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ORIGINAL ARTICLE **OPEN ACCESS**

A Comprehensive Study on Performance of Electrocoagulation in the Removal of COD and Turbidity from Textile Wastewater -A Pilot Plant Scale Study

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ABSTRACT

Electrocoagulation has proved to be an efficacious technology for the elimination of stubborn pollutants from different types of waste water by electrochemical approach. The textile industry is the most polluting amongst the other dye industries and textile wastewater is recognized by the more concentration of BOD and COD. This paper provides a comprehensive study ofrecent advancements in electrocoagulation that focuses on textile wastewater treatment using electrocoagulation for the elimination of BOD and COD. This review examines the optimum elimination efficiency of Organic matter such as COD and BOD by studying the different key parameters such as type of electrodes used, current density, optimum pH, electrolysis time, and stirring time. Finally, suggestions are made which will help in performing the treatment by choosing the most appropriate set of working parameters.

Key Words: *Turbidity, Chemical oxygen demand, Electrocoagulation, Textile wastewater*

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INTRODUCTION

Electro-coagulation is the most prominent method and cost-effective for the elimination of suspended impurities as well as used to reduce or remove the excess concentration of ions and chemicals such as biological oxygen demand, chemical oxygen demand and turbidity from the wastewater. Because of its versatility and environmental friendliness, electrocoagulation has lately gained attention as a viable approach for treating industrial wastewater.[15] Most old approaches are becoming ineffective due to the considerable heterogeneity in the content of textile wastewaters. Furthermore, in recent years, the cost of treating textile effluent has risen at a rapid rate. As a result, a quest for new cost-effective treatment options is necessary. Electrocoagulation has been offered as a possible option in recent years.[11] The electrocoagulation process was investigated under a variety of circumstances, including different current densities and the effect of experimental tension. For each trial, the efficacy of COD and turbidity reductions were investigated. [9,15]. Thismethod uses a direct current source between metal electrodes immersed in affluent, causing electrode plates to dissolve into the effluent [1]. In this process, the negatively charged particle is stabilized by the positively charged particles, and also due to intra mixing of the sample with the help of magnetic stirrer leads to the settling down of suspended impurities after a certain duration [2] At the right pH, metal ions can form a wide range of compounds. of coagulated species and metal hydroxides that precipitate and destabilize and agglomerate the dissolved pollutants or absorb dissolved pollutants particles suspended in the air [8]. The physicochemical procedures have the drawback of high reagent costs and low soluble COD elimination.[12].

Chemical therapy is also used. may result in secondary contamination as a result of the addition of coagulants that may pollute the treated water aqueous [3]. The effluent taken from the textile industry contains a higher amount of COD, BOD, and Turbidity, with the help of this Electrocoagulation process we can reduce the concentration level in the sample and after further treatment of the sample, it can be used for non- potable reuse. [6]. Electrocoagulation has been used to successfully treat a variety of wastewaters, including electroplating wastewater, laundry wastewater, and photovoltaic wastewater. [8,13]. Meanwhile, the EC method has been widely utilised to decolourize a variety of materials. effluent from the textile industry.[14].On the chemical oxygen demand (COD) and turbidity removal efficiencies, the impact of key wastewater properties such as conductivity and pH, as well as significant process factors such as current density and operation duration, have been investigated.[17,16] This project has attained more elimination efficiency of COD, BOD & Turbidity by varying the optimum parameters like pH, RPM of the Stirrer, Current intensity of the DC supply, and Hydraulic Retention time.[7] The most extensively used electrode materials for the Electrocoagulation process of Iron, Copper, and Aluminium amongst the various electrodes Aluminum is most effective and cost-efficient while compared to the other materials. [5,9] It shows higher elimination efficiency when it is used to treat domestic wastewater samples. Aluminium has only 61 % of the conductivity of copper but has only 30 % of the weight of copper. Generally, in the Electro-coagulation process, the addition of oxygen appears place at the anode, and loss of oxygen appears at the cathode. Many electrodes had similar COD and turbidity removal performance, however Aluminium.[10] the electrode was picked because of its low cost. The following equations represent the major chemical reactions that occur at the anode and cathode when utilising Al electrodes [4,5]

