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STUDY OF ELECTROCHEMICAL TREATMENT FOR INDIGO DYE WASTEWATER RESULTING FROM TEXTILE SECTOR (BLUE DENIM PLANT)

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ABSTRACT

This study aims to apply the electrochemistry-based approaches for removal of pollutants in wastewaters, such as electrochemical oxidation, electrochemical reduction, electrocoagulation and electrocoagulation/flotation processes. The main aim is to examined the impact of several operating parameters such as bipolar electrode element (Fe/Al etc), electrolysis time (RT), current intensity (I), pH, chemical support and interelectrode distance (IED). Optimization of process & operating parameters by considering different electrode materials. To determine the effects of different experimental parameters like current density, pH, Inter electrode distance, electrolysis time, conductivity in batch process. Comparison of technical and economic aspects of electrochemical treatment over conventional treatment technologies.

INTRODUCTION

❖ Background

Over the last 3 decades, several large, modern, integrated denim textile mills exporting their products mostly to the developed countries and also catering to the ever growing domestic need of denim have been established in the country. Moreover, denim is 100 % cotton fabric universally blue in shades due to Indigo Blue Dye Average total water consumption in the denim plant would vary from 100-300 Liters/Kg of the finished fabric. These are indicative values only. In spite of variations in the finished products, actual operational practices followed, the raw, untreated effluent from a

composite denim textile mill almost universally depicts blue color and high alkanity in terms of pH. As mentioned above, the typical blue colour of the effluent is because of the indigo blue dye, one of the wet group of dyes, most commonly used in dying of the denim. Therefore, large part of the dye comes out in the effluent imparting blue colour, and raising its Chemical Oxygen Demand (C.O.D.).

2.2 ELECTROCOAGULATION FOR TEXTILE WASTE WATER TREATMENT

The EC process is distinguished by the fast rate of impurity removal, compact size of the equipment, simplicity in its operation and low operating and equipment costs (Chen et al., 2000). EC has various controlling factors during its processing: the initial dye concentration, electrolysis time, current applied, initial pH of the solution, solution conductivity, type of electrode material, inter electrode distance, type of electrolyte and its concentration, etc. Optimisation of these parameters for attaining maximum efficiency is found to be critical. Since there are a wide variety and of structurally different dyes, optimization of these process controlling factors on the dyes play a major role in competent dye elimination. Hence, an elaborate study on the literature in dye removal using electrocoagulation process was carried out based on the themes given in Figure 2.3.

MATERIAL AND METHODS

❖ **Experimental Setup**

The Fig.1. Shows the batch experimental set-up. An electrocoagulation cell, a DC power supply and the electrodes (4 Aluminum as the cathode and 3 Fe as the anode) are involved in the electrochemical unit. An anode and cathode which spacing of 10mm and 15 mm (depending on the experiment) between each other has the same dimensions (230mm X 170 mm X 3mm) as a Monopolar electrode. 78200 mm2 was the total effective area of the electrode. Before every experiment conducted, all the electrodes were washed with dilute HCL. The experiments were carried out in a batch mode. Monopolar electrodes used with electrode distance 15mm and 10 mm. 10 Ampere and 24 volts are fixed in the power supply unit. Each run was carried out at time interval of 15min, 20min, 25 min, and 30 min, once the DC power supply was started. Experiments were carried out to determine the effect of electrode material, Electrocoagulation time, interelectrode distance, and initial pH. After the experiment, 500ml treated sample was taken from each plate and then kept undistributed for 60 min in order to allow the flocs to settle. Subsequently, after settling the sample of supernatant was collected to perform the analysis of Color and COD.

