Optimization of Textile Dye Effluent using copper and Zinc Electrodes

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Abstract - *Electrochemical methods are being used increasingly as an alternative treatment process for the remediation of textile waste water. Although the vast majority of waste water supply systems deliver "Safe" water after treatment, incidental and often undetected contamination does not occurs. Hence, the increasing demands of high quality water, initiated investigators to show considerable attention towards the low cost waste water treatment and its re-use.*

This paper discusses the attempts to the treatment of textile effluent containing indigo dye by Electro Chemical treatment. Electro chemical degradation process was performed using Copper and Zinc electrodes. The influence of effluent pH, supporting electrolyte, Total Dissolved