Anode:	(s)	$\rightarrow$	$Al2+ +2e^-$
Cathode:	$2H2(l)+3e^-$	$\rightarrow$	$H2(g) +2OH^-$
Reaction:	$Al2+2H2(l)$	$\rightarrow$	Al (OH)2 +3OH^-

MATERIAL AND METHODS

Experimental setup

In this experiment a 200ml glass beaker and a pair of aluminium electrodes (as shown in fig1) and each of the electrodes with uniform Dimensions of 11cm X 02cm X 0.1cm and overall contact area of the electrode surface with the textile industry effluent is (9cm x 2cm) = (2 x 18 + 1.8) = 37.8$cm2$. A DC power supply is used to transfer direct current to the electrodes and a hotplate stirrer device and a magnetic bar setup are used to regulate the RPM (Rotation per Minute) and a multimeter is used to measure the current, voltage, and ampere in the process.

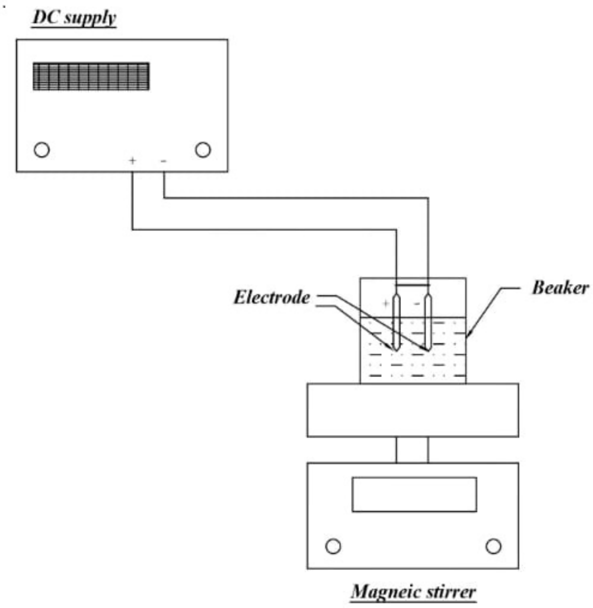

FIG 1: Experimental setup

Materials:

- Pair of aluminium electrodes(anode and cathode)
- DC power supply
- Magnetic stirrer

- Beaker

Experiment Method

In this experiment a 200ml glass beaker and a pair of aluminium electrodes and each of the electrodes with uniform Dimensions of 11cm X 02cm X 0.1cmand overall contact area of the electrode surface with the textile industry effluent is (9cm x 2cm) =(2 x 18 + 1.8) = 37.8cm^2. In each run a DC power of 0.6A supply is used to transfer direct current to the electrodes and a hotplate stirrer device and a magnetic bar setup is used to regulate the RPM and a multimeter is used to measure the current, voltage and ampere in our process.

In each run a sample of 200cm^3 is taken in a glass beaker and the operating conditions

Operational parameters	Operating value
Current density (J)	160A/m^2
Electrode spacing	10 mm
Current (I)	0.6 A
Potential difference	9 v
Rotation speed	200 RPM
Duration	60 minutes

RESULT AND ANALYSIS

INITIAL CHARACTERISTICS OF TEXTILE WASTEWATER SAMPLE

Table 1: Characteristics of Textile wastewater

Characteristics of sample	Amount of presence
BOD	850 (ppm)
COD	3467 (ppm)
Turbidity	5700 (NTU)
TSS	1800 (ppm)
TDS	5100 (ppm)
TS	6900 (ppm)
EC	3450 (μS/cm)
pH	6.5

Analytical methods

In this experiment, the overall efficiency results were calculated as

1) COD elimination% $= \frac{Initial\ COD - Final\ COD}{Final\ COD} \times 100$

2) **Turbidity elimination** % $= \frac{Initial\ Turbidity - Final\ Turbidity}{Final\ Turbidity} \times 100$

In this process-dependent, it was treated with its original pH level and the value of the PH is not altered before the treatment and the treatment of the sample was carried at room temperature (24oC).

