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THE EFFECT OF CURRENT AND TIME FOR COD (CHEMICAL OXYGEN DEMAND) AND COLOR DEGRADATION IN THE ELECTROCOAGULATION PROCESS OF BATIK WASTEWATER

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Abstract: The development of the batik industry has been extremely high since recognized as a world cultural heritage by UNESCO in 2009. The development of the batik industry is directly proportional to the waste generated. The batik industry produces liquid waste that can pollute the environment, especially from leftover dyes, washing and rinsing residues, and *pelorodan* (wax relief) water. The contaminants found in the batik industry are organic materials, heavy metals, suspended solids, oils, and fats. Liquid waste can harm the ecosystem, so it needs to be treated before being discharged into the environment. Various wastewater treatment processes can resolve the negative impacts caused by the pollution of the batik industry wastewater, and one of them is electrocoagulation. Electrocoagulation is a process of destabilizing suspensions, emulsions, and solutions containing contaminants by flowing direct current which causes flocs, so they are easily precipitated. The electrocoagulation process does not use chemicals, so it is environmentally friendly and needs faster time. In this study, the batik industry located in Bandung City uses an electrocoagulation process for wastewater treatment. Processing is using an electrocoagulation reactor capacity of six liters. Variations in the experiments conducted were current and time. The varied currents were 0.5 A, 1 A, 1.5 A, 2 A, and 2,5 A and the time varied were 10, 15, 20, and 25 minutes. Based on the results of these experiments, it was shown that the optimum condition of the electrocoagulation process for batik wastewater treatment was with a current of 2.5 A for 25 minutes. These conditions decrease the COD value and color absorbance of the treated waste. The COD value of the effluent decreased to 81.6 mg/l with a treatment efficiency of 95.04% and color absorbance of 0.231 at a maximum wavelength of 284 nm with a processing efficiency of 46%.

Keywords: batik, electrocoagulation, wastewater treatment, chemical oxygen demand, color, current, and time.

1. INTRODUCTION

Batik is one of the sources of cultural heritage in Indonesia. Each region that produces batik has a distinctive style that distinguishes it from batik from other regions. No wonder batik was designated as one of the world's heritages by UNESCO in 2009. Batik production in Indonesia is increasing every year. The number of batik industries in Indonesia is estimated at 6,120 units with a workforce of 37,093 people and can reach a production value of around 407.5 billion rupiahs per month or the equivalent of 4.89 trillion rupiahs per year [1].

Making batik is one of the sources of livelihood for Indonesians. Behind the potential and glory of batik, there are by-products of batik production. Batik produces liquid waste which in massive quantities can pollute the environment if not treated first. Batik production, which is still on a small industrial scale, makes batik processing minimal, even according to survey data, 81% of batik craftsmen do not do waste treatment [1]. Currently, the community of batik craftsmen has started to process batik. Various studies were conducted to treat batik waste, ranging from solar photocatalytic [2], the use of TiO_2 [3], neutralization and electrocoagulation [4], and electrocoagulation [5].

Electrocoagulation is a process of destabilizing suspensions, emulsions, and solutions containing contaminants by flowing direct current which causes flocs, so they are easily precipitated. The electrocoagulation process does not use chemicals, so it is environmentally friendly and needs faster time. In this study, the batik industry located in Bandung City uses an electrocoagulation process for wastewater treatment. Influencing Factors electrocoagulation process are temperature, contact time, electric current, voltage, and degree of acidity (pH) [5].

In previous studies, the use of electrocoagulation for batik processing was conducted for quite a long time [5]. Besides that, some studies use scrap iron as electrodes [6]. In this study, the electrocoagulation process was conducted with a shorter time and aluminum as the electrode.

This study aims to determine the effect of the current and optimal time to treat batik waste using an electrocoagulation process. The use of aluminum electrodes is designed in such a way that it can be used in optimal quantities. The batik waste used is batik waste which contains indigo dye from one of the batik industries in Bandung.

ISSN : ……….

2. MATERIALS AND METHODS

2.1 Materials

Batik wastewater used in this research is from Batik Industry in Bandung. The batik waste used is batik waste which contains indigo dye. The reactor made has a generator with a maximum output current specification of 15A, a maximum output voltage of 24 volts, a maximum amperage and voltage regulator, and displays current, voltage, and power in and out of the generator in real-time. The chamber for sewage treatment has a capacity of 6 liters. The electrode material used is aluminum. For the testing process, several chemicals were used such as concentrated sulfuric acid for COD (Chemical Oxygen Demand) and $K_2Cr_2O_7$ 0.1 N as a digestion solution, 0.1 N FAS solution, and ferroin indicator for COD (Chemical Oxygen Demand) titration. All chemical substances are found in the analytical chemistry laboratory of the Politeknik STTT Bandung.