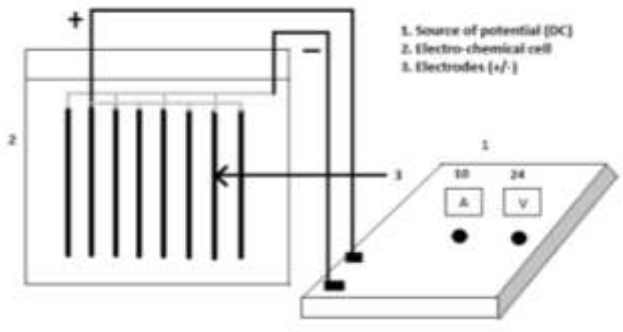

Figure 1: Schematic diagram of the experimental set-up

❖ **CHARACTERISTICS OF EFFLUENT SAMPLE:**

The indigo dye effluent used in this study was obtained from a blue denim manufacturing unit, which is located at Ahmedabad, Gujarat, India, and stored in air-tight plastic cans at 4ºC before treatment. Characteristics of the Effluent sample is COD (mg/L) range: 1100 – 1400, BOD (mg/L) range: 500-700, SS (mg/L) range: 1000-2000, pH: 7-7.8.

RESULTS AND DISCUSSION

The results of the experimental studies on the treatment of the indigo dye wastewater resulting from blue denim manufacturing by using Aluminium and Iron as an electrode material and the effect of a different operating parameter such as electrolysis time & electrode distance are presented in graphical representation as below graphs (Fig: 2 to 5)

