TREATMENT OF TEXTILE EFFLUENT USING CONTINUOUS STIRRED TANK ELECTROCHEMICAL REACTOR

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ABSTRACT

The aim of the present study is to treat the textile effluent using Continuous Stirred Tank Electrochemical Reactor. RuO_2 coated Ti and stainless were used as an anode and cathode respectively. The influence operating parameters such as effluent flow rate, initial effluent concentration, current density and initial pH of the effluent have been studied for the color removal of the effluent. The maximum color removal has been achieved at lower flow rate, lower initial effluent concentration and higher current density and alkaline pH.

Keywords: Continuous Stirred Tank Electrochemical Reactor; Textile effluent; color removal.

I. INTRODUCTION

Effluents from the textile industry are not only colored but also contain large amounts of color, COD, BOD and dissolved solids. Textile industry is the one producing huge amount of waste water. Due to stringent environmental regulations, treatment is mandatory before discharge the effluent. Conventional treatment methods include activated carbon adsorption, solvent extraction, chemical and biological methods. These methods are having their own pros and cons when they applied individually (Lin and Peng Chi, 1994). Recent years advanced oxidation technique is growing much faster to treat the industrial effluents. Due to the increasing economic, social, legal and environmental pressure the best available technology to perform without producing any secondary pollution is electrochemical technology. The advantage of electrochemical treatment has environmental compatibility, versatility, energy efficiency, safety, selectivity, amenability to automation, and cost effectiveness (Walsh, 2001).

Electrochemical Methods have been successfully applied in treatment of several industrial waste waters Mahesh et al., 2006, Vlyssides et al., 1999).Few literature studies are electro oxidation of CI Acid Orange 7 using boron doped diamond electrode (Fernandes et al., 2004), electro oxidation of phenol in a parallel plate reactor using Ruthenium metal oxide electrode (Yusuf Yavuz and Savas Koparal, 2006), degradation of methyl parathion in aqueous solution using Ti/Pt and Stainless steel as the electrodes (Apostolos Vlyssides et al., 2004).In the present study focused on the treatment of textile effluent using electro oxidation and the influence of various operating parameters were critically analyzed.

II. EXPERIMENT

Schematic of an experimental set up is shown in figure 1. Experiments were conducted in a continuous stirred tank electrochemical having 300 ml capacities. Oxide coated titanium metal is used as anode and stainless steel is cathode. Experiments were carried out under galvanostatic conditions using a DC-regulated power source (HIL model 3161) of 0–5A and 0–30V.

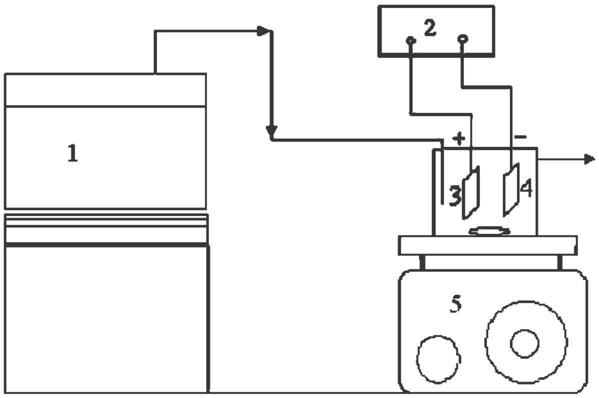

Fig. 1. Schematic of Continuous Stirred Tank Electrochemical Reactor experimental setup
1. Over head Tank; 2. DC power supply; 3. Anode; 4. Cathode; 5. Magnetic stirrer.

Synthetically prepared Acid Red 88 dye effluent is taken in the cell and uniform mixing is achieved by using magnetic stirrer. Samples were collected at regular intervals of time for color removal.

