS)

The highest TSS (Total Suspended Solids) and TDS (Total Dissolved Solids) values were found in Sample D, confirming that the wax–caustic mixture produces large quantities of suspended particulates and dissolved inorganic salts. The caustic soda used in the wax removal process causes emulsification of organic residues and dissolves inorganic components, increasing both suspended and dissolved solids in the effluent [19].

In contrast, Sample G, which represented filtered soil or control water, exhibited the lowest values for all parameters (BOD, COD, TSS, and TDS). This sample indicates the natural background level of water unaffected by batik processing and demonstrates the ability of soil filtration to reduce particulates and chemical loads through natural adsorption and sedimentation processes [20].

The presence of high TSS and TDS in batik wastewater can reduce light penetration in receiving waters, affecting aquatic photosynthesis and potentially leading to eutrophication. Moreover, dissolved ions such as Na^+, Cl^-, and SO_4^{2-} can alter the conductivity and salinity of water, disturbing aquatic ecosystems [21].

The highest TSS and TDS values were found in sample D which showed a lot of suspended particles and inorganic salts. Sample C has a high COD due to the influence of the synthetic dye Remasol. Meanwhile, the G sample, which is the result of soil filtration, has the lowest value and can be used as a natural control.

The TSS (Total Suspended Solids) and TDS (Total Dissolved Solids) values are important parameters that reflect the level of turbidity and the content of dissolved solids in wastewater. TSS shows the number of suspended and insoluble solid particles such as fabric fibers, soil, and wax residues, while TDS measures total dissolved solids, including inorganic ions such as Na^+, Cl^-, and SO_4^{2-} [21].

The measurement results showed that sample D had the highest TSS and TDS values. This condition is caused by a mixture of wax waste and cosmic solution (NaOH) used in the process of pausing and batik fabric. The process produces a lot of wax, soap, and inorganic salt residues that increase the number of suspended particles and increase the content of dissolved solids [19]. In addition, high pH conditions in alkaline waste can accelerate the dissolution of inorganic substances, so that the TDS value increases significantly.

Meanwhile, sample C showed high COD values, which was mainly due to the use of a synthetic dye of the Remasol type (azo-based reactive dye). This dye is known to have a complex molecular structure and contains sulfonate groups that are highly stable against biological degradation [16]. Due to its resistance to natural oxidation, Remasol contributes to an increase in COD values, although not all of them can be biodegraded. The content of this dye can also give a strong color to the waste and inhibit the penetration of light in the waters, which has an impact on reducing the photosynthetic activity of aquatic organisms.

On the other hand, the G sample, which is the result of soil filtration, has the lowest TSS, TDS, BOD, and COD values. This shows that soil has a natural ability to filter solid particles, absorb inorganic ions, and lower the concentration of organic matter through natural adsorption and filtration processes [20]. Thus, the G sample can be used as a natural control that represents the water condition without chemical contamination from the batik process.

Overall, this data confirms that the batik process, especially the dyeing and polishing stages, is the main source of increased pollutant loads of solids and organics. Control efforts need to focus on initial filtration, sedimentation, and the use of environmentally friendly chemicals so that the TSS, TDS, and COD parameters can be suppressed before the discharge of waste into the environment.

Environmental Implications

Overall, the results demonstrate that the batik wastewater samples contain high concentrations of organic and inorganic pollutants, posing serious environmental concerns if discharged without adequate treatment. The combination of high BOD, COD, TSS, and TDS indicates both organic load and chemical complexity, which can deplete dissolved oxygen (DO) in water bodies and harm aquatic life [17].

To mitigate these impacts, pretreatment methods such as coagulation-flocculation, adsorption using lignocellulosic materials (e.g., bagasse cellulose or activated carbon), and biological treatment systems (aerobic or anaerobic reactors) should be considered. These approaches have been reported to effectively reduce organic load and suspended solids in textile wastewater [18].

The batik industry is one of the fastest-growing creative economy sectors in Indonesia. However, the batik production process produces liquid waste that contains dyes, chemicals, and organic compounds that have the potential to pollute the environment. Parameters such as BOD, COD, TSS, and TDS are often used to evaluate wastewater quality. Waste with high BOD and COD values indicates a high content of organic matter which can cause a decrease in dissolved oxygen in the waters. Meanwhile, the TSS and TDS values reflect the degree of turbidity and dissolved solids in the water.

