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The Ability of Electricity to Treat Dairy Waste

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Abstract—**Dairy waste from industrial activities may affect environment and human health. Many methods have been used to treat dairy waste such as biological treatment, coagulation and sedimentation system, DAF system (dissolved air flotation) and many more. The strength of organic contaminants from dairy waste are very high compared with other typical waste streams such as domestic and municipal wastes. Dairy wastes affect the chemical composition in the water and contribute negative impact to animal and aquatic plant. The objective of this research is to determine the ability of electricity to treat dairy waste. This study was focus on the effect of current density, concentration of sample and duration of current flow. Simple electrochemical cell with steel plate (anode) and aluminum plate (cathode) was used for this study. The effectiveness of this method was determined by measuring BOD and turbidity removal. Based on this study, it was found that electricity was able to treat dairy waste. The amount of current density, duration of electric current flow and concentration of the sample does affecting the percentage of turbidity and BOD removal. Electricity was able to remove turbidity more then 99.0 %. While for BOD, the removal rate was below than 80.0 %.**

Keyword: dairy waste, electricity, treatment

I. Introduction

Dairy waste caused serious environmental pollution and health problem in many ways. Dairy waste contains a large amount of organic material. That makes the treatment of dairy waste are important. Treatments of dairy waste are expensive, so cost effective treatment systems are needed. Usually treatments of dairy waste are based on coagulant method and biological treatment [1]. One of alternative method that has been used to treat other wastewater is by using electricity. Examples of method that used electricity are electrocoagulation, electrolysis and many more. This study used the application of electrolysis to treat dairy waste. The process is based on principles involving response of water contaminants to strong electric fields [2]

Waste water from the industry dairy product could be categorized into two types. First type is involving cooling water. It contribute 2/3 or more to volume of waste water. Second type is comprised from waste water produced from production process. Composition of waste water produced is depending on type of industry [3]. Liquid waste from dairy product has several common characteristics. Usually dairy waste consists largely of diluted milk or milk products. The organic contaminants result in the dairy waste having very high strengths compared with other typical waste streams such as domestic and municipal wastes. There are marked variations in hourly, daily and seasonal composition and flow rate as well as major variations related to the product manufacturing mix in multi product plants. Dairy waste has high five-day biological oxygen demand (BOD_5) and chemical oxygen demand (COD) levels and a high initial rate of oxygen uptake.

There are many methods that used electricity. The most familiar one is electrolysis. Electrolysis works best when the water is free from particles, oil, or biological material. This is because particles, oil, and biological slime can coat and foul the electrodes in the cell, causing the efficiency to drop [4].Other method used is electrocoagulation. Electrocoagulation is a simple and efficient method for the treatment of many contaminated wastewaters not only heavy metals but also oil, solids, dye or organics. It has been increasingly used for treating industrial wastewater in the last decade. Electrocoagulation process is characterized as fast rate of pollutant removal, compact size of equipment, simplicity in operation, and low capital and operating costs. In addition, it is more effective in treating wastewaters containing small and light suspended particles.[4]

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Before this, many researches has been done by using the electricity method. Ching (2005) has proved that the domestic greywater can be removed by using electricity with bipolar aluminum electrode, while, Norhani (2006) done research of metal removal from electroplating by using electroagulation method. Kuan (2005) done research about treating chemical mechanical polishing (CMP) wastewater by using electricity; while, Cheng G. (2000) has done research about restaurant wastewater treatment by using electrocoagulation method.

II. METHODOLOGY

Method of this study was based on laboratory test. The laboratory test was divided into two stages which were laboratory test for sample before and after treatment.

The samples that were used in this experiment are artificial wastewater. The samples were prepared by using different concentration, which was 1.0 g/1, 2.0 g/1, 3.0 g/l, 4.0 g/l and 5.0 g/1. Artificial dairy waste was prepared by mixing milk powder with discharge water.

