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Suspended Organic Removal by Electrocoagulation Process

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Abstract

Electrocoagulation is an electrolysis process with the aimed of destabilizing suspensions, emulsions, and solutions containing contaminants. The process was to connect the direct current (DC) through the water to become flok that it was easily separated. This electrocoagulation process required an electrolyte solution and an electrode. Batik wastewater was used as an electrolyte solution and Aluminium as the electrode. The mechanism of the coagulation process for reducing organic suspension was, on an electrolyte in this case was batik wastewater placed two Aluminium electrodes (cathode and anode) and connect it to the direct current, so it's called electrochemical process. This research aimed to treat wastewater batik by using electrocoagulation process in eliminating of suspended organic. This was due to the fact that wastewater was generally alkaline and has high organic matter and high suspended solids. Suspended solid produced in the process of preparation. Based on the electrocoagulation process, the treatment variables in this research are, variations of current strength are 1, 2, 3, 4 and 5 Ampere and contact time are 60,90,120,150 and 180 minutes. While other influential factors were as a fixed variable. The specified variables were the thickness of the plate and the distance between the plate, the temperature according to the ambient temperature. In this research, the optimum removal of Tss and COD at the largest electric current was 5 A and at 180 minutes of detention time. Removal percentage of Tss reached 94.87% while COD removal reached 93.19%.

Keywords: Aluminium electrodes, electrocoagulation, removal, suspended organic

INTRODUCTION

Human activities in the field of industry contributed to pollute the environment, especially surface water. Wastewater of industries could pollute surface water without treatment. In the production process, batik industry used a lot of chemicals and water. These chemicals commonly used in dyeing processes. The characteristics of wastewater in the batik industrial contained suspended solids or organic materials, heavy metals, oils and grease, so it has to be treated before throughout into surface water in order not to harm the environment. In the process of preparation of materials and staining, produced Chemical Oxygen Demand (COD) and color. The various treatments commonly used in batik industrial waste were deposition, adsorption, filtration, and flotation. It was difficult to find the most effective and efficient method to solve this problem.

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Based on research that has been done before Rachmawati *et al.* (2014) by using electrocoagulation, the optimum percent removal of TSS was 80 % at 140 minute and 21 volts. Lestari & Agung (2014) obtained the result of the optimum percent removal of TSS was 90% at 2.5 A and 180 minutes.

Electrocoagulation was coagulation process using direct current electricity by electrochemical process. The electrochemical proses was decomposition electrolytic phenomenon, one of which electrode was made of aluminium. In this process was reduction and oxidation process. The electrocoaglation process aimed to determine the effect of electric currents on dissolved and suspended organic matter in batik waste.

METHODS

Materials and Equipment

Material used is wastewater of batik, and there were no chemical agent that used in this research. Equipment used are contact tank as reactor, power supply and Aluminium electrodes (Al) with a width of 10 cm and a length of 20 cm. Before use, the electrode surface first washed with distilled water then dried. This study used a batch system.

Method

Electrocoagulation process showed in Figure 1.

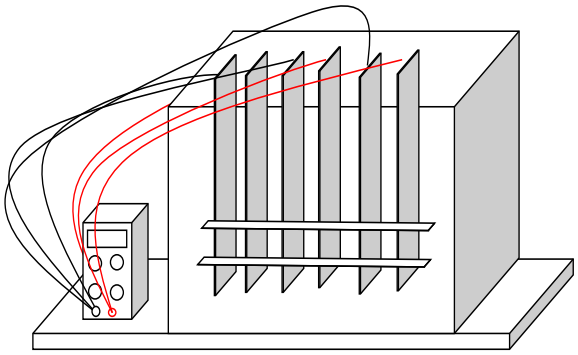

Figure 1. Electrocoagulation Unit

Wastewater of batik was analyzed before the electrocoagulation process. Total suspended solid, pH, turbidity and Chemical Oxygen demand were parameter had to be analyzed in the laboratory. Wastewater was poured into the reactor, and the volume of wastewater was 5 L. Electrocoagulation process was started by switch on power supply to set electrical current 1,2,3,4,5 Ampere and detention time 60,90,120,150 and 180 minutes. Effluent was analyzed after the proses, the parameter was analyzed pH, Total Suspended Solid, turbidity and Chemical Oxygen Demand.

RESULT AND DISCUSSION

This Research explained the effectiveness process to remove of organic matter. Characteristic of batik wastewater had high organic matter, alkali content, insoluble solid matter and heavy metals. This research explained the increasing removal of insoluble solids so the organic significant matter significant influenced it. The following results were tabulated in the Total Suspended Solid and Chemical Oxygen Demand.

The initial concentration of Total Suspended Solid (TSS) of batik's wastewater was 5460 mg / L. The initial concentration of COD was 3379.2 mg / L. While Standard of TSS was 50 mg / L and COD equal 150 mg / L, which indicates that it concentration could throughout inti surface water.

Table 1. Percent Removal of Total Suspended Solid (Tss)

Time	Electric Current, Ampere				
	1	2	3	4	5
60 minutes	69.23	83.52	84.21	91.81	91.94
90 minutes	71.35	86.99	87.23	92.35	92.55
120 minutes	73.57	88.13	91.94	92.77	92.86
150 minutes	78.97	90.03	92.15	93.12	93.5
180 minutes	80.89	91.98	93.15	93.83	94.87

The electrocoagulation process was not the only process to remove organic matter, but required the others unit process after electrocoagulation's process. This was shown in the largest removal process only reaching 94.87% of initial TSS concentrations. Meanwhile, in accordance with the standard, the required removal of 99.08%.

