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Short Communication

Removal of Colour of Spent Wash by Activated Charcoal Adsorption and Electrocoagulation

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Abstract

Electrocoagulation is a complex process with a multitude of mechanisms operating synergistically to remove pollutants from the water. In this paper, application of electrocoagulation using common electrode materials (aluminum and iron) to a simulated reactive distillery effluent was investigated. Based on the dynamic characteristics of batch electro coagulation, three operating stages (lag, reactive, and stabilizing) are proposed to identify the relationships among the zeta potential. The experimental results showed that the removal efficiency was better, reaching to about 62%, when applying activated charcoal adsorption before treating with the electrocoagulation cell. The study focuses on the effect of electrolysis time, current density, initial pH, inter-electrode distance, initial dye concentration and type of supporting electrolyte. In the sets of experiments the optimum condition for dcolourisation has been found out.

Keywords: Electrocoagulation, spectrophotometer, colour, sacrificial electrodes.

Introduction

Electrocoagulation: Textile industries are among the most polluting industries in terms of the volume and the complexity of treatment of its effluents discharge. Wastewaters generated by textile industries are known to contain large amounts of toxic aromatic compounds, especially azo dyes. It is well known that some azo dyes and their degradation products, such as aromatic amines, are highly carcinogenic[1]. Spent wash samples collected from the neighborhood industry plant Ichalkarngi (India) revealed a high contamination by synthetic dyes, most of them being toxic. Azodyes which contain one or more azo bonds (–N N–), are among the most widely used synthetic dyes[2]. The discharge of such dyes in the ecosystem is considered as a major environmental concern.

During last few decades, electro coagulation (EC) using various electrode materials such as cast iron, stainless steel, aluminum or graphite have been successfully applied to "hard" industrial Wastewater.[3] EC involves the generation of coagulant in situ by the dis- solution of metal from the anode with simultaneous formation of hydroxyl ions and hydrogen gas at the cathode. This process produces the corresponding aluminum or iron hydroxides and/or polyhydroxides. The generated gas also helps to float the flocculated particles at the water surface.EC was proposed before the turn of the 20th century. Most studies have focused on the effect of manipulating parameters (e.g. conductivity, pH, current density) on removal efficiencies of certain pollutants, rather than a fundamental, holistic and systematic approach to understand EC mechanism and its controlling parameters.

I. Kabdas[3], has studied the application of electrocoagulation using common electrode materials (aluminum and stainless steel) to a simulated reactive dyebath effluent. They have focused study on focused on the effect of individual reactive dyebath components on color and COD removal rates and efficiencies by electrocoagulation. They reported that electrocoagulation using stainless steel electrodes was found to be more effective particularly for color abatement. Na_2CO_3 significantly reduced the process efficiency both in terms of color and COD removals. An adverse effect on COD removal efficiency was also observed for the sequestering agent. On the other hand, increasing the NaCl concentration not only enhanced color and COD removal efficiencies but also compensated the adverse effects of Na_2CO_3 and sequestering agent on the electrocoagulation process. Wei-Lung Chou et.al[2] worked on the feasibility of reducing COD and turbidity from real oxide chemical mechanical polishing (oxide-CMP) waste water. They have reported that the silica particles were destabilized and settled at the critical electrolysis time, which was estimated to be about 12 min under an applied voltage of 20V and a supporting electrolyte of 200 mg/L. The corresponding turbidity removal occurred mostly during the reactive stage. They also investigated the process variables, including applied voltage and electrolyte concentration, in terms of COD removal efficiency and turbidity removal. S. Aoudj et.al[4] has applied electrocoagulation for the colour removal of solutions containing direct red 81. They performed their experiments for synthetic solutions in batch mode. They have also studied the effect of electrolysis time, current density, initial pH, inter-electrode distance, initial dye concentration and type of supporting electrolyte. They reported that the optimum

condition for colour removal are initial pH of about 6, current density of 1.875mA/cm2, inter-electrode distance of 1.5cm and finally the use of NaCl as supporting electrolyte. In best conditions, high decolouration efficiency was obtained, reaching more than 98% of colour removal.

I. Ayhan S¸ engil et.al[5] worked on removal COD and oil–grease from dairy waste water by using direct current electrocohagulation. In the EC of dairywastewater, the effects of initial pH, electrolysis time, initial concentration of COD, conductivity and current density were examined. They reported that the overall COD and oil–grease removal efficiencies reached 98 and 99%, respectively. The optimum current density, pH and electrolysis time for 18,300 mg COD/L and 4570 mg oil–grease/L were 0.6 mA/cm2, 7 and 1 min, respectively. Mean energy consumption was 0.003 kWh/kg of COD. B. Gourich et.al investigated the performance of a continuous electrocoagulation (EC) process for decolorization and chemical oxygen demand (COD) abatement of a synthetic textile wastewater using aluminum electrodes. The effects of the relevant wastewater characteristics such as conductivity, influent pH and inlet dye concentration, but also of the key operating conditions such as current density and residence time were studied in order to optimize process performance. The results showed that color induced by a red dye was effectively removed (with a removal yield higher than 85%) for wastewater with a COD of 2500 mg/L and a dye concentration lower than 200 mg/L when pH ranged from 6 to 9, residence time was 14 min, current density was 31.25mA/cm2 and water conductivity was 2.4mS/cm for an inter-electrode distance of 1 cm. Under these conditions, the COD abatement was also higher than 80%.