In this study, the Spectrophotometer HACH DR 4000 was used to determine the amount of nitrate and phosphorus in the dairy waste sample before and after treatment.

In the treatment process, current is the main source to carry out treatment process by using electrolysis cell. Electrolysis cell is a circuit arrangement which comprises of electrode muffled into electrolyte and connects to current. Size of electrode plate is 75 mm x 75 mm x 1 mm and 3 cm distance between electrodes were used. NaCl with 10 g/L doses was added into sample as electrolyte substance. Electrolyte is a chemical dissolve that able to conduct electricity

The preliminary test was done to obtain the optimum value of concentration, duration and current density that used in final laboratory test. These tests were used to obtain the amount of concentration, duration and current density that able to give above 90% of turbidity removal.

Five different value of artificial wastewater concentration was prepared. The values of concentration were 1.0 g/1, 2.0 g/l, 3.0 g/l, 4.0 g/l and 5.0 g/l. Current density was maintained by means of precision DC power supply and duration for each test was 15 minutes. The optimum amount of concentration was determined based on graph (Turbidity Versus Concentration).

The range of duration that was used during the experiments was between 5 minutes to 25 minutes. The amount of concentration that used were based on the optimum amount of concentration obtains from the previous test. The optimum amount duration was determined based on graph (Turbidity Versus Duration).

The ranges of current density that was used are between 32 A/m^2 to 54 A/m^2. Current density was maintained by means of precision DC power supply. 750 ml of artificial wastewater was used for each range of current density. Duration and concentration for each test was determined based on previous test by taking the optimum value of duration and concentration. Then optimum amount of current density was determined from graph (Turbidity Versus Current Density).

In final treatment test, optimum value of current density, duration of electric current flow and concentration of sample were used from previous tests. Sample that was used in this stage was fix based on the concentration in the previous laboratory test. After the treatment, flocs were formed and floating at the surface of sample. The method that was used to removed flocs was by filtration.

For each test, initial and final value of parameter was measured. Percentage of parameter removal was determined by using equation 1.

$$\text{Percentage of parameter removal} = \frac{\text{(Initial value - Final value)}}{\text{Initial value}} \times 100 \quad \text{..... (1)}$$

III. RESULTS AND DISCUSSION

All the analysis was focusing on the performance of the electric energy that was connected to iron and aluminum electrode under the influence of duration, current density and concentration. The analysis was based on result from the preliminary laboratory test and final laboratory test. The performance of the process was assessed based on the percentage of BOD_5 and turbidity removal.

Preliminary Laboratory Test

The first test was under the influence of concentration. The amount of concentration used was 1.0 g/l to 5.0 g/l. The higher concentration the harder for it to be remove. Based on figure 1, the percentage of turbidity removal decreased when the concentration increased. Up to concentration 2.0 g/l the rate of turbidity removal was higher then 95%. However, beyond this concentration the rate of turbidity removal was decreasing. This was proven in next laboratory test by taking 2.0 g/l concentration as an optimum value and fixed concentration for further test.

Second test was done under the influence of duration. Range of duration used for this test was 5 to 25 minutes. Based on the result, percentage of turbidity removal was increasing from 5 to 15 minutes. The trend of the result obtained was shown in figure 2. However, after 15 minutes the percentage of turbidity removal become constant, proved that if the duration was still increasing the percentage of turbidity removal were still the same. Based on this, 15 minutes had been chosen as a fixed duration for further testing. During the process, floc was form and floating at the surface of reactor, proved that electricity cause electrocoagulant process to occur. Then the flocs were removed by using vacuum filtration equipment.

In the third test, the process was under the influence of current density. Based on the result of the test, the increment in current density also increased the percentage of turbidity removal. As shown in figure 3 an increase of current density from 32 A/m2 to 54 A/m2 yields an increase of turbidity removal from 29% to 99.8%. Based on the graph, the amount of current density that gave turbidity more then 95% removal are 54 A/m^2. The result proved that current density value influenced coagulation in this process. Current density value was dependent to electrode plate's area which was used. When current density increased, the draw strength of electron also increased. In this case, particles of sample also attracted and producing flocs as were suspended waste materials.

