Treatment of Dairy Industry Waste Water by Electrocoagulation (EC) Technique Removal of BOD, COD, Turbidity and Color

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Abstract— The removal of COD and BOD from dairy wastewater was experimentally investigated using direct current (DC) electrocoagulation (EC). In the EC of dairy wastewater, the effects of initial pH, electrolysis time, initial concentration of COD and BOD, and Voltage were examined. The COD and BOD in the aqueous phase were effectively removed when aluminum plates were used as sacrificial electrodes. The optimum operating range for each operating variable was experimentally determined. The batch experimental results revealed that COD in aqueous phase was effectively removed. The overall COD and BOD removal efficiencies reached 94% and 83% respectively. The optimum Voltage, pH and electrolysis time were 25V, 7, 75 min, respectively.

Key words: Electrocoagulation, Dairy Wastewater, Aluminium Electrode, BOD and COD

I. INTRODUCTION

Electrocoagulation has a long history. The first plant was built in London in 1889 for the treatment of sewage where electrocoagulation treatment was employed via mixing the domestic wastewater with saline water. The principle of Electrocoagulation was first patented in 1906 by A. Edietrich & was used to treat bilge water from ship. In 1909, J.T. Harries received a patent for wastewater treatment by electrolysis using sacrificial aluminum and iron anodes in the United States [1]. The dairy industry, like most other agro-industries, generates strong wastewaters characterized by high biological oxygen demand (BOD) and chemical oxygen demand (COD) content. Furthermore, the dairy industry is one of the largest sources of industrial effluents. A typical European dairy generates approximately 500 m^3 of waste effluent daily. Since dairy waste streams contain high concentrations of organic matter, these effluents may cause serious problems, in terms of organic load on the local municipal sewage treatment systems. Environmental problems can results from discharge of dairy wastewater (DW). Introduction of Most of the wastewater volume generated in the dairy industry results from cleaning of transport lines and equipment between production cycles, cleaning of tank trucks, washing of milk silos and equipment malfunctions or operational errors. DW treated using Physico-chemical and biological treatment methods. However, since the reagent costs are high and the soluble [2]. Electrocoagulation has the advantage of removing the smallest colloidal particles compared with traditional flocculation–coagulation, such charged particles have a greater probability of being coagulated and destabilized because of the electric field that sets them in motion. In addition, electrocoagulation-flotation is capable of reducing waste production from wastewater treatment and also reduces the time necessary for treatment [3].

II. ELECTROCOAGULATION PROCESS

The EC is a process in which the anode material undergoes oxidation whereas the cathode subjected to reduction and hence, various Monomeric and polymeric metal hydrolyzed species are formed at the electrode surface. These metal hydroxides remove organics from wastewater by sweep coagulation and by aggregating with colloidal particles present in the wastewater to form bigger size flocs and ultimately get removed by settling. The metal ions generation takes place at the anode and hydrogen gas is released from the cathode. This hydrogen gas would also help to float the flocculated particles out of the water by process called electro flotation. When aluminum is used as electrode materials, the electrochemical reactions are as follows.

A. At Anode

$$Al \longrightarrow Al^{3+}{}_{(aq)} + 3e^- \quad (1)$$

B. At Cathode

$$3H_2O + 3e^- \longrightarrow 3/2H_2\,(g) + 3OH^- \quad (2)$$

In the solution

$$Al^{3+}{}_{(aq)} + 3H_2O \rightarrow Al\,(OH)_3 + 3H^+{}_{(aq)} \quad (3)$$

As seen in the above reactions EC is a combination of oxidation, flocculation and flotation. The EC occurs in three steps. In first step, coagulant is formed because of oxidation of anode. In second step, pollutants get destabilized and in last step the destabilized matters get united and then removed

III. MATERIALS & METHODS

A. Analytical Methods

A sufficient quantity of wastewater is collected from nearby dairy industry. Wastewater discharge point and characterization of sample is carried out according to standard methods. The methods are fallowed for various parameters as shown in table below.

