Electrocoagulation Application in The Processing of Palm Oil Mill Effluent from Anaerobic Fixed Bed Reactor

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Abstract

The production of Crude Palm Oil (CPO) in Indonesia keep increase following the amount of wastewater that being produced. Therefore laboratory scale research of processing of palm oil mill effluent of anaerobic fixed bed reactor with electrocoagulation technique was conducted. Electrocoagulation is a process of coagulation using a direct current through an electrochemical events are symptoms of electrolyte decomposition. This research aims to determine the influence of voltage in the adaptor to the performance of this electrocoagulation system and to determine the optimum operating time for the liquid waste treatment. The material that being used is palm oil mill effluent with electrocoagulation equipment devices with the discharge of 1.5 liters/minute, the residence time of wastewater at 1 hour, 5 cm electrode spacing, as well as the strong current of 8, 9, 10, and 11 Ampere. The results obtained by the reduction in COD (Chemical Oxygen Demand) at the highest voltage of 9 volts at 120 minutes of operating time 95,76%, the reduction of TS (Total Solid) obtained at the highest voltage of 10 volts at 90 minutes of operating time 24,41%, the reduction of TSS (Total Suspended Solid) the highest obtained at the operating time of 180 minutes and a voltage of 10 volts give the rejection 91,78 %.

Key Words : POME, Electrocoagulation, COD, TS, TSS.

Introduction

Indonesia was the first country in the world as a producer of CPO (Crude Palm Oil), followed by Malaysia and Thailand (Ditjen PPHP, 2006). But it raises some new problems, namely the amount of waste generated. Where the waste produced can pollute the environment if not treated properly. Palm oil mill effluent produced in large quantities, which ranged between 600-700 liters/tonne of fresh fruit bunches (FFB) or approximately 65% of FFB. (Husni, 2010). There are some wastewater treatment technologies that have been applied generally like coagulation-flocculation, sedimentation, neutralization, activated sludge and anaerobic processes. This technology is commonly used in all types of industrial wastes containing specific waste. For waste that contain heavy metals soluble, the technology mentioned above is not efficient. This is because the cost will increase by using chemicals and also will increase volume of solid waste that being generated. Therefore acquired one of the most effective ways and cheap, by the method electrocoagulation (Mukmin, 2006). Electrocoagulation is a method that is capable of removing various kinds of pollutants in water, the suspended particles, heavy metals, petroleum products, the color of the dye, a solution of humus, and deflouridasi water. The advantage of this method are the value of efficiency is quite high and not required the addition of chemicals (Purbaningsih, 2008).

Some research that has applied this technology confirm that by using electrocoagulation can redude the COD, pH, TS and TSS of POME (palm oil mill effluent). Nasution(2012) reported

that by using this electrocoagulation method, the reducing of COD and TS from POME was achieve up to 81.18% and 82.9% while Purbaningsih (2008) reported that the pair of electrodes Iron (Fe) as the anode Carbon (C) as the cathode can reduce the turbidity and color from POME was achieve up to 91.5% and 88.7% in the leachate treatment using batch reactors and Husni (2010) reported that the percentage obtained the reducing of COD, turbidity, color and TSS from POME was achieve up to 93.46, 98.40%, 97.55% and 95.30% while Shivayogimath(2013) reported that by using electrocoagulation method when treat solid leachate obtained the reducing of COD and turbidity was achieve up to 95.8% and 96.6% while Chantaraporn(2010) reported that the reducing of oil, COD, TSS and TS was achieve up to 72%, 64%, 53% and 43% and also Nasution(2013) reported that by using Al electrode with raw POME, the reducing of COD and Turbidity was achieve up to 57.66% and 62.5% and with pretreated POME can reduce COD and turbidity up to 62.35% and 90.55%.

Materials and Methods

The main material used in this study was POME from Biogas Reactor processing of PT. Mitra Agung Sawita Sejahtera, Bandar Sakti Bandar Tinggi, Simalungun, Sumatera Utara. Meanwhile, COD Reagent Vial, distilled water, 1,6 m porous filter paper and H_2SO_4 pa were used for sample preservation and analysis of the response parameters.

The main equipment required includes glass basin size (12 x 12 x 36) cm as electrocoagulation bath (batch) with capacity of 5.184 L and effective at 4.500L, regulatory source of direct current (DC power supply), 2 pairs of aluminum plate is used as an electrode, plate thickness used is 0.8 mm, the effective area of 864.48 cm^2, stopwatch, measuring cup 1000 mL and bucket waste storage. The schematic of the electrocoagulation shown in Figure 1.