III. RESULT AND DISCUSSION

Effect of supporting electrolyte

The effect of supporting electrolyte concentration on initial effluent concentration [IEC] is shown in the figure 2. It can be ascertained from the figure 2 that an increasing supporting electrolyte concentration the reduction rate of initial concentration is increased. It is observed from the figure, for 750mgl^{-1} and 1000mgl^{-1} reduction rate is almost same. Hence 750mgl^{-1} is selected as optimum supporting electrolyte concentration.

Effect of current density

Experiments were carried out for five different current densities [CD] keeping other parameters constant. The color removal rate increases with current density and is given in the figure 3. This may be due to the fact that the rate of generation of hypochlorite ion increased with current density, which eventually increases the pollutant degradation.

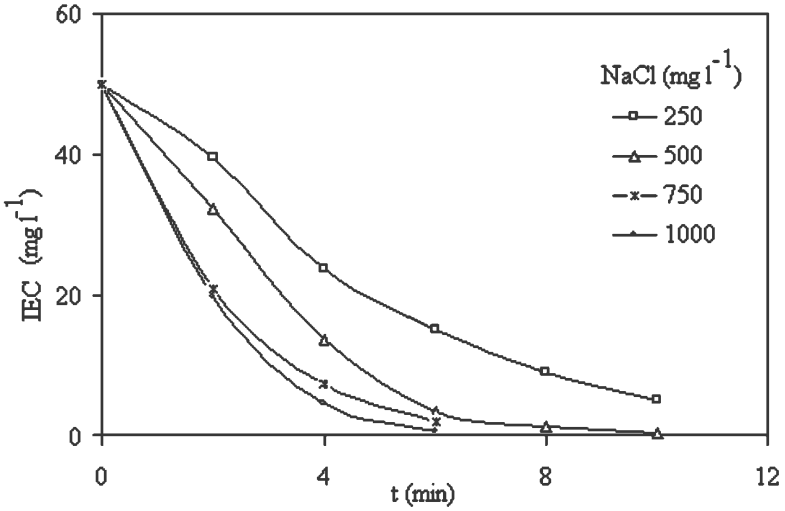

Fig. 2. Effect of supporting electrolyte concentration on initial concentration of Acid Red 88. IEC: 50mg l^{-1}; Current density: 8mAcm^{-2}.

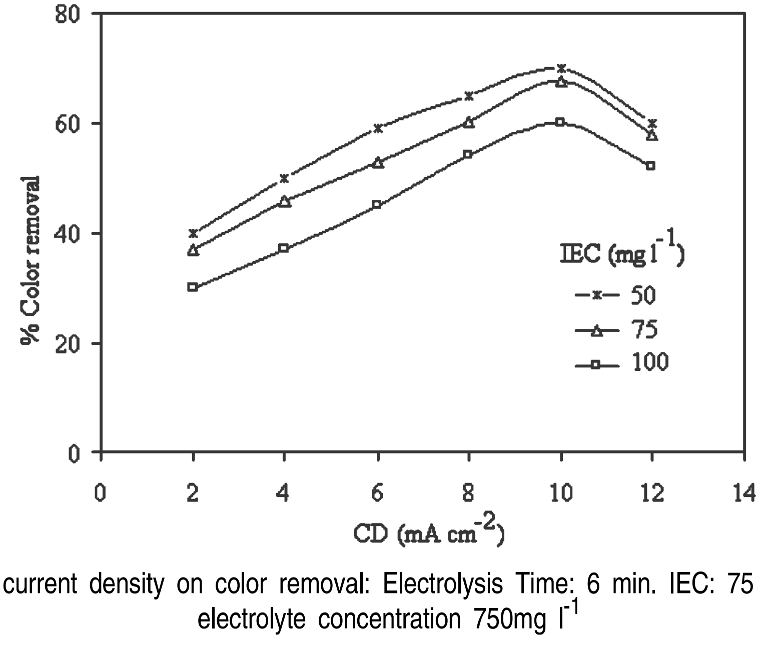

Fig. 3. Influence current density on color removal: Electrolysis Time: 6 min. IEC: 75 mg l^{-1}; Supporting electrolyte concentration 750mg l^{-1}

Effect of flow rate

The effect of various flow rates (Q) on color removal has been studied and shown in the figure 4. The flow rate increases the rate of color removal decrease. This is due to when the flow rate increase eventually decreases in residence time.