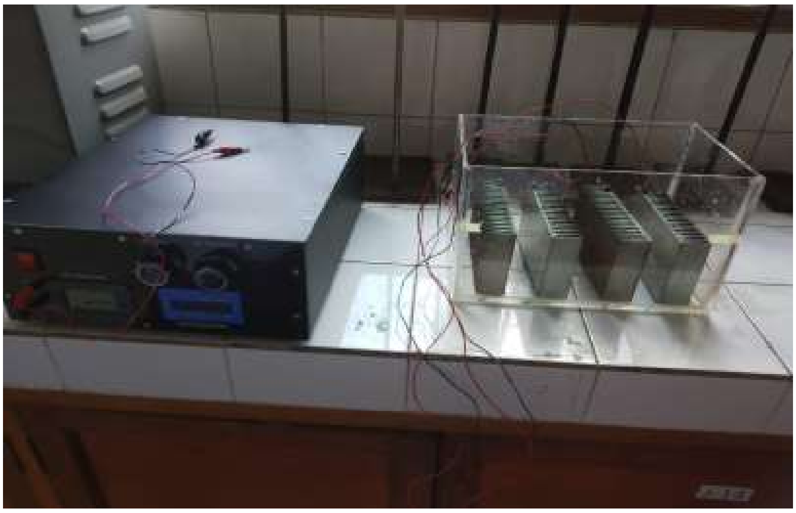

figure 1. electrocoagulation’s reactor

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2.2 METHODS

In this study, batik waste treatment was conducted using the electrocoagulation method with a batch system. The reactor image can be seen in Figure 1. The variation in current strength is 0.5 A, 1 A, 1.5 A, 2 A, and 2.5 A, and the time varied were 10, 15, 20, and 25 minutes. The distance between the electrodes is 5 cm.

After the treatment of batik waste with an electrocoagulation process with a batch system, COD and color testing was conducted. Sample for COD and color testing were taken after the electrocoagulation process was completed. COD testing refers to SNI 6989.2:2009, while color testing uses spectrophotometry on maximum wavelength.

3. RESULTS

The results of processing batik waste by electrocoagulation showed a decrease in the value of COD, color, and changing pH. In general, the results of the electrocoagulation process can be seen in Table 1 below:

Table 1. Influent and Effluent of Batik Wastewater with Electrocoagulation Process.

No.	Parameter	Influent	Effluent*
1	COD (mg/l)	1.641,6	81,6
2	Color (Abs)	0,420	0,228
3	pH	7,46	8,06

*Electrocoagulation Process at 2,5 Ampere and 25 minutes

The percentage degradation in COD resulting from the electrocoagulation process of batik wastewater in various experiments can be seen in Table 2 and the percentage color removal at a maximum wavelength of 286 nm can be seen in Table 3.

Table 2. Chemical Oxygen Demand (COD) Percentage of Batik Wastewater with Electrocoagulation Process.

COD Degradation (%)

Time (Minute)	Electricity Current (A)				
	0,5	1	1,5	2	2,5
10	9,94	50,00	45,00	35,38	55,26
15	18,29	58,17	50,00	50,29	62,67
20	32,46	60,00	55,61	74,90	75,15
25	32,46	61,22	70,00	75,15	95,03

Table 3. Color Removal (%) of Batik Wastewater with Electrocoagulation Process.

Colour Removal (%)

Time (Minute)	Electricity Current (A)				
	0,5	1	1,5	2	2,5
10	9,76	5,95	12,50	14,88	12,02
15	18,33	13,10	18,81	15,95	36,90
20	12,14	15,00	28,81	12,74	37,86
25	11,90	11,07	44,64	14,88	45,12

The COD of batik wastewater influent which was 1,641.6 mg/l after being processed can decrease in various variations of the process, the COD values in these variations can be seen in Table 4 below:

Table 4. Chemical Oxygen Demand (COD) of Batik Wastewater with Electrocoagulation Process.