Table 2: ALUMINIUM ELECTRODE PERFORMANCE

S.No	Characters	Initial	Final	Removal efficiency (%)
1	pH	3	5	-
2	Electrical conductivity(mS/cm)	13.6	3.4	-
3	COD (ppm)	1500 ppm	150	92.50
4	Turbidity	343 NTU	87.46 NTU	74.50
5	Color	Light brown	Colourless	-
6	Total solids	8240mg/L	1940mg/L	76.45
7	Total dissolved solids	7800mg/L	1490mg/L	80.89
8	Total suspended solids	440mg/L	100mg/L	77.27

ALUMINIUM ELECTRODE PERFORMANCE

The above Table 2 portraits the initial and final comparison of aluminium electrodes. The effect of relevant operating conditions such as pH, electrolysis duration, stirring speed were helpful to note the electrode performance. The result indicates that electrocoagulation is prominent and could achieve the removal efficiency of characters at high rate. Aluminium electrode combination is better for electrocoagulation process.

OPERATING PARAMETERS RANGE

S.NO	PARAMETERS	RANGE
1	Ph	3-7
2	Contact time	30-120 mins
3	Stirring speed	200-800 rpm

Effect of HRT during electro-coagulation for elimination efficiency of COD and turbidity at 200rpm:

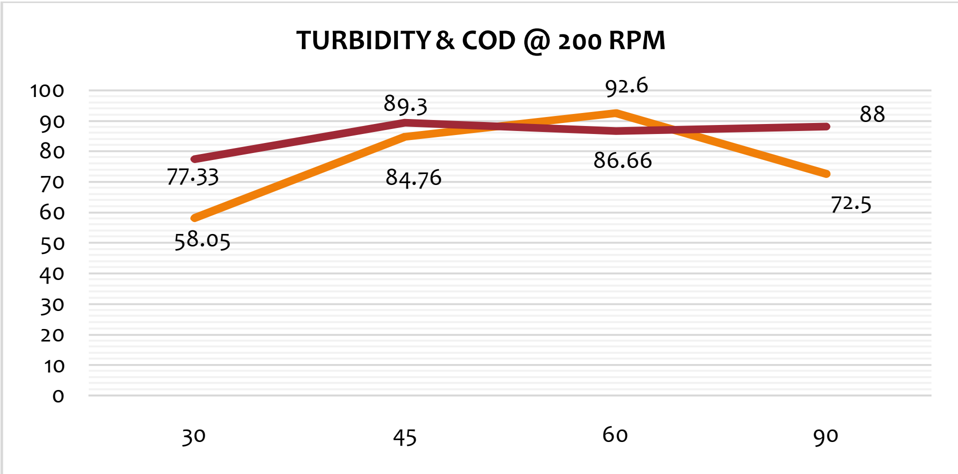

Fig 2: Elimination efficiency of TURBIDITY & COD by varying SPEED at 200 RPM.

In this graph, the elimination efficiency of COD and turbidity are plotted along Y-axis and the HRT was plotted along the X-axis. Initially, at 30mins the elimination efficiency on turbidity was observed as 58.05% and COD elimination efficiency was 77.33%. At 45mins the elimination efficiency of the COD & turbidity was 89.32% and 84.70%. The elimination efficiency was increased when the sample was treated for 60mins, the elimination efficiency of COD was 86.66% and the elimination efficiency of the Turbidity was 92.50%. At 90mins the sample attained the more elimination efficiency of COD 88% and for turbidity, it was 72.50% for this process the current intensity that passed through the electrode was 15volt and the spacing between the electrodes was 2cm and the overall stirring speed was set as 200RPM in the magnetic stirrer and it was constant for all the HRT. The optimum elimination efficiency on COD was attained 89.32% during the time interval of 45mins and the optimum elimination efficiency on turbidity was attained as 92.5% at 60mins.

Effect of HRT during electro-coagulation for elimination efficiency of COD and turbidity at 400rpm

In this graph, the elimination efficiency of the COD and turbidity were plotted along Y-axis and the HRT was plotted along the X-axis. Initially, at 30mins the elimination efficiency of turbidity was observed as 68.66% and COD elimination efficiency was 53.60%. At 45mins the elimination efficiency of COD & turbidity was 13.85%and 40.66%. When the sample was cherished for 60mins the elimination efficiency of the COD is 23% and the elimination efficiency of the Turbidity was 62%. At 90mins the sample attained the elimination efficiency of COD is 75% and turbidity was around 76% for this process the current intensity passed through the electrode was 9volt and the spacing between the electrodes was 2cm and the overall stirring speed was set into 200RPM in the magnetic stirrer and it was constant for all the HRT. The optimum elimination efficiency on COD was attained as 75% during the time interval of 90mins and the optimum elimination efficiency on turbidity was attained as 76% at 90mins.

