2D Electrocoagulation of Navy-Blue 3G Dye Wastewater Using Aluminium Electrode

Chirag Gohil[1], Dr. Abhipsa R Makwana[2]

[1]M.E Student, Civil Engineering Department (Environmental Section), Faculty of Technology and Engineering, The Maharaja Sayajirao University of Baroda

[2]Assistant Professor, Civil Engineering Department (Environmental Section), Faculty of Technology and Engineering The Maharaja Sayajirao University of Baroda

Abstract: ***Textile or dye wastewater is complex and toxic due to presence of complex chemicals in them hence difficult to treat with conventional biological treatment. Electrocoagulation and adsorption using granular activated carbon (GAC) are good treatments when dispersed color is present in the solution. This paper reports effect of current density and dye concentration on color removal (%) when simulated dye wastewater was subject to 2D electrocoagulation where, added dimension is particle electrode between conventional anode and cathode assembly. Complete removal of color was observed at higher time or more current density; simultaneously initial dye concentration has shown inverse effect on color removal.***

Keywords: Navyblue 3G, electrocoagulation, adsorption, current density

1. Introduction

Conventional coagulation is a phase separation method of pollutant from effluent for safe disposal in nature. Conventional coagulation performs when coagulating ions are added from outside. Similar ions (Fe^{+3} or Al^{+3}) can be generated through electrocoagulation treatment using cacrificial electrode [1-4]. Electrocoagulation requires DC current to dissolve metal ion from electrode made from metal. Normally aluminium or ferrous are used as sacrificial electrode. When DC current passes through anode cathode assembly, metal ions are formed at anode while hydroxide ions are formed at cathode [5]. Metal ion and hydroxide ions get combined and forms metal hydroxide flocs which carry destabilization and aggregation of pollutants. Further, at cathode hydrogen bubbles are also formed which can carry electrofloatation of pollutants [2,3].

High COD concentration, high pH, temperature, strong color and lower biodegradable nature makes dye /textile wastewater disposal more challenging [6]. Oxidation, conventional coagulation, biological treatment and flocculation are common treatments applied to dye wastewater [6]. All these conventional treatments have their own disadvantages. Coagulation can increase burden on sludge disposal, adsorption needs extra cost for regeneration of adsorbent, microbial treatments are inefficient for dye wastewater due to complexity and toxicity of waste. On the other hand EC process has been used successfully by several researchers during last one and half decade. EC process can separate dispersed color through phase separation but to achieve faster removal color adsorption using GAC can be possible solution.

This study focuses on effect of current density and dye concentration on simulated dye wastewater color removal through electrocoagulation in presence of GAC particle electrode.

2. Materials and Method

The experiments were performed on Navy blue 3G dye solution with varying initial concentrations from 50 mg/L to 150 mg/L. the working volume of dye solution was 500 mL. 115 mm x 100 mm x 100 mm acrylic reactor was used with aluminium electrode of 90 mm x 75 mm x 5mm size. GAC particle electrode was also of same size, filled with granular activated carbon. Interelectrode spacing was kept at 50 mm. One anode-one cathode assembly was used in a convention electrocoagulation cell. Effect of current density was studied in a range from 1-10 mA/cm^2 with electrolysis time from 0-90 min, % color removal was taken as response parameters.

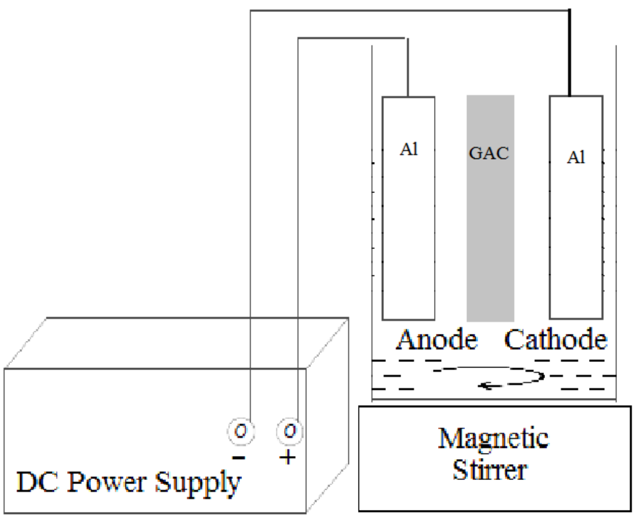
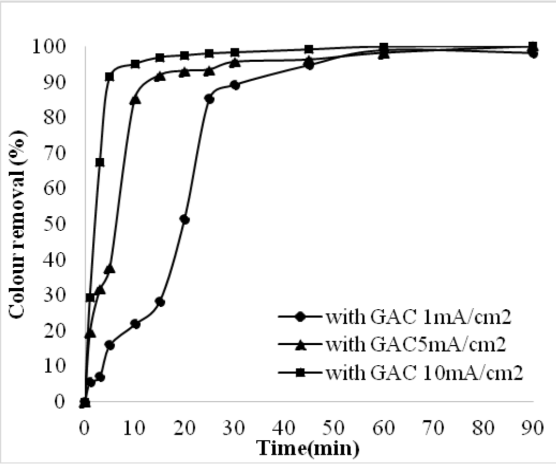


