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TREATMENT OF DAIRY INDUSTRY WASTE WATER BY ELECTROCOAGULATION (EC) TECHNIQUE

REMOVAL OF BOD, COD, TURBIDITY AND COLOR

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Abstract: *The dairy industry generates strong wastewater characterized by high BOD, COD, nutrients and inorganic content. Furthermore, the dairy industry is one of the largest sources of industrial effluents. Hence, the cost effective treatment of dairy effluents for environmental protection is a challenging task. The removal of pollutants from dairy is experimentally investigated using direct current electrocoagulation (EC). In this study, the effect of pH, electrolysis time (ET), applied voltages were examined. The COD and turbidity in the aqueous phase was effectively removed when aluminum electrodes were used. The optimum value of voltage, pH and ET were found to be 25V, 7.0 and 60 minutes respectively. To study the effect of inter electrode spacing and effect of different initial pH for the removal of COD, TSS, TDS, oil and grease at constant voltage for the iron electrode, it involves the generation of coagulants in situ by dissolving the ions from the electrode by Electro coagulation (EC) is one of the commonly used processes for the treatment of wastewater*.

KEY WORDS*: Electrocoagulation, Dairy wastewater, Alluminium electrode, BOD, 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 & were 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.

At Anode:

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

At Cathode:

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

In the solution: $Al^{3+}_{(aq)} + 3H_2O \rightarrow Al\ (OH)_3 + 3H^+_{(aq)}$ (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

3.1 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.

Table.1
Characteristics of dairy effluents

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 ($\mu s/cm^{2)}$	Conductivity cell/ Potentiometric

3.2 BATCH EXPERIMENTAL SETUP AND METHODOLOGY

The batch experimental studies are conducted to optimize various parameters such as pH, electrolysis duration and Voltage. The experiment is performed with 4 electrodes connected to DC power supply. The space between each electrode is 1cm for every experiment & a voltage of 5, 10, 15 & 20 is supplied as per the requirement. The volume of solution in each experiment is 1.5 liter. Magnetic stirrer is used in all tests to ensure a homogeneous solution in the batch reactor containing wastewater. About 3gm/lit of Boric acid is added as Electrolyte to the wastewater for each batch the wastewater concentration is reduced to half the study to reduce the time and current consumption to obtain better efficiency. Electrodes are washed with 15-20% of HCL fallowed by a detergent wash before the experiment [4].

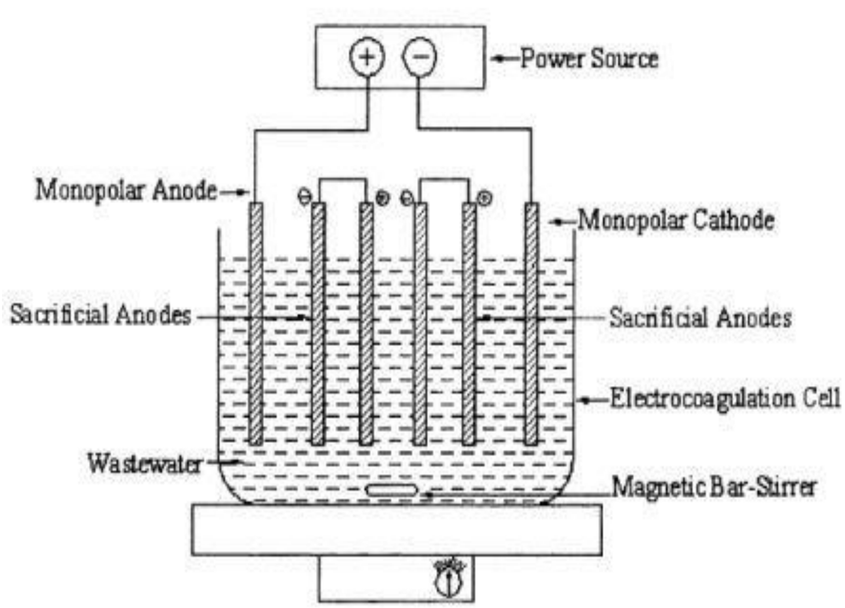

Figure: Bench-scale EC reactor with Monopolar electrodes in serial connection.

IV. Conclusion

This paper has given a review of the successfully electrocoagulation application, for the removal of specific problematic factors (such as color, recalcitrance and toxicity) that cannot be removed effectively via conventional treatment methods. The interest is double: economic and environmental. The technical feasibility study is a good base for future industrial units of the electrocoagulation. However, a number of possible future studies using the same experimental setup are apparent. For optimal performance and future progress in the application of this innovative technology considerably more work will need to be done in better reactor design, understanding and process control has to be provided. It is apparent that this technology will continue to make inroads into the wastewater treatment arena because of its numerous advantages and changing strategic global water needs.

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