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SONGKET INDUSTRY WASTEWATER PROCESSING USING ELECTROCOAGULATION METHOD

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Abstract. The increment of Songket popularity as the traditional fabric from South Sumatra increases the production of Songket and the wastewater produced during the dying process. The dying process produces the reddish wastewater, and if it is disposed of directly into the environment, it will have a negative impact on the waters. The wastewater treatment of this reddish liquid is by electrocoagulation method. Electrocoagulation method is contaminants removal by electrical and chemical treatment system. The electrocoagulation method in this research was conducted in a batch where the wastewater was treated using 16.5 x 7.0 x 0.2 cm aluminum electrode. The parameters varied were the current density and processing time to determine the pH value, color intensity, BOD5, COD, TSS, and phenol levels. The optimum condition obtained from this study at a current density of 25 A/m^2 with a processing time of 160 minutes. The effectiveness of Songket wastewater electrocoagulation was 67.28% for TSS, 54.13% for BOD5, 63.64% for COD, color intensity 79.21% and phenol content of 74.93% respectively. The result has fulfilled the quality standard of textile industry wastewater treatment.

Keywords : wastewater, songket industry, electrocoagulation, aluminum electrodes.

1. INTRODUCTION

The liquid waste of the songket industry has become a major problem in controlling the environmental impact of the textile industry. The entry of dyes from waste into the waters has caused the physical and chemical characters of water resources to change. In order to fulfill quality standards, liquid waste must be processed in an integrated manner, both those produced during the production process and after the production process [1].

The management of liquid waste in the production process is intended to minimize the volume, concentration, and toxicity of waste. Processing of liquid waste after the production process is intended to eliminate or reduce the levels of pollutants contained in it, until liquid waste meets the requirements to be disposed of (fulfilled the quality standard) [2].

The most liquid waste management carried out by textile factories is coagulation (clumping) followed by adsorption of pollutants by passing wastewater through zeolite and activated charcoal [3].

There are several centers of songket fabric industry in Palembang that can be found in Ilir Barat II District and 14 Ulu Village. Every songket fabric production is preceded by yarn dyeing activities. Each dyeing process will produce 40 liters/day of waste flow for one limar set for one type of color while the colors used vary. There are 83 units of yarn dyeing business units, so in a month 1200 liters of wastewater is produced or 438,000 liters/year for one type of color. If the color used consists of 5 kinds of color, 2.190,000 liters/year of liquid waste will be produced. Almost all other songket industries are home industries that are not equipped with adequate wastewater treatment [4,5].

To overcome the problem of songket industrial waste above, it requires an innovative, inexpensive and effective method of processing waste before the liquid waste is disposed of into the environment [6]. The electrocoagulation method can be used to treat songket industry wastewater and has several advantages compared to the coagulation method using chemicals [7],

Electrocoagulation is the process of clumping and deposition of fine particles contained in water using electrical energy. The electrocoagulation process is carried out on an electrolytic vessel in which there are two direct current electric conductors that we know as electrodes. The part of the electrode immersed in the waste solution will be used as an electrolyte [8]. If in one electrolyte solution two electrodes are placed then the electrode is flowed by a direct current of electricity then an electrochemical process will occur in the form of electrolyte decomposition symptoms, i.e., positive ions (cations) move to the cathode and receive electrons reduced and negative ions move to the anode and give up the oxidized electron, so that later it will form a floc which is able to bind contaminants and particles in the waste [9].

The electrocoagulation process is formed by dissolving metal from the anode which then interacts simultaneously with hydroxy ion and hydrogen gas produced from the cathode [10]. Matteson introduced "Electronic Coagulator" where the electric current given to the anode dissolves aluminum into a solution which then reacts with hydroxy ions (from the cathode) to form aluminum hydroxy [11]. Hydroxy flocculates and coagulates suspended particles so that a process of separation of solids from wastewater occurs. A similar process was also carried out in Brittain in 1956, only the anode used was iron and used to treat river water [11].