Effect of initial effluent concentration

In order to study the rate of degradation, various initial effluent concentrations have been varied. The degradation rate is decreased with increase in effluent initial concentration. Figure 5. This may be explained that the ratio of OCl^- to the effluent concentration decreases with increase in effluent initial concentration.

Effect of pH

Experiments were conducted under acid, alkaline and neutral conditions and the observed results are given in Figure 6. It can be ascertained from Figure 6 that the rate of color removal increased significantly when the electrolyte pH increased. Increase in electrolyte pH increases the OH radicals favors the hydrolysis reaction and consequently the rate of oxidation. The reaction was favorable at neutral and alkaline conditions.

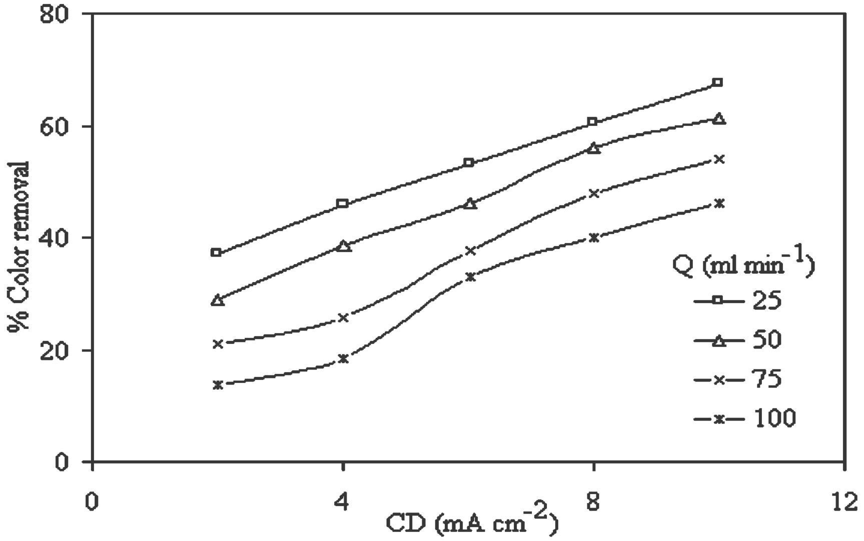

Fig. 4. Influence of current density on color removal. IEC: 75 mg l^{-1}

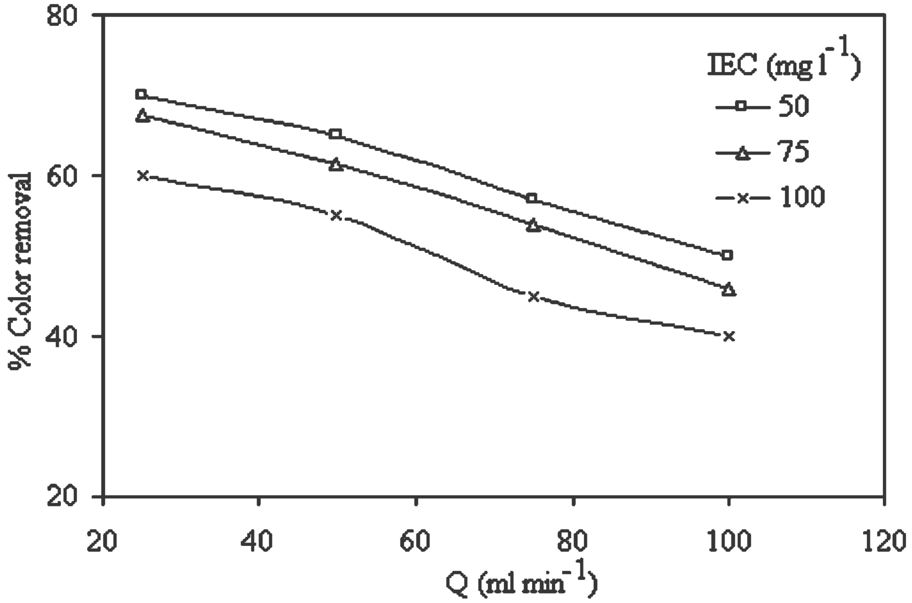

Fig. 5. Influence of flow rate on color removal for different initial effluent concentration. Current density: 10mA cm^{-2}

Power consumption