Chemical Oxygen Demand (mg/l)

Time (Minute)	Electricity Current (A)				
	0,5	1	1,5	2	2,5
10	1.478,40	820,8	902,9	1.060,80	734,4
15	1.341,40	686,6	820,8	816	612,8
20	1.108,80	656,6	728,7	412	408
25	1.108,80	636,6	492,5	408	81,6

4. DISCUSSION

In this study, the processed waste came from the rest of the batik IKM Batik dyeing located in Bandung that used indigo dye. The electrocoagulation process conducted in this study used an electrocoagulation device with a capacity of 6 liters with various variations of current and retention time. This study shows that the current and processing time affect the results of COD, color analysis, and pH in the waste treatment using electrocoagulation.

3.1. COD Degradation

Based on Table 2, the longer the processing time, the more degraded organic compounds. The COD value at 10 minutes at 0.5 amperes did not change significantly, only decreased to 1478.40 mg/l and the maximum decrease occurred at a processing time of 25 minutes with an electric current of 2.5 amperes is 81.6 mg/l. This condition has complied with the Indonesian standard of textile waste at 150 mg/l ((Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor P.16/MENLH/Setjen/KUM.1/4/2019).

In the electrocoagulation process for 10 minutes with 0.5 amperes, it only reduces the COD value by 9.94% and has an increase in efficiency up to 95% at a processing time of 10 minutes and a current of 2.5 amperes.

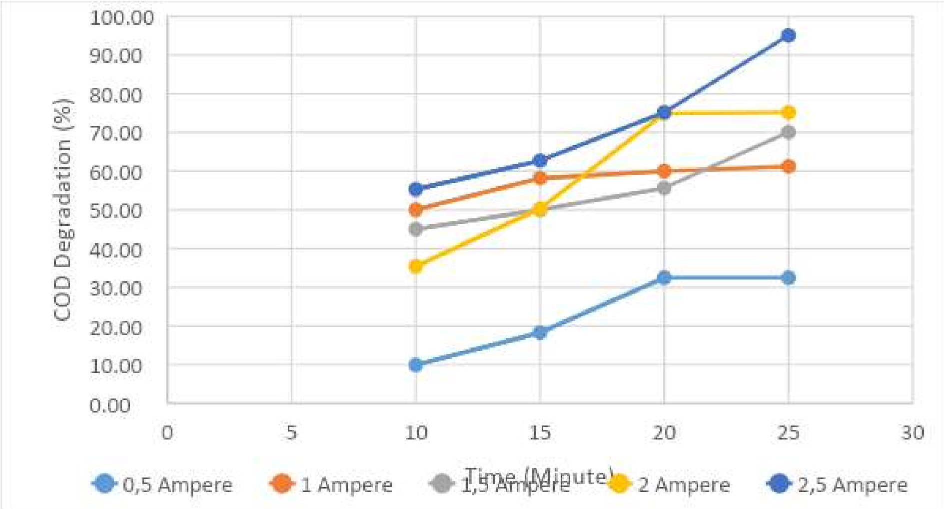

Figure 2. Chemical Oxygen Demand (COD) Percentage of Batik Wastewater with Electrocoagulation Process

Based on the picture above, it is known that the longer the time contact and the greater the current then the decrease in COD is also getting big. This is due to the process of oxidation and reduction in the reactor electrocoagulation. At the electrodes, oxygen gas is formed and hydrogen which will affect COD reduction. Based on the double theory layer, decreased COD due to floc formed by compound ions organics bind to coagulant ions which is positive. Molecules in batik wastewater are formed into floc, colloidal particles in sewage particle binding.

3.2. Color Removal

In the batik industry, the color used is the synthetic color it can be naphthol or indigo dye and it is a color pseudo, pseudo color is a color that is caused by turbidity or suspended material that causes true color including colloid.