Figure 1: Experimental set up 2D electrocoagulation cell

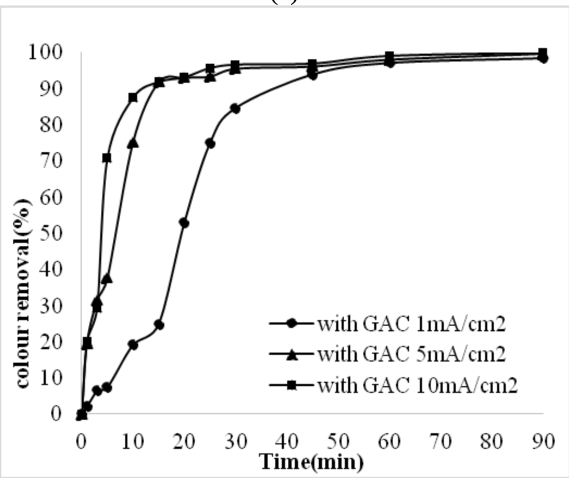
3. Results and Discussion

Fig. 02 shows effect of current density and time on color removal at varying dye concentration. At 50 mg/L dye concentration, 89, 95 and 98 % color removal was achieved after 30 min time at 1 mA/cm^2, 5 mA/cm^2 and 10 mA/cm^2

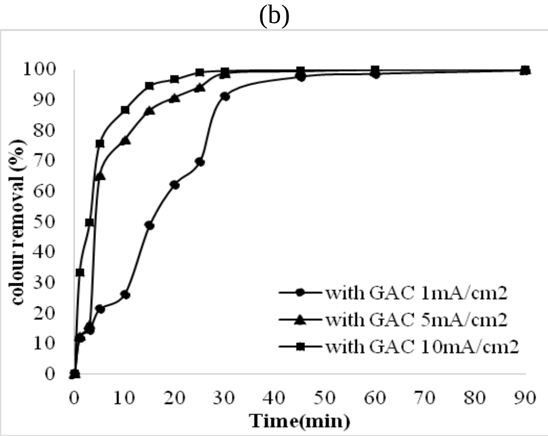
current densities respectively. At 100 mg/L dye concentration, 84, 95 and 96 % color removal was achieved after 30 min time at 1 mA/cm^2, 5 mA/cm^2 and 10 mA/cm^2 current densities respectively. While at 150 mg/L dye concentration, 91, 98 and 99 % color removal was achieved after 30 min time at 1 mA/cm^2, 5 mA/cm^2 and 10 mA/cm^2 current densities respectively. Two major trends are observed; increase in current or time increases color removal due to more metal hydroxide floc formation and enough time for complete destabilization and aggregation of impurities [7,8]



(a)

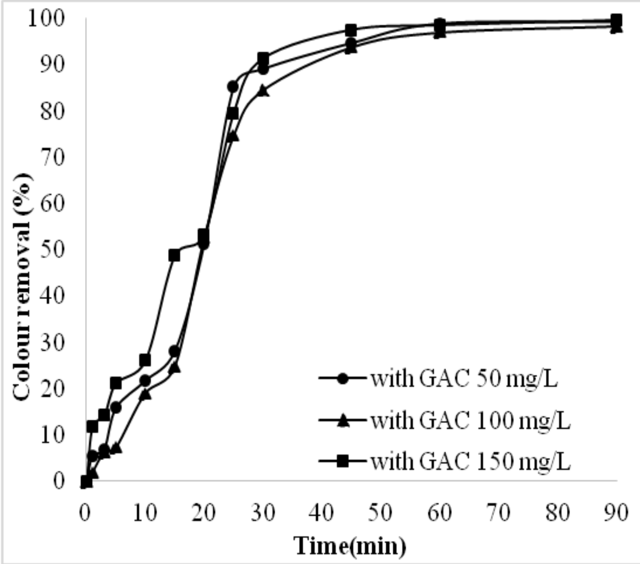


(b)

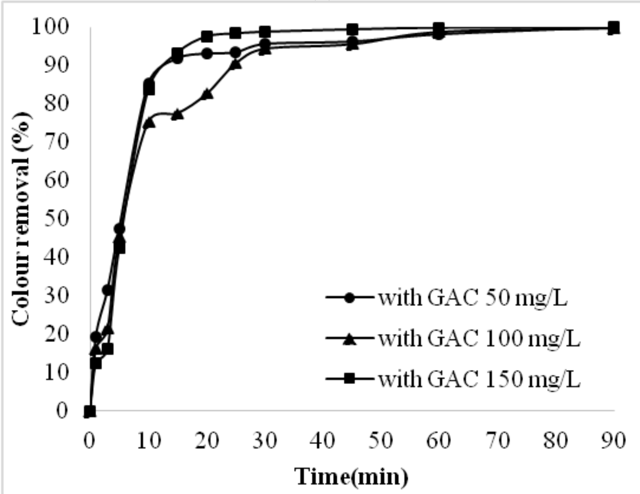


(c)