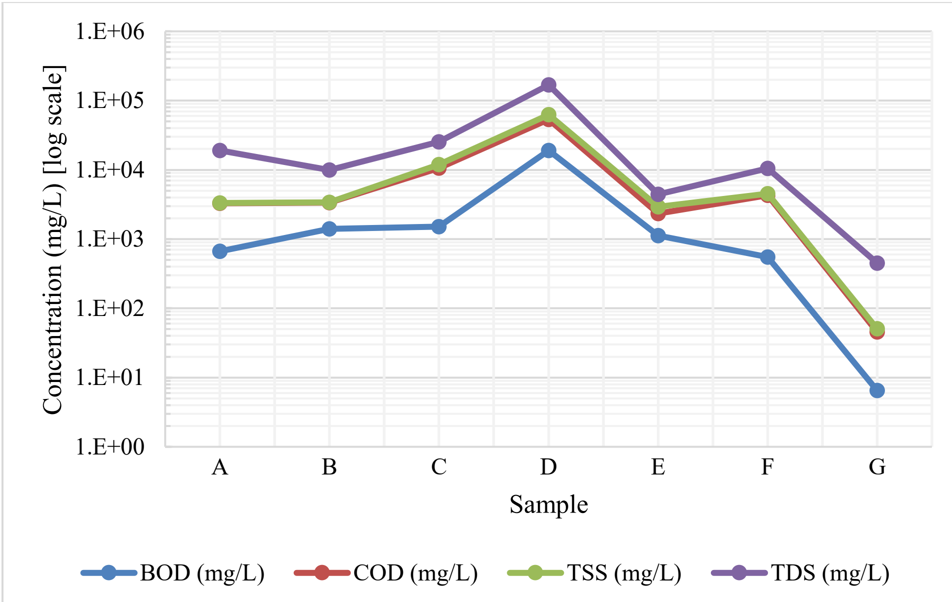

Figure 1: Comparison of BOD, COD, TSS, and TDS values among seven batik wastewater samples

This study analyzed the physicochemical characteristics of batik industry wastewater from Yogyakarta, Indonesia, focusing on BOD, COD, TSS, and TDS parameters. Figure 1 reveales that most samples—particularly those containing mixtures of wax (malam) and caustic soda (NaOH)—exhibited pollutant concentrations far exceeding the permissible limits of the Indonesian standard for textile effluent (BOD ≤ 150 mg/L; COD ≤ 300 mg/L). The highest organic load (BOD and COD) was found in Sample D, attributed to the presence of wax residues, fatty acids, and alkaline compounds that are resistant to biodegradation. Meanwhile, Sample C, containing Remasol dyes, also showed elevated COD levels due to complex aromatic dye structures that are difficult to oxidize or degrade biologically [22], [23].

In terms of solids content, Sample D again exhibited the highest TSS and TDS, indicating a high concentration of suspended particles and dissolved salts derived from alkaline processing. Conversely, Sample G, representing filtered soil or natural background water, had the lowest parameter values, confirming its suitability as a natural control. The combined high values of BOD, COD, TSS, and TDS demonstrate that batik wastewater poses significant environmental risks, including oxygen depletion, turbidity, and potential toxicity to aquatic organisms [22], [23], [24].

To mitigate these environmental impacts, pretreatment and integrated wastewater management strategies are essential [25], [26], [27]. Recommended measures include coagulation–flocculation to remove suspended solids, adsorption using eco-friendly materials such as bagasse cellulose, lignin, or activated carbon [22], [23]. [24], photocatalytic methods [25], soil media [28], foam separation [29], nanomaterials [30], [31], and also biological treatment (aerobic or anaerobic systems) to reduce organic loads. Furthermore, replacing hazardous synthetic dyes with biodegradable or natural colorants could significantly reduce the chemical burden of batik wastewater. Adoption of these technologies, coupled with continuous environmental monitoring and community awareness, will support a more sustainable and eco-friendly batik industry in Indonesia.

IV. CONCLUSION

Based on the results of the research and discussion, it can be concluded that

1. All batik liquid waste samples except G show BOD, COD, TSS, and TDS values that are far above the quality standards.
2. Sample D showed the highest level of contamination with a BOD of 19,038.7 mg/L and a COD of 34,442.3 mg/L.

3. Batik waste with synthetic dyes and chemicals such as kaustic and wax has great potential to pollute the environment.
4. Integrated waste treatment based on environmentally friendly technology is needed so that batik SME activities remain sustainable.

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