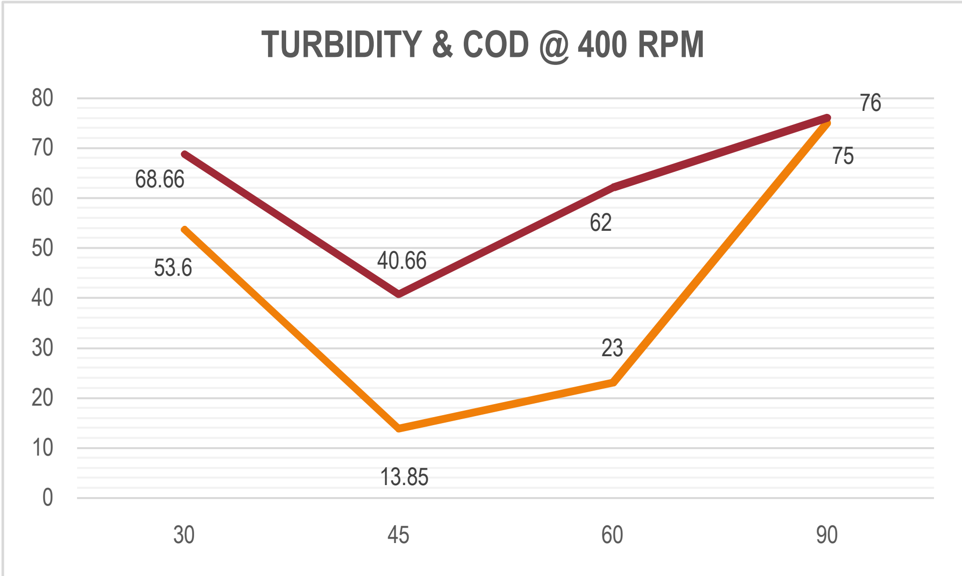

FIG 3: Elimination efficiency of TURBIDITY & COD by varying TIME at 400 RPM.

Effect of rotation speed during electro- coagulation for elimination efficiency of COD and turbidity for 120 mins

In this graph, the elimination efficiency of COD and turbidity were plotted along Y-axis and the RPM was plotted along the X-axis. All the samples were cherished for 120mins, when the sample was treated for 500RPM the elimination efficiency of turbidity and COD attained was 79% and 66.67%, in this graph we infer the maximum elimination efficiency on turbidity has occurred. When the sample was cherished for 600RPM the elimination efficiency for COD and turbidity attained was 70.67% and 69.65%, the more elimination efficiency ofturbidity was inferred in this stage. When the sample was treated for 800RPM the elimination efficiency of turbidity and COD was 62% and 61.33%.

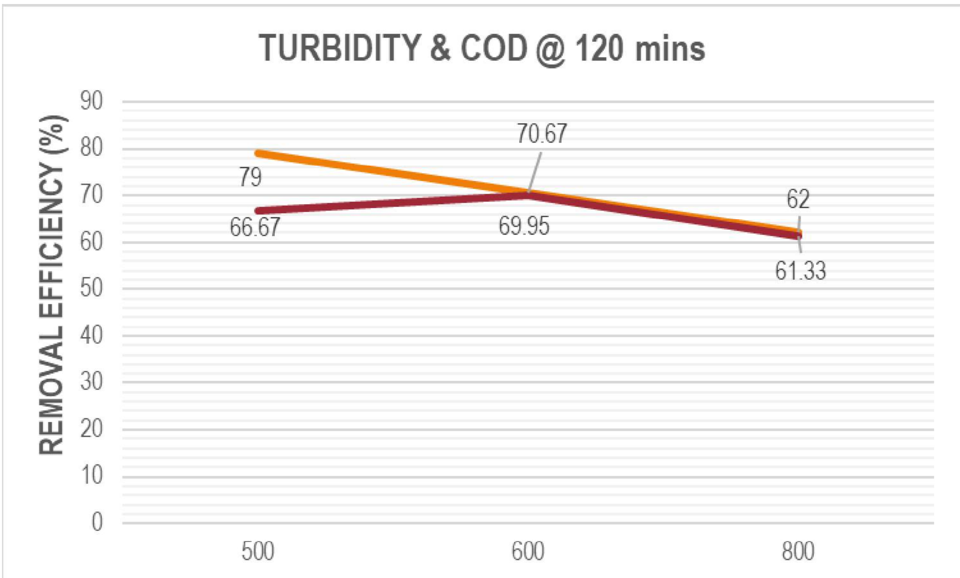

FIG 4: elimination efficiency TURBIDITY & COD by varying SPEED

Effect of pH during electro-coagulation for elimination efficiency of COD and turbidity for 60mins