The specific energy consumption is defined as the ratio between energy in put in terms of kW hr to the kg of COD removal. The effect of current density on power consumption is shown in the Figure 7. It can be noticed from Figure 7 that the power consumption increases with current density and the power consumption is increases with decreasing flow rate. This is due to the fact that more power is consumed for higher current density. Decreasing flow rate increase the residence time, eventually increase the COD removal results increase the power consumption.

Mass flux

The effect of flow rate on mass flux is shown in the figure 8. Mass flux of the system decreases with the decrease in flow rate. The mass flux depends on the time of operation, the effect of residence time plays an important role in the process. The easily oxidizable parts present in the effluent contribute to the decrease in the color at low flow rate.

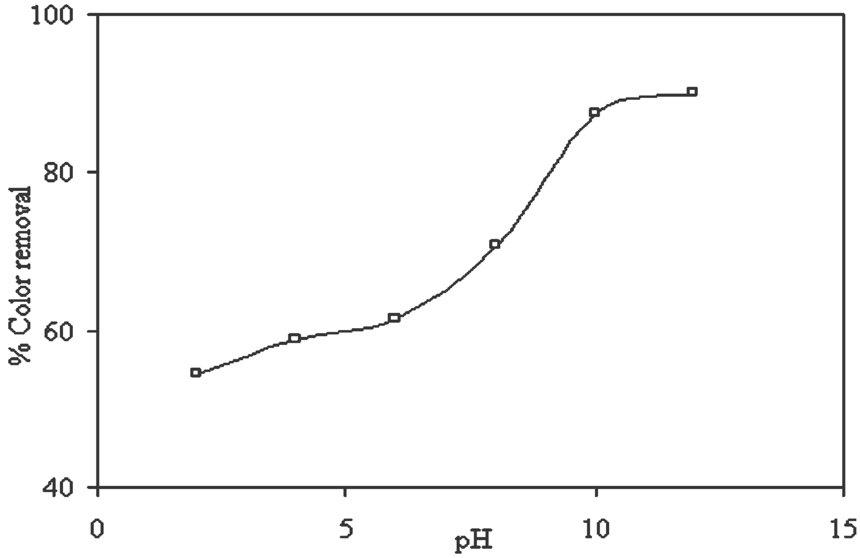

Fig. 6. Effect of pH on color removal IEC: 75mg l^{-1}; Current density: 10mA cm^{-2}; Supporting electrolyte concentration 750mg l^{-1}