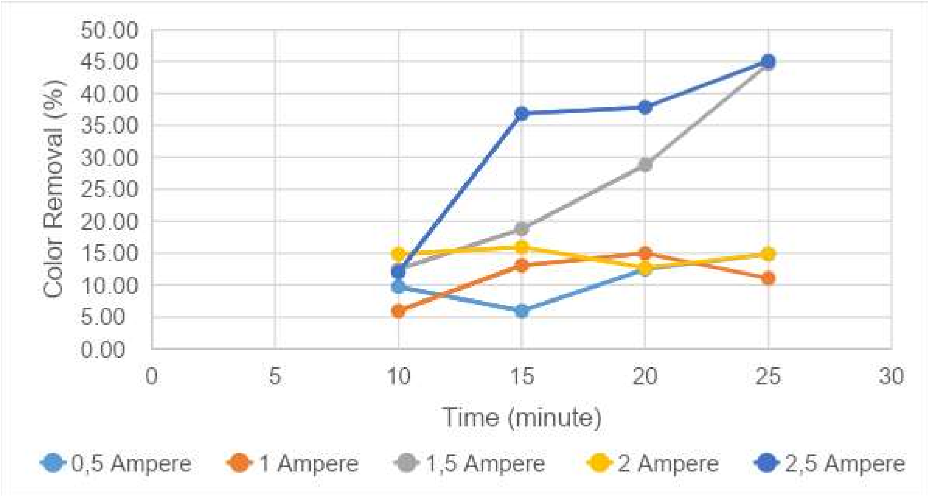

Figure 3. Color Removal (%) of Batik Wastewater with Electrocoagulation Process.

As seen in Figure 3, the color of the waste can decrease to a maximum of 45.12% when the electrocoagulation process is 25 minutes with a current of 2.5 amperes. The color absorbance of the effluent which was initially 0.420 at a wavelength of 285 nm became 0.228 after being processed using an electrocoagulation device (Table 5) above.

Table 5. Color Absorbance of Batik Wastewater with Electrocoagulation Process.

Color Absorbance (Maximum wavelength 285 nm)					
Time	Electricity Current (A)				
(Minute)	0,5	1	1,5	2	2,5
10	0,379	0,395	0,368	0,358	0,370
15	0,343	0,365	0,341	0,353	0,265
20	0,369	0,357	0,299	0,350	0,261
25	0,370	0,374	0,233	0,358	0,231

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3.3. pH Condition

Based on the data in table 4, there was a change in pH after the electrocoagulation process. The initial effluent solution 7.46 turned more alkaline in each process variation. at the optimum condition of the process, the time is 25 minutes, and the current is 2.5 amperes, and the pH of the solution becomes 8.06. This condition has complied with the standard of textile waste in pH 6 -9 (Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia Nomor P.16/MENLH/Setjen/KUM.1/4/2019).

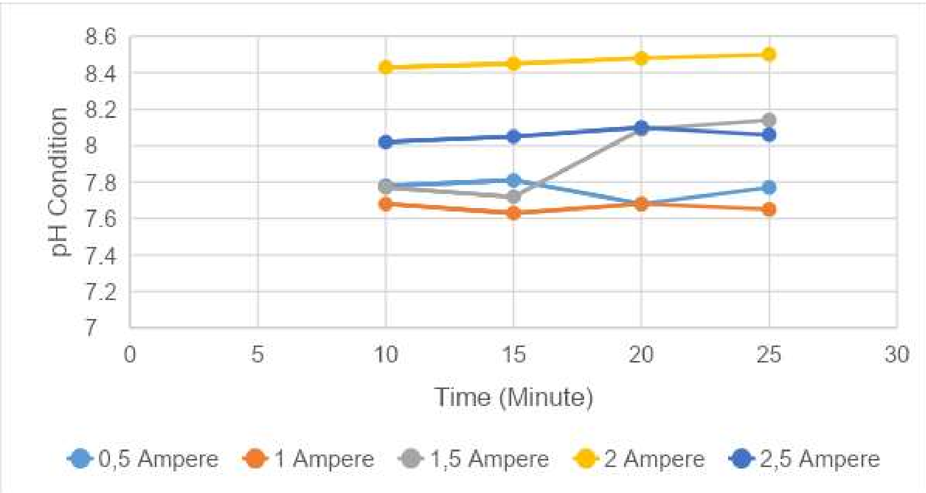

Figure 4. pH Condition effluent batik wastewater of electrocoagulation process

In the electrocoagulation process the electrolysis of water takes place to produce hydrogen gas and ions hydroxide, the longer the time contacts are used, the more rapid formation of hydrogen gas and hydroxide ion, if the hydroxide ion is produced then will raise the pH in the solution [5]. Figure 4 showed that the maximum pH was 8,50 at the time process of 25 minutes with two amperes of electric current.

5. CONCLUSIONS

In general, this research showed that the best condition for electrocoagulation process batik wastewater treatment is 2,5 Ampere at 25 minutes. In this condition, the COD value of the effluent decreased to 81.6 mg/l with a treatment efficiency of 95.04%, pH 8,06, and color absorbance 0.231 at a maximum wavelength of 284 nm with a processing efficiency of 46%. Based on the experiment, the COD and pH values have complied with the standards of textile waste so that the result of processing using this wastewater can be disposed of directly into the environment.

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