2. METHOD

For wastewater treatment, a series of electrocoagulation devices are used consisting of aluminum electrodes, regulators, digital multimeters, and anode and cathode connecting cables. The sample used was liquid songket industry wastewater in the Kertapati area. The stages of songket industry wastewater treatment are:

a. The electrodes used were 16.5 cm long, 7 cm wide, 1 cm distance between electrodes, 0.2 cm electrode thickness.
b. Songket liquid waste is inserted as much as 800 mL into a 1000 ml beaker.
c. After the beaker is filled with waste, the voltage flow is turned on by activating the adapter using a 12 volt voltage with variations in current density of 25 A/m^2, 45 A/m^2, 65 Am^2, and 85 A/m^2 and the operating time of each process for 40 minutes, 80 minutes, 120 minutes, and 160 minutes.
d. The results of the electrocoagulation process were deposited for 2 hours
e. Next, the distillation from the precipitate is filtered.
f. The characteristics of the electrocoagulation process were determined by measuring pH, BOD5, COD, TSS, color intensity, and phenol levels in the filtered surface.

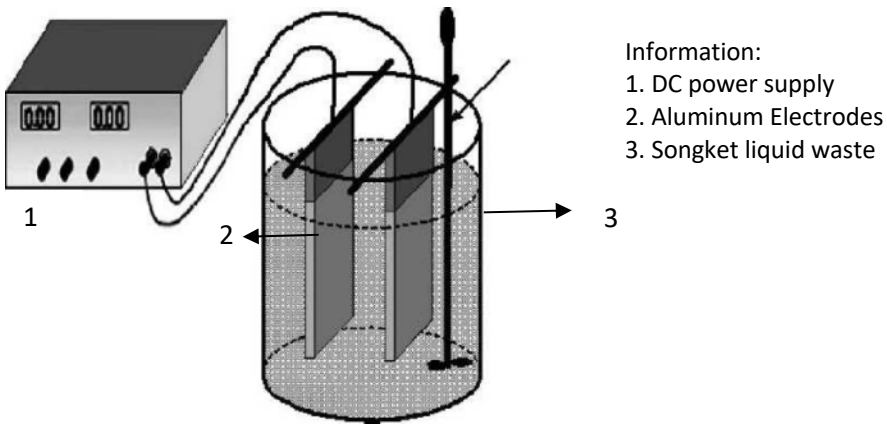

Figure 1. Electrocoagulation Reactor

3. RESULTS AND DISCUSSION

Preliminary Analysis of Characteristics of Songket Liquid Waste

Results of Preliminary Analysis of Songket Liquid Waste as Table 1.

Table 1. Results of Preliminary Analysis of Songket Liquid Waste

No.	Type of Analysis	Quality standards	Analysis results
1.	pH	6 – 9	10.73
2.	BOD_5 (mg/L)	50	213.5
3.	COD (mg/L)	100	702
4.	TSS (mg/L)	200	985
5.	Color intensity	-	1120
6.	Phenol levels (mg/L)	0.5	7.85

Source: Environmental Quality Standards based on South Sumatra Governor Regulation No. 8, year: 2012.

From the results of the initial analysis of songket liquid waste in Table 1, the pH value and the decrease in TSS, BOD5, COD, color intensity, phenol levels did not exceed the clean water quality standard. However, high BOD5 and COD values must be processed to reduce BOD5 and COD levels. This is because the high levels of BOD5 and COD will cause potential contamination for both surface water and groundwater. In addition, the level of phenol in songket liquid waste also exceeds the limit of the quality standard of clean water needs to be reduced in order to be able to meet the requirements for disposal to the environment, and those that have reached or less than the standard quality of phenol can be disposed of into the environment. Clean water is water that meets the requirements for the environment, both from pH, BOD5, COD, TSS, color intensity and phenol levels.