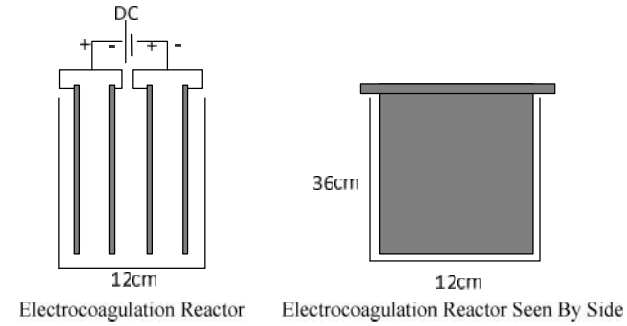

Figure 1. Schematic of the electrocoagulation

The wastewater that being used is the POME output of anaerobic pond, while the electrode that being used is aluminium. Experiment runs for 3 hours with 30 minutes each for sampling and run in batch system with variation of voltage 8, 9, 10 and 11. Before and after

running the electrocoagulation reactor, the POME will be analyzed the COD, pH, TS and TSS with given time of 0, 30, 60, 90, 120, 150 and 180 minutes.

Assembly of Electrocoagulation Reactor

Electrocoagulation reactor used is a batch type reactor. The reactor in the form of a square tub made of glass with dimensions: length 12 cm, width 12 cm and height 36cm. Each electrode plate was cut to a uniform size. Furthermore, the electrode is connected to a voltage source (DC power supply) with the electrode spacing in accordance with a predetermined.

Preparation of Waste Biogas Reactor

Liquid waste originating from the reactor biogas is the main material to be processed in this study. Waste Biogas reactor effluent is taken and put into buckets or jerry cans, to further analyzed in accordance with the required parameters (COD, pH, TS and TSS). For COD analysis, sample preservation is done by putting into dark glass bottles of 100 ml.

Analysis

The calculation of percentage of reduction of COD, pH, TS and TSS after the experiment conducted can be seen as this formula : $\%Reduction = \frac{C0-C}{C} x\ 100\%$
Where C_0 and C are the concentration of COD, pH, TS and TSS before and after the experiment.

Results and Discussion

Figure 2 presents that using aluminium electrode can remove the COD from the raw POME from inlet of anaerobic pond. As can be seen, with the power of 9 V, the graphic keep going up and down and reach the highest peak two times with efficiency of 95,76% at 10 minutes, while with power of 8 V the graphic is steady it reach its highest peak at 95,59% at 120 minutes, while with 10V it going up and reach its highest peak at 78,72% at 180 minutes and with 11V, it reduced with the lowest efficiency with the highest peak at 180 minutes with 34,02%. As the theory, the more supply power given, the more removal COD will be. But at 11 V has the lowest of rejection because the system be unstable for the highest voltage. The more power given to the system, the more removal of COD, pH, TS and TSS (Nasution, 2012).