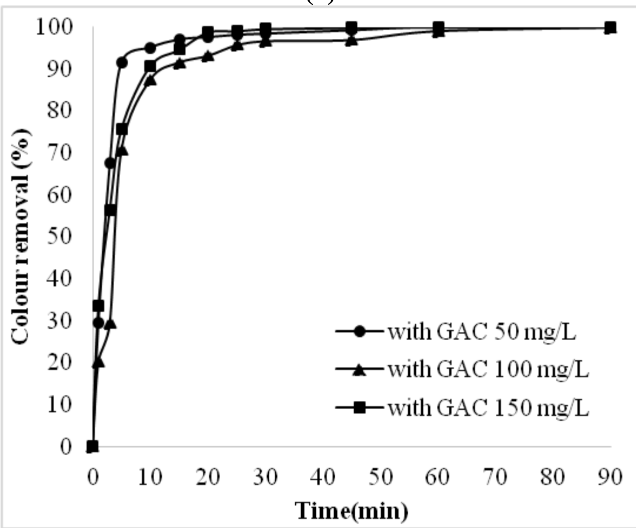
Figure 2: Effect of current density on color removal for varying initial dye concentration (a) 50 mg/L (b) 100 mg/L (c) 150 mg/L



(a)



(b)



(c)

Figure 3: Effect of dye concentration on color removal for varying current density (a) 1 mA/cm^2 (b) 5 mA/cm^2 (c) 10 mA/cm^2

Fig. 03 represents effect of dye concentration on color removal with respect to time given for treatment. At lower current of 1 mA/cm^2, after 30 min time 89, 84 and 91 % color was removed from 50 mg/L, 100 mg/L and 150 mg/L dye solution. At current of 5 mA/cm^2, after 30 min time 95, 94 and 98 % color was removed from 50 mg/L, 100 mg/L and 150 mg/L dye solution. While at current of 10 mA/cm^2 after 30 min time 98, 96 and 100 % color removals were observed from 50 mg/L, 100 mg/L and 150 mg/L dye solution. This means that, increase in dye concentration forms large flocs which entraps more color and hence more removal has been observed at higher waste strength.

4. Conclusion

Positive effect of current and electrolysis time has been observed on dye color removal. Hence proper optimization of current needed and time from treatment exposure to be done to suggest best treatment solution.

Similarly, influent dye concentration also possesses significant effect on removal efficiency. Applied current and dye concentration show interaction effect, as at lower current more removal while at highest current more removal but at moderate current less removal has been observed hence thorough optimization of pollution load and current to be done. Based on previous study it has also been noted that presence of GAS particle electrode, fastens color removal compared to EC alone. Spectroscopy shows no other peak formation in treated dye solution means no intermediate dye complexes are formed during EC process.

References

[1] Brillas, E., Martínez-Huitle, C.A., 2015. Decontamination of wastewaters containing synthetic organic dyes by electrochemical methods - An updated review. App. Cata.B: Environ. 166–167, 603–643.
[2] Chen, G., 2004. Electrochemical technologies in wastewater treatment. Sep. Purif. Technol. 38, 11–41.
[3] Martinez-Huitle, C.A., Brillas, E., 2009. Decontamination of wastewaters containing synthetic organic dyes by electrochemical methods: A general review. App. Catalysis B: Environmental 87, 105-145.
[4] Rajeshwar, K., Ibanez, J.G., 1997. Fundamentals and application in pollution abatement. Academic Press, San Diego, CA.
[5] Barrera-Diaz, C., Uren˜a-Nun˜ez, F., Campos, E., Palomar-Pardave, M., Romero- Romo, M., 2003. A combined electrochemical-irradiation treatment of highly colored and polluted industrial wastewater. Radiat. Phys. Chem. 67, 657–663.
[6] Kobya, M., Bayramoglu, M., Eyvaz, M., 2007. Techno-economical evaluation of electrocoagulation for the textile wastewater using different electrode connections. J Hazar. Mater. 148, 311-318.
[7] Mollah, M.Y.A., Morkovsky, P, Gomes, J.A.G., Kesmez, M., Parga, J., Cocke, D.L., 2004. Fundamentals, present and future perspective of electrocoagulation. J. Hazard. Mater. B114, 199-210.
[8] Makwana, A.R., Ahammed M.M., 2016. Continuous electrocoagulation process for the post-treatment of anaerobically treated municipal wastewater. Process Safety and Environmental Protection 102, 724-733.

Author Profile

Mr. Chirag Gohil has completed his B.E. in Civil Engineering from Civil Engineering Department at Faculty of Technology and Engineering, The Maharaja Sayajirao University of Baroda, Gujarat, and currently M.E. student at same university and department. He has worked on electrocoagulation of dye wastewater.

Dr. Abhipsa R Makwana has completed B.E. (Civil), M.E. (Civil) in Environmental Engineering from The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India. She has also completed her PhD in Civil Engineering from Sardar Vallabhbhai Patel National Institute of Technology, Surat, India. She is serving as Assistant Professor in Civil Engineering Department at Faculty of Technology and Engineering, The Maharaja Sayajirao University of Baroda. She has 15 years of teaching experience with 07 years of research experience.