Effect of Current Density and Process Time on pH

The pH level is an expression of the concentration of hydrogen ions (H^+) in water. pH is very important as a parameter of clean water quality because pH controls the type and speed of reaction of some materials in water.

The decrease in pH in the electrocoagulation process occurs because of the alkalization process of Al_3^+ ions added in the water so that there is a reaction with a hydroxy ion from hydrolysis of water which produces Al $(OH)_3$ and hydrogen ions.

In Figure 2 we can see a decrease in pH in songket wastewater with an initial pH of 10.73 which belongs to the alkaline category, after treatment, there is a significant increase in pH which reaches pH 6.79 which is near neutral where the pH range is between 6-9.

From this graph, it can be seen that pH tends to decrease with the length of time the process with a pH range of 6-10. The best results in decreasing pH are those that occur at a current density of 45 A/ m^2 with a process time of 160 minutes which results in pH 7.39 with neutral pH.

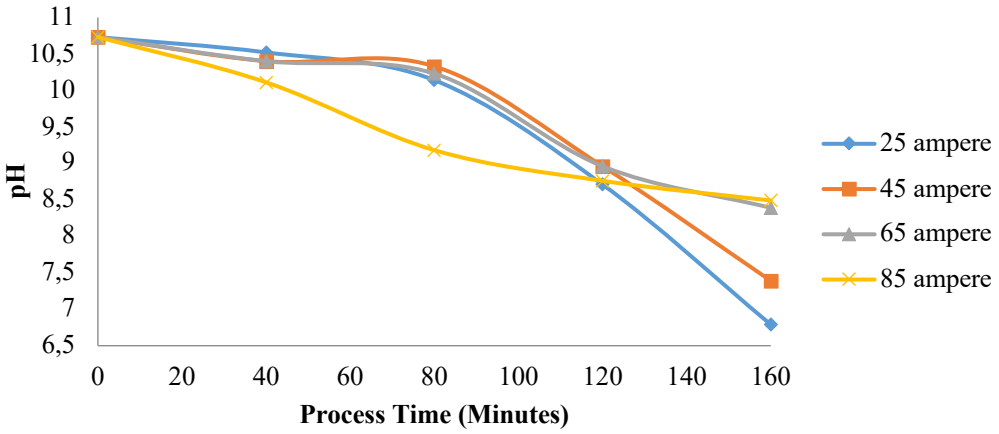

Figure 2. Graph of Effect of Current Density and Process Time on pH

Effect of Current Density and Processing Time on BOD_5

The results of electrocoagulation of songket liquid waste against the BOD5 value were seen to decrease. From Figure 3 it can be seen the best results for the decrease in BOD value is at 160 minutes and current density is 25 A/m^2 with BOD5 value 30 mg/ L, where the maximum permissible level is 50 mg/L and by electrocoagulation waste treatment with current density 25 A/m^2 and process time 160 can reduce BOD5 levels up to a value of 30 mg/L, compared with current densities and different processing times do not reach 30 mg/L, but some are below the value of 50 mg/L, and there are also which is still high above 50 mg/L which means that the current density and processing time are suitable so that it can produce a significant decrease in BOD5 levels.

The results of the BOD_5 analysis determine the quality of the body of water which is the amount of oxygen needed by microorganisms to decompose the organic matter contained in water under aerobic conditions. High BOD_5 values play an important role in determining the ability of water bodies to support the growth of algae and aquatic organisms which will result in increased growth. The higher the population of bacteria, the higher the level of water pollution.