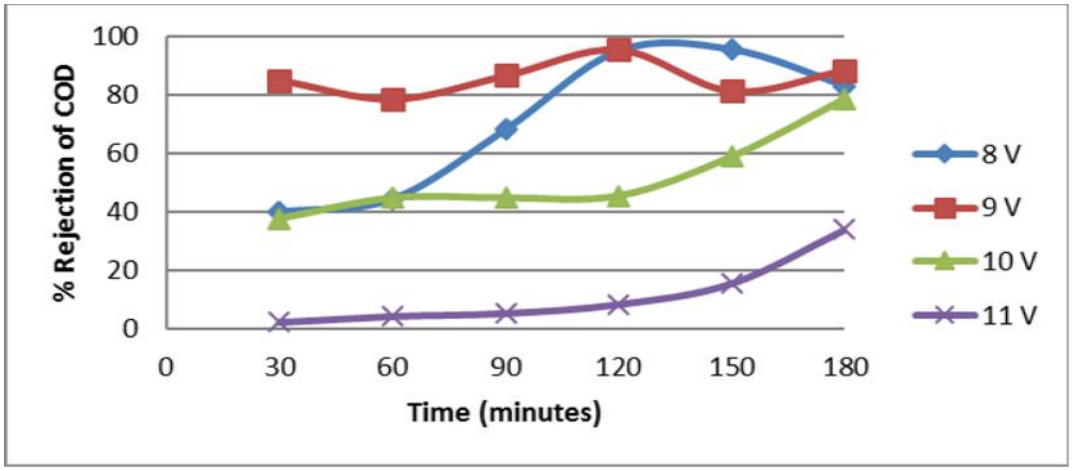

Figure 2. Reduction of COD

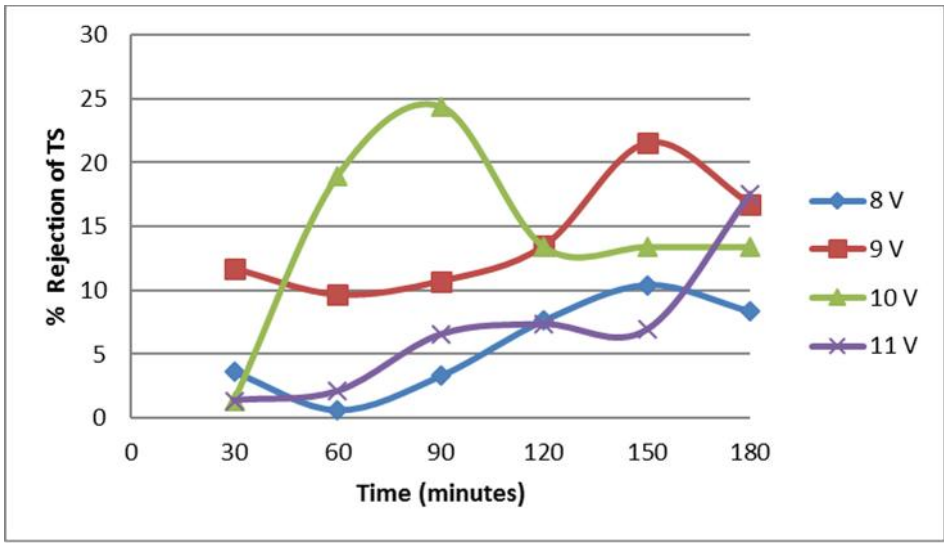

Figure 3. Reduction of TS

At Figure 3, the reduction of TS while 8V given to the system, it keeps reducing the TS with low efficiency but steady and reach its highest peak at 180 minutes with 10,39%, while 9V given to the system, it reduced the amount of TS and slowly going up and reach its highest peak at 150 minutes with 21,54%. While with 10V, it is going up to its highest peak and then going down drastically with the reduction highest peak of TS at 90 minutes with 24,41% and then being down and stable. When 11V given to the system, it reach the highest peak at 180 minutes with 17,57%. The more COD removed, then the more TS will be reduced (Nasution, 2012).

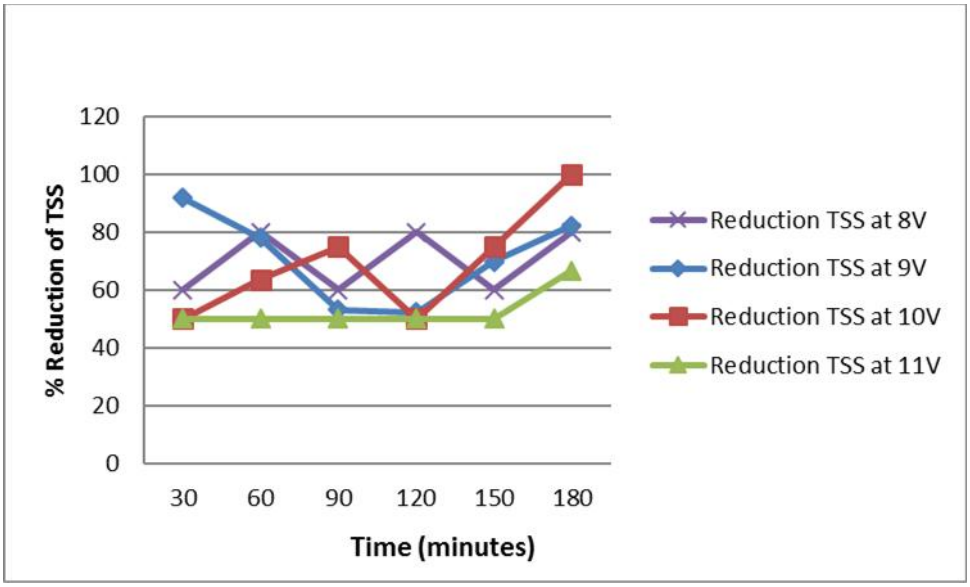

Figure 4. Reduction of TSS

At Figure 4, when 8V was given to the system, the graphic keep going up and down and reach three highest peak with 80% efficiency while at 60,120 and 180 minutes. When 9V was given and can be seen at the graphic that it going down and going up again but with highest efficiency 91,78% at 30 minutes. While 10V was given and the graphic keep going up and reach its highest peak with 91,78% efficiency at 180 minutes. While 11V was given, the graphic keep steady and then going up and reach its highest peak at 180 minutes with 66,67%, as the theory, the more TS removed, then the more TSS will be removed too. The more TS removed, then the more TSS will be removed too from the system (Nasution, 2012).

Conclusions

Electrocoagulation is an economical, effective and efficient ways to treat the palm oil mill effluent in term of time rather than using the other ways such as sedimentation, stabilisation pond, anaerobic facultative biological process, etc. The effectiveness of this method is rely on the electrode that used electricity to reduce the COD, BOD, pH, TS, TSS and colour of the wastewater so that can be disposed to the river flow.

Acknowledgements

This study was sponsored by DIKTI and colaboration with IOPRI. We would like to say thanks to PT.Mitra Agrimas Sawita Sejahtera Palm Oil Mill for facilitating the research activities by providing samples of palm oil mill effluents.

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