Chih-TaWang et.al[7] described the removal efficiency of COD in the treatment of simulated laundry wastewater using electrocoagulation/ electroflotation technology. Experimental results showed that the removal efficiency was better, reaching to about 62%, when applying ultrasound to the electrocoagulation cell. The solution pH approached neutrality in all experimental runs. The optimal removal efficiency of COD was obtained by using the applied voltage of 5V when considering the energy efficiency and the acceptable removal efficiency simultaneously. The highest COD removal reported was 999mgdm−3 kWh−1

Materials and Methods

The spent wash used in the experiment is obtained from nearby Industry having following specification

Specification of Spent Wash: pH : 4.5- 5, colour :- brown, solubility : 100% soluble in water, COD : 100000-150000 mg/lit, BOD : 95000 – 100000 mg/lit, dissolved solids: - 1500 -30000

Activated Charcoal Adsorption: Carbon has been used as an adsorbent for centuries. Early uses of carbon were reported for water filtration and for sugar solution purification. Activated carbons ability to remove a large variety of compounds from contaminated waters has led to its increased use in the last thirty years. Recent changes in water discharge standards regarding toxic pollutants has placed additional emphasis on this technology. Adsorption is a natural process by which molecules of a dissolved compound collect on and adhere to the surface of an adsorbent solid. Adsorption occurs when the attractive forces at the carbon surface overcome the attractive forces of the liquid. Granular activated carbon is a particularly good adsorbent medium due to its high surface area to volume ratio. One gram of a typical commercial activated carbon will have a surface area equivalent to 1,000 square meters. This high surface area permits the accumulation of a large number of contaminant molecules. After giving pretreatment of adsorption using activated carbon spent wash was used to study the effect of electrocohagulation process.

Experimental Set Up:

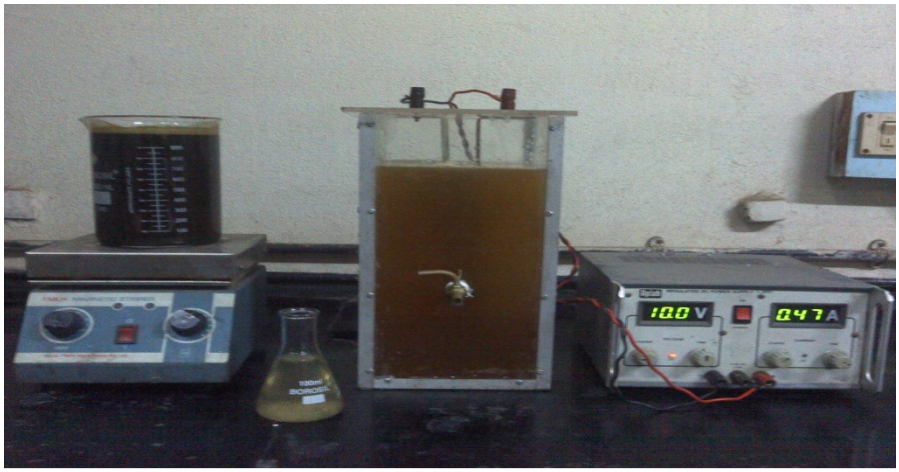

Figure-1
Experimental Setup for colour removal using adsorption and EC

In this experiment 100 ml of fresh distillery spent wash was taken in 500ml agitated vessel. In which 10 gm of activated charcoal was added and solution allowed to stirred for half an hour. Then solution from agitated vessel sends to EC through the filtration. The value of colour removal was calculated after 30min of interval.

Results and Discussion

Various runs were carried out to study effect of EC on absorbance and pH of the effluent coming out after EC. For consideration four best runs is reported in this paper. In which Ist run was carried out by using EC only, whereas run no 3 and 4 were carried out using adsorption with Activated charcoal which is followed by EC.

From figure-1 and table-1 it is observed that, the value of absorbance decreases from 1.684 to 1.005 time passes from 30min to 150 min. In this run sample was passes through EC only where the distance between two electrode was maintained 5cm. The height of electrode was kept 8cm.