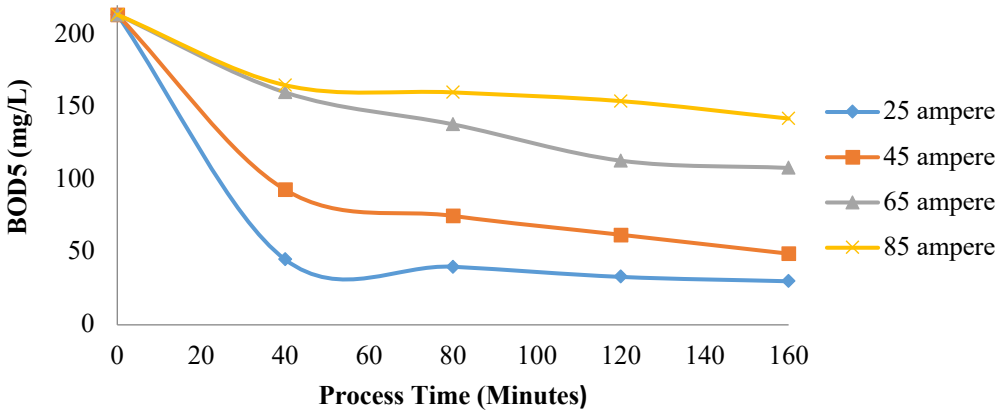

Figure 3. Graph of Effect of Current Density and Process Time on BOD_5

Effect of Current Density and Processing Time on COD

COD is the quantity or amount of oxidants that react with samples under certain conditions. The amount of oxidant used is proportional to the oxygen demand. Organic and inorganic compounds in the sample are oxidized subjects, but organic compounds are more dominant. COD is often used as a measure of the number of pollutants in water.

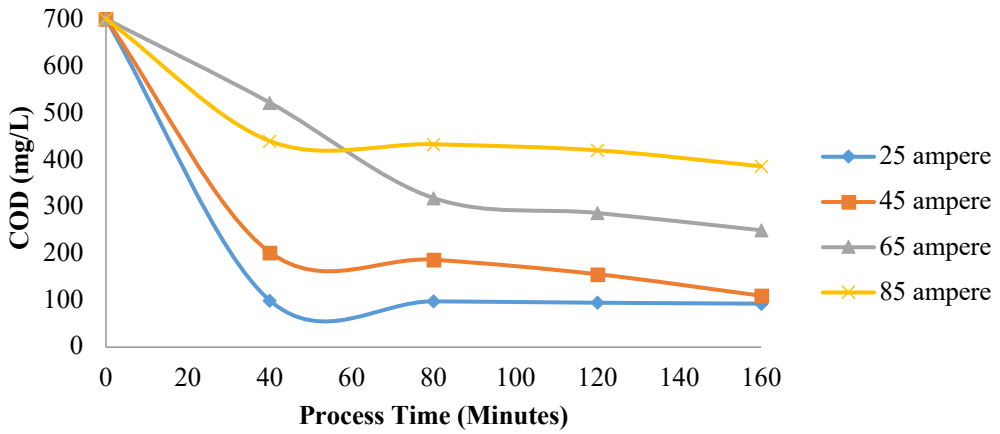

Figure 4. Graph of Effect of Current Density and Process Time on COD

Base from Figure 4, the results of the study of songket wastewater using the electrocoagulation method can be seen the best results in decreasing the value of COD at 160 minutes with a current density of 25 A/m^2 where the decrease in COD values in these conditions is very drastic from 702 mg/L to 93 mg L.

The process of decreasing the value of COD in electrocoagulation occurs through destabilization. Colloidal destruction is carried out by metal cations that form polyvalent polyhydroxide. This complex compound has a high adsorption side which makes it easier for the process of aggregation with various pollutants that form large material which is easily separated by flotation techniques because the density/density of material becomes smaller.

Effect of Current Density and Processing Time on TSS

Figure 5 shows the results of the electrocoagulation of songket liquid waste that has been carried out, the best results on a decrease in TSS value ie at 160 minutes with a current density of 25 A/m^2 where the value drops from the initial TSS value 985 mg/L to 163 mg/L, where the maximum allowed is 200 mg /L so the results at the current density of 25 A/m^2 and processing time for 160 minutes already meet the quality standard requirements. The process of decreasing TSS is very influential where TSS is a pollutant that is in a suspended form. If wastewater contains high TSS, it can be concluded that the waste is of poor quality and has the potential to damage the aquatic ecosystem in particular.