In this graph, the elimination efficiency of COD and turbidity were plotted along Y-axis and the pH was plotted along the X-axis. In this process, the sample was treated at different PH and the stirrer speed was 200RPM, the current intensity was 9v and HRT was 60mins. At PH=5.3 the elimination efficiency of COD and turbidity was 69.6% and 91.9%. At PH=5.8 the elimination efficiency of COD and turbidity was

62.13% and 94% and the maximum elimination efficiency of the turbidity was inferred. At PH=6.3 the elimination efficiency of COD and the turbidity was 70.13% and 90.85% and the more elimination efficiency of the COD is inferred.

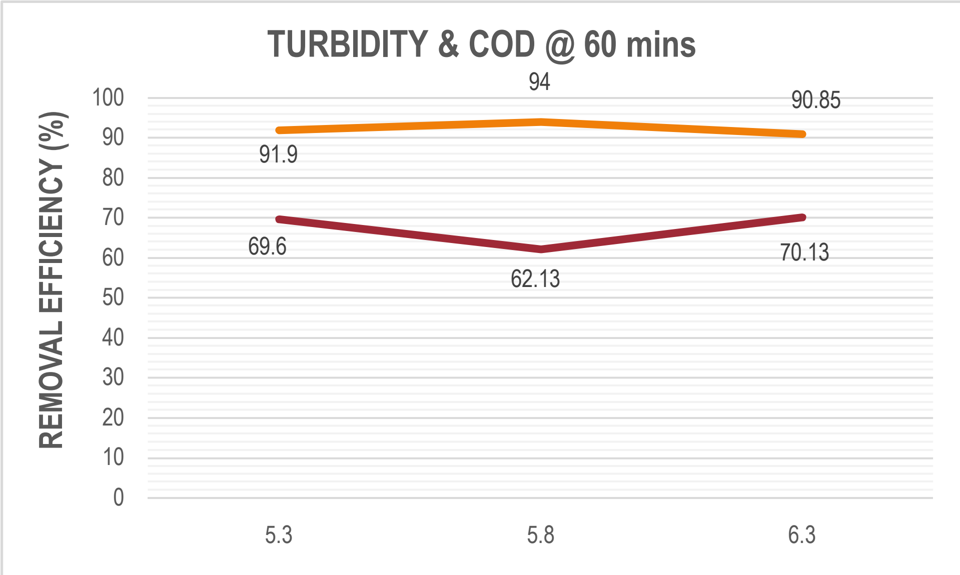

FIG 5: Removal efficiency of TURBIDITY & COD by varying pH.

CONCLUSION

Through this research work, the identification of optimal parameters such as pH, HRT, Rotation speed has been optimized. The use of aluminium as sacrificial electrode material in the electrocoagulation treatment of textile wastewater has been discovered to be pH-dependent. According to the findings, aluminium has higher COD and turbidity removal efficiencies in acidic medium (pH 6) than iron in neutral and alkaline medium. High process efficiency is favoured by high conductivity. The optimum elimination efficiency is attained at HRT of 60mins; rotation speed of 200RPM; at a pH of 6.3. At such conditions the elimination efficiency of COD, Turbidity was 87.0% and 92.5%, whichever is maximum. The disadvantage is electrode gets rusted after continuous treatment. To prevent such conditions the electrodes must be washed with appropriate solutions like HCl. Also, in textile wastewater, there will be a presence of foaming agents which forms a layer around the electrode and reduces the efficiency. These two significant operating costs and operating would undoubtedly have a significant impact on the choice of sacrificial electrode content for specific wastewater characteristics, as well as COD and turbidity removal standards imposed by environmental restrictions on process effluents.

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