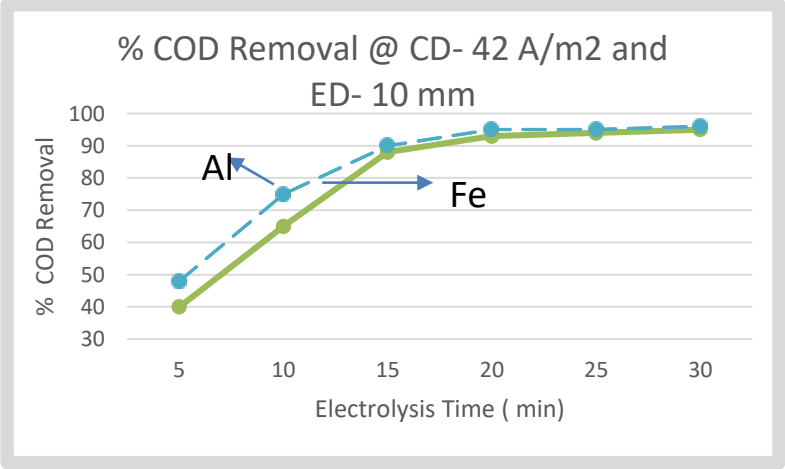

Figure 2: % COD Removal @ 10 mm Inter Electrode Distance

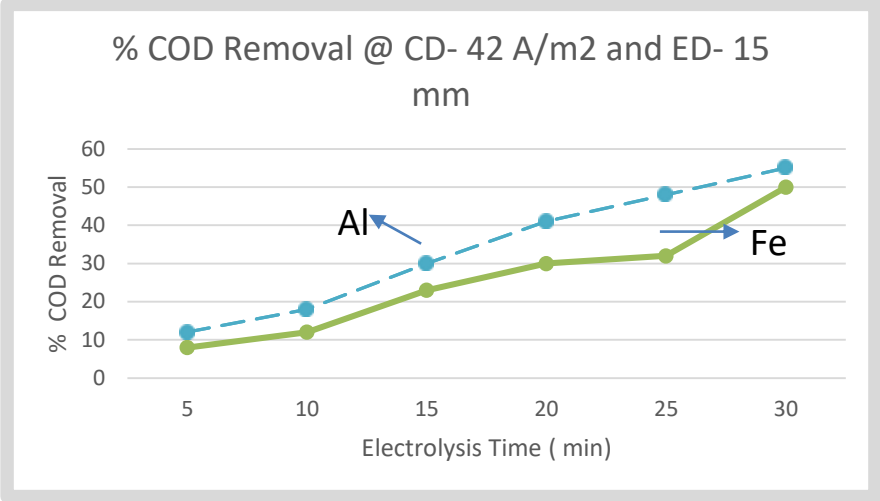

Figure 3: % COD Removal @ 15 mm Inter Electrode Distance

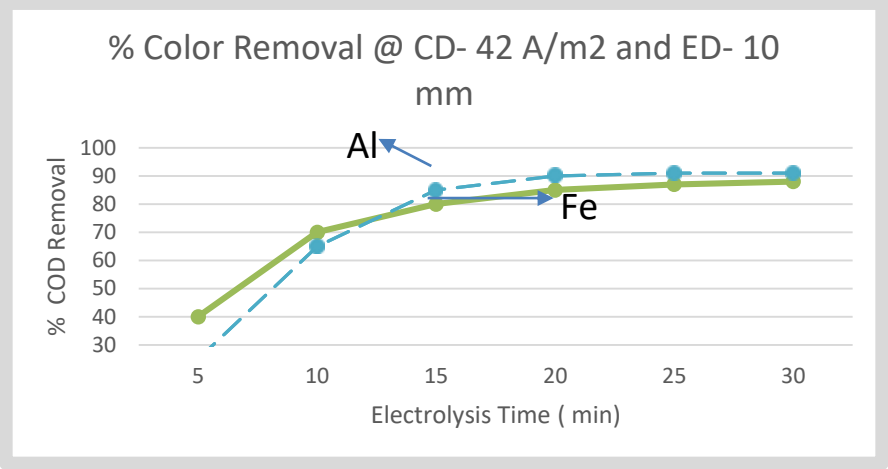

Figure 4: % Color Removal @ 10 mm Inter Electrode Distance

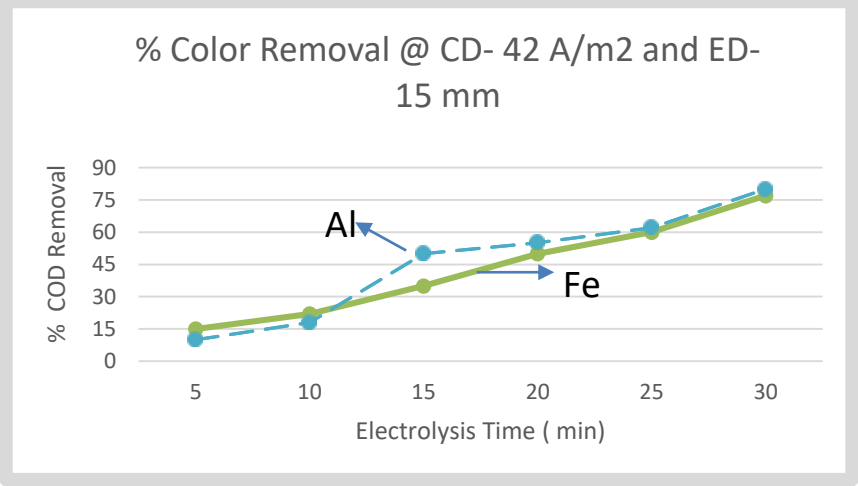

Figure 5: % Color Removal @ 15 mm Inter Electrode Distance

CONCLUSIONS

The influences of current density, pH, electrode distance, electrolyte concentration, and electrolysis time on indigo dye wastewater resulting from blue denim manufacturing by electrocoagulation have been examined. Two different electrode aluminium and iron were used for the electrocoagulation. Here the current density is kept constant at 42 A/m^2. For Iron electrode, the maximum efficiency obtained is 95 % at 10 mm inter-electrode distance after 30 min of electrolysis time. However, it is to be noted that there was no significant increase in efficiency after 15 min of electrolysis time. Beyond which the energy consumption will increase, but no significant change in COD removal will obtain. The similar trend observed for color removal also. While at 15 mm distance the removal efficiency is low for COD and color removal i.e. 50 and 77 %. For Aluminium electrode, the maximum efficiency obtained is 96% COD removal and 91% Color removal at 10 mm inter-electrode distance after 30 min of electrolysis time. However, it is to be noted that there was no significant increase in efficiency after 15 min of electrolysis time. Beyond which the energy consumption will increase, but no significant change in COD removal will obtain. Similar trend observed for color removal also. While at 15 mm distance the removal efficiency is low for COD and color removal i.e. 55 and 80%. From the above analysis results for the Aluminium and Iron electrode, it is found that the optimum inter electrode distance is 10 mm, and electrolysis time is 15 min.

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