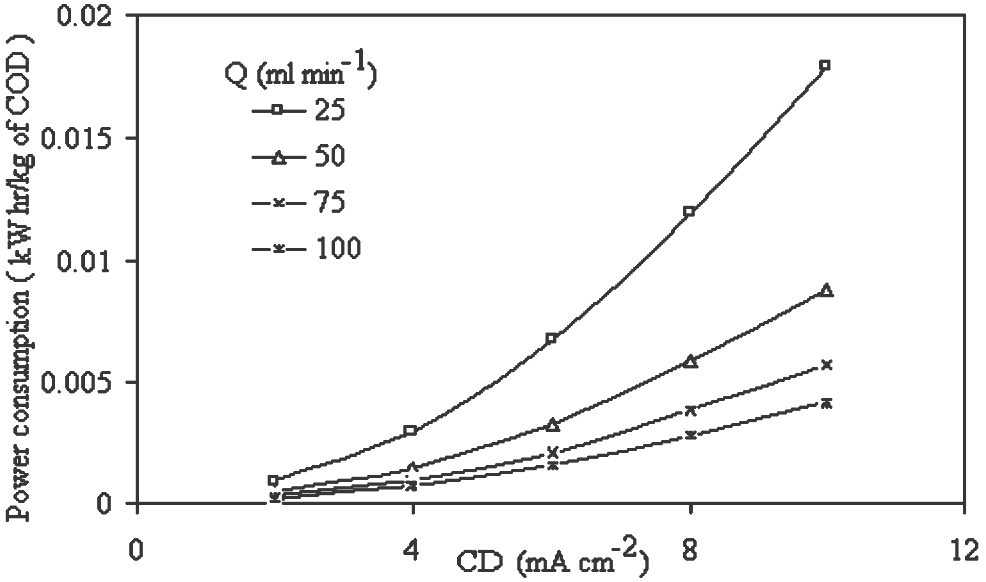

Fig. 7. Effect of current density on power consumption for different flow rate: IEC: 75mg l^{-1}

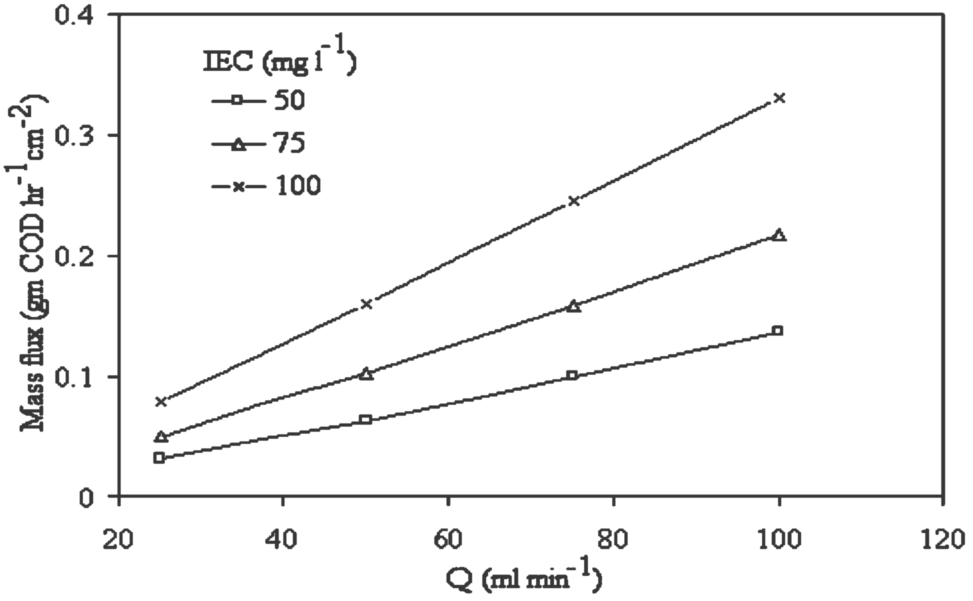

Fig. 8. Effect of flow rate on Mass flux for different flow rate: IEC: 100mg l^{-1}

IV. CONCLUSION

Experiments were carried out to dye house effluent using electrochemical techniques covering wide range of operating conditions in a Continuous Stirred Tank Electro Chemical Reactor. The influence of initial effluent concentration, current density, flow rate and pH on color removal has been critically examined. The color removal rate is decreased with increasing initial effluent concentration and effluent flow rate. Further the 90% of the color removal is achieved at 10mA cm^{-2} and pH 10. It can be concluded that electrochemical technique is an alternative for conventional treatment techniques.

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