Sl. No	Parameters	Methods
1	pH	pH-Meter
2	Colour	Spectro-Photometer
3	COD (mg/l)	Open reflux
4	BOD_5(mg/l)	Winkler's
5	Conductivity (µs/$cm^{2)}$	Conductivity cell/ Potentiometric

Table 1: Characteristics of dairy effluents

B. Batch Experimental Setup and Methodology

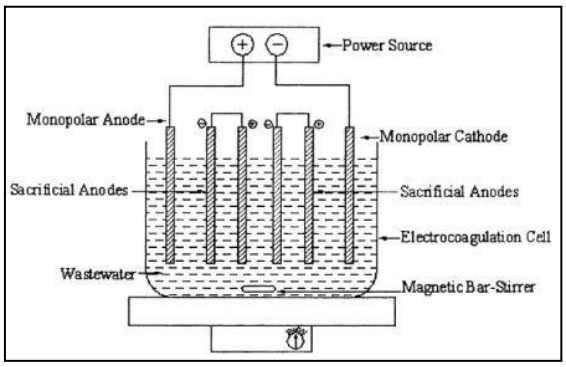

Fig. 1: Bench-scale EC reactor with Monopolar electrodes in serial connection.

IV. Results and Discussion

The experiment was carried out by increasing pH of the raw wastewater to 7.0 with different voltages 10V, 15V, 20V and 25V. The COD was reduced 80%, 86%, 90% and 94% respectively at 1hours of electrolysis duration. The removal efficiency results remained constant for 75mins of electrolysis duration Fig 2.

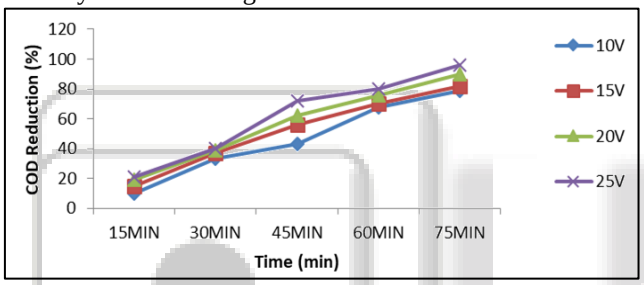

Fig. 2: COD removal with electrolysis time for different voltages at pH 7.0

The experiment was carried out by increasing pH of the raw wastewater to 7.0 with different voltages 10V, 15V, 20Vand 25V. The BOD was reduced 68%, 79%, 82% and 83% respectively at 1hours of electrolysis duration. The removal efficiency results remained constant for 75mins of electrolysis duration Fig 3.

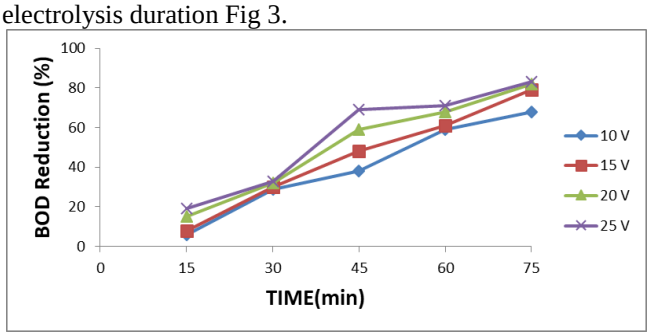

Fig. 3: BOD removal with electrolysis time for different voltages at pH 7.0

V. Conclusion

Electrocoagulation is a feasible process for the treatment of Dairy Industry effluent waste water, characterized by the high oil and greases content, fluctuated COD and BOD concentration. The treatment of waste water using Aluminum electrodes was affected by the initial pH, the current density, electrodes distance, NaCl concentration, rotational speed, The results showed that optimum operating condition were found to be an initial pH of 7, current density of 25mA/cm2, rotational speed of 100 rpm, NaCl concentration of 1 g/l and electrolysis time of 60 min. this experimental clearly showed that under the optimal conditions, about, 94% COD and 83% BOD were successfully removed. The COD and BOD percentage removal were found to increase with the increase in sodium chloride concentration, current density, impeller rotational speed. Power consumption was found to lowest at 7 pH. From the experimental results it is found that electrocoagulation technique could be successfully used for the recovery of water from Dairy industry.

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