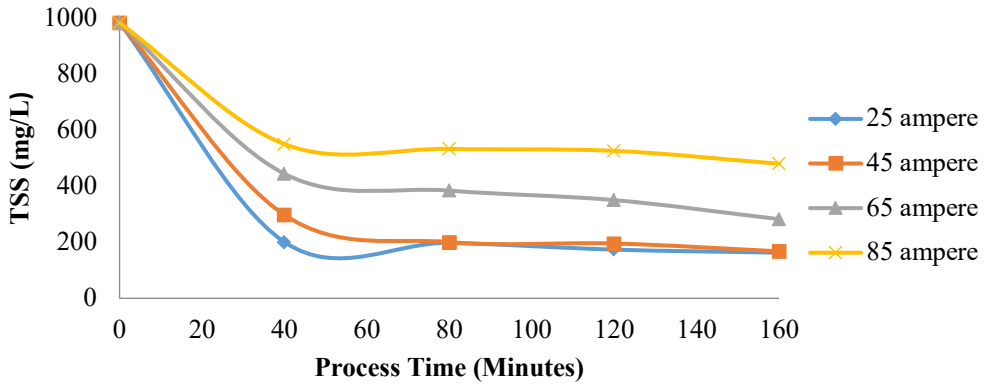

Figure 5. Graph of Effect of Current Density and Process Time on TSS

The TSS reduction process in electrocoagulation occurs when solid material from suspended solids is adsorbed into the coagulant of $Al(OH)_3$ or adsorbed into air bubbles. The results of this adsorption will be separated upwards (flexed) so that there is a decrease in TSS concentration in wastewater.

The source of TSS pollutants is both organic and inorganic chemicals that form a suspension in the wastewater. In addition, the source of TSS also comes from metals that form complex compounds both with hydroxides or other anions which these compounds are suspended in the waste solution either because of the nature of the molecular size of the compounds or the nature of the polarity possessed [12].

Effect of Current Density and Process Time on Color Intensity

From the experiments that have been done, the data shows that each change in current density and length of process time will produce different electrocoagulation efficiency. The longer the contact time, the lower the intensity of the color produced to approach the clear color. From Figure 5 it can be seen that the decrease in color intensity in the largest waste is achieved at 160 minutes process time and a current density of 25 A/m^2 from the initial results of 1120 to 24 where the water color has become clear compared to the original color of red songket liquid waste.

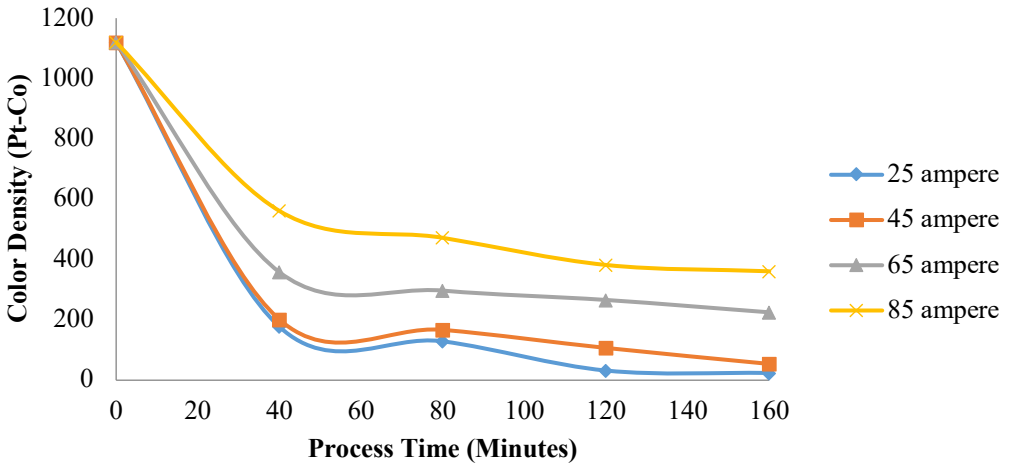

Figure 6. Graph of Effect of Current Density and Process Time on Color Intensity

Songket liquid waste contains color because in the coloring of all the dyes given will be absorbed by the thread so that it will cause the remnants of the dye. Sunlight is an important factor in photosynthesis. The results of photosynthesis will produce oxygen which will then be used to decompose organic matter.

Songket liquid waste that is colored if it is directly thrown into the water will cause color in the waters. This will inhibit the process of photosynthesis in the waters. Clean water quality standards have a color value between 5-50 PtCo [13].

Effect of Current Density and Process Time on Phenol Levels

If the water in the waters has been contaminated by phenol content, then the water is very dangerous to use. Phenol can disrupt the central nervous system which can lead to fainting and coma. Phenol can also cause hypothermia (decreased body temperature) and myocardial depression. If phenol is in contact with the skin it will cause burns, if contact with the eyes can cause irritation, swelling, corneal bleaching and ultimately blindness [14, 15]. There are many more effects of the phenol content for that phenol content in the waters is very wary and it is expected that the phenol content in the waters does not exceed the water quality standard so that it is safely used by the community.

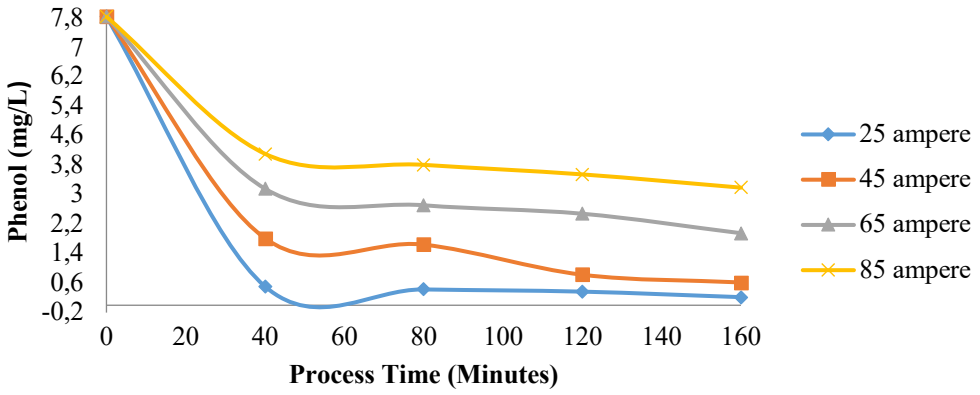

Figure 7. Graph of Effect of Current Density and Process Time on Phenol Levels

From Figure 7 it can be seen that the reduction of phenol content in the largest songket liquid waste was reached at 160 minutes at 25 A/m^2. In this condition, the phenol content in the filtrate is 0.22 mg/L from the initial analysis of 7.85 mg /L, where the maximum allowed phenol level should not be more than 0.5 mg /L.

4. CONCLUSION

Based on the results of preliminary analysis of songket liquid waste taken from songket craftsmen, the characteristics of songket liquid waste were obtained, namely pH 10.73; BOD_5 213.5 mg/L; COD 702 mg/L, TSS 985 mg/L, color intensity of 1120, and phenol content of 7.85 mg/L.

With the optimum condition of the electrocoagulation process of songket wastewater treatment for 160 minutes and current density of 25 A/m^2, the effectiveness of electrocoagulation of songket wastewater was obtained by 67.28% for TSS, 54.13% for BOD5, 63.64% for COD, 79,21% for color intensity and 74.93% for phenol levels. These results have fulfilled the textile industry wastewater quality standards.

From the research that has been done, it can be suggested that in carrying out the processing of songket industry wastewater by further electrocoagulation method to vary the voltage used and analyze the metal content in the waste.

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