In 2nd run spent wash was first send for the pr treatment of sand filtration and then it was passed to the EC with distance between electrode 3cm and height 22cm. in this run it was observed that the absorbance decreases from 1.984 to 0.550 as the time passes from 30min to 150min during the course of experiment as shown in figure-1 and table-1

In 3rd and 4th run spent wash first passed through the adsorption process. Where 10gm of activated carbon was used for 1lit of spent wash, and then the sample send to the EC with distance between electrode 3cm and height of electrode 22cm. In this runs it was observed that absorbance decreases from 1.247to 0.253, 1.363 to 0.360 respectively as time passes from 30min to 150min as shown in figure-1 and table-1

Table-1
Variation of Absorbance with Time

Experimental runs	30 min	60 mins	90 min	120 min	150 min
Run 1	1.684	1.383	1.244	1.112	1.005
Run 2	1.984	1.942	1.931	0.932	0.550
Run 3	1.247	1.112	0.822	0.358	0.253
Run 4	1.363	1.323	1.244	0.429	0.360

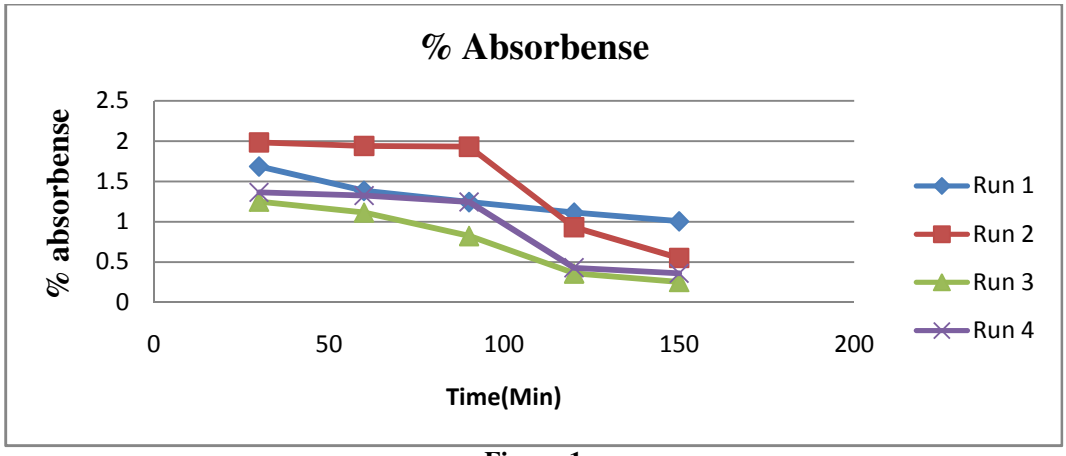

Figure-1
Variation of Absorbance with Time

Table-2
Varation of pH with Time

Experimental runs	30 min	60 min	90 min	120 min	150 min
Run 1	6.66	6.87	7.02	7.41	8.20
Run 2	6.67	6.97	7.08	7.50	8.30
Run 3	6.25	6.42	6.85	7.04	7.72
Run 4	6.02	6.54	6.71	6.75	7.61

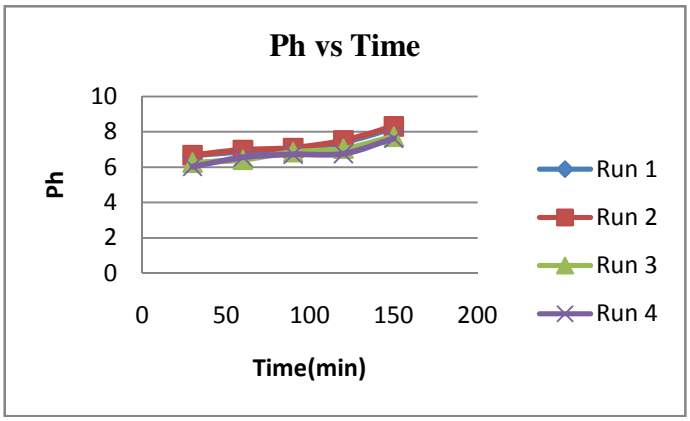

Figure-2
Variation of pH with Time

During the course of experiments it was observed that pH of the sample increases as the time passes. As shown in figure-2 and table-2 during all four runs the effect of pre- treatment and adsorption was not observed for the change of pH.

Conclusion

In this study, the electrocohagulation process was applied for removing the colour of spent wash. Pretreatment was given to spent wash before treating it in EC. During the experiment following results were obtained: i. Maximum removal of colour without use of adsorption process before EC found to be 1.005 at the end of 150 min. ii. Maximum removal of colour with adsorption process before EC was found to be 0.550 at the end of 150 min. iii. Maximum removal of colour with the use of sand filtration before EC was found to be 0.253 at the end of 150 min. iv. % of colour removal is found to be 72.78%. v. The nature of variation of pH is found to be almost constant during the course of experiments.

In essence one can conclude that its better to go for adsorption using activated carbon before the spent wash feed to the EC.

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