The largest TSS removal in this study was obtained at 180 minutes and at a current of 5 Amperes. Processes that occur in electrocoagulation were positive Ions moving to negative electrode (cathode) and negative ions moving to positive electrode (anode). When the charged ions were in contact with the electrode there would be electrochemical reactions. In the positive electrode (anode), negative ions release electrons and oxidized. In the negative electrode (cathode), positive ions capture the electrons and reduced. In the process would appear air bubbles (Prabowo *et al.*, 2012).

The bubbles bind organic matter in the wastewater as the electrolyte. Then the substances in bubbles lifted to the surface and float. The floating substances formed as like slim sludge ad called a floc. Figure 2 showed the bubbles binding the organic material forming the floc and lifted to surface. The separation of suspended organic matter from the batik wastewater solution occurs on the surface, so there was no precipitation on the bottom of the reactor.

Figure 2. Bubbles binding the organic material forming the floc and bringing it towards the surface.

The explanation of the Total Suspended Solid (TSS) process shown in Figure 3. Percentage of Total Suspended Solid (TSS) removal increased in high electric current and the longer detention time. At an electric current of 5 Ampere, air bubbles were formed only 2 minutes when the electrocoagulation process was running. This indicates that the reaction occurs was more rapidly at the electric current of 5 Amperes, so that the floc forming process was optimum in longer detention time, which was 180 minutes.

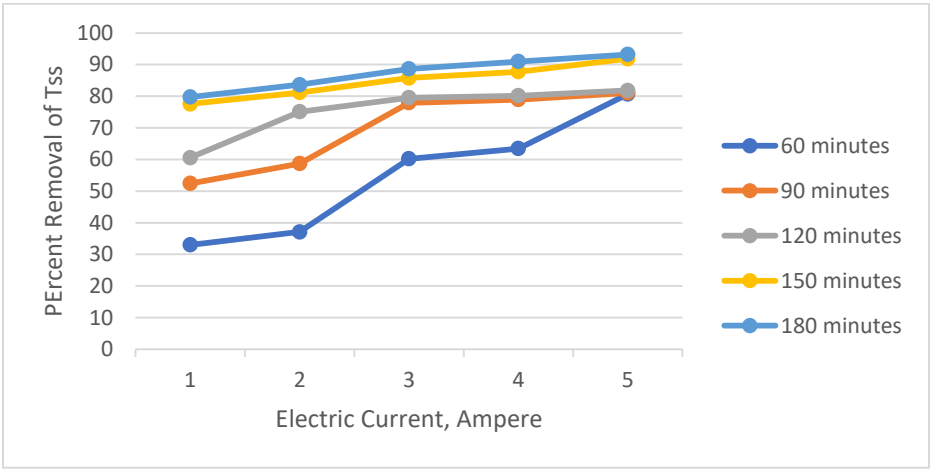

Figure 3. The Influence of Electric Current and COD Removal

At the electrocoagulation process the longer the detention time and the greater of the electric current increased the pH of the wastewater. The process of water electrolysis happened in electrocoagulation process. The water electrolysis process produced hydrogen ion and hydroxide ions. The hydrogen ion and hydroxide ions could be formed fast in the longer detention time. So many hydroxide ions were produced, it raised pH in wastewater. The increasing conditions of pH can be explained in Table 3 and Figure 4.

Table 3. pH Measurement in Electrocoagulation Process

Time	Electric Current, Ampere				
	1	2	3	4	5
60 minutes	9.03	9.65	9.65	9.65	10.78
90 minutes	10.11	10.39	10.47	10.56	10.89
120 minutes	10.77	10.85	10.99	11.15	11.42
150 minutes	10.98	11.05	11.13	11.32	11.5
180 minutes	11.3	11.42	11.49	11.55	11.69

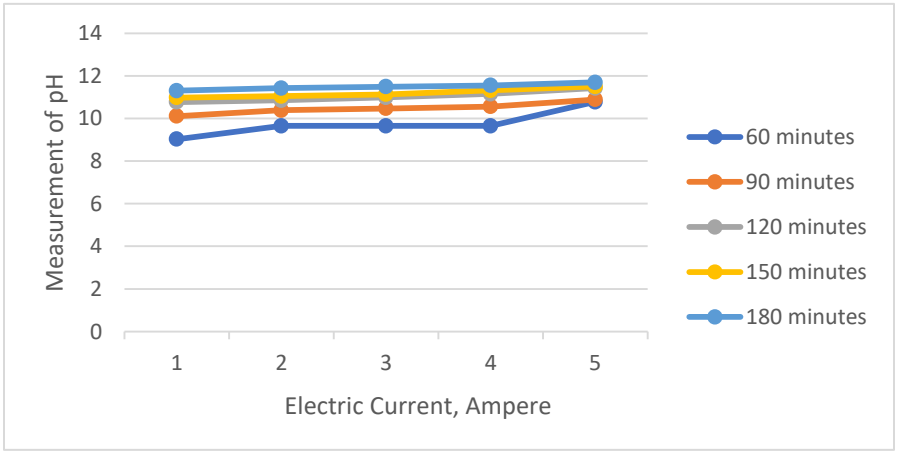

Figure 4. The Influence of Electric Current and pH

CONCLUSION

At the electrocoagulation process, the longer of detention time and the greater of the electric current increased the pH of the wastewater. The process of water electrolysis happened in electrocoagulation process. The water electrolysis process produced Hydrogen ion and hydroxide ions. The hydrogen ion and hydroxide ions could be formed fast in the longer detention time. So many hydroxide ions were produced, it raised pH in wastewater. In this research, the optimum removal of Tss and COD at the largest electric current was 5 A and at 180 minutes of detention time. Percentage removal of Tss reached 94.87% while COD removal reached 93.19%.

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