Final Laboratory Test

Final laboratory test was done based on the optimum value obtained in the preliminary laboratory test. Three numbers of factors were used, which were duration of current flow, concentration of sample and current density. Results of final laboratory test for dairy waste sample before and after treatment were used to obtain percentage removal of BOD_5 and turbidity. Based on the result obtained, dairy waste treatment by using electrolysis was able to remove turbidity effectively at the rate of 99.0 % removal. The removal rate for BOD_5 was under 80.0 %.

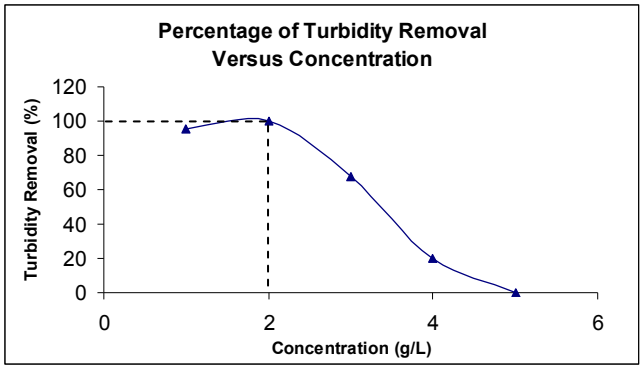

Figure 1: Percentage changes of turbidity removal to concentration with 15 minutes duration, 750 ml volume of sample and 54 A/m^2 of current density.

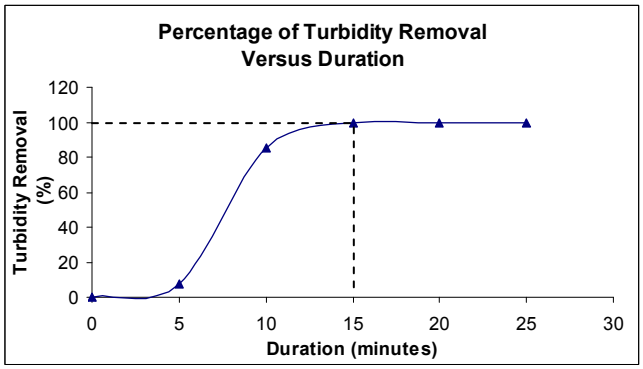

Figure 2: Percentage changes of turbidity removal to duration with 54 A/m^2 of current density, 750 ml volume of sample and 2.0 g/l of concentration.

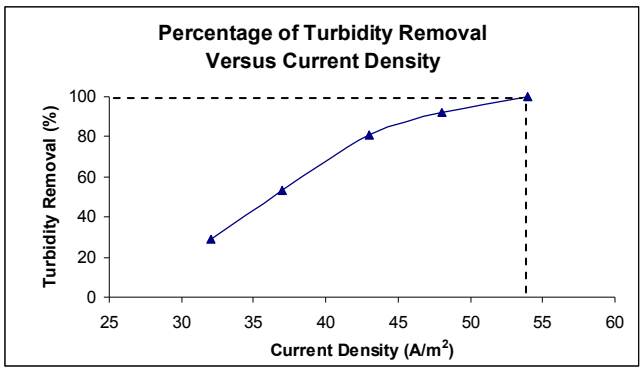

Figure 3: Percentage changes of turbidity removal to current density with 15 minutes duration, 750 ml volume of sample and 2.0 g/l of concentration.

IV CONCLUSIONS

Current density, duration of current flow and the concentration of the sample are the main factors affecting the removal percentage. Based on the results obtained, electricity is able to removed turbidity and BOD_5 effectively at the rate 99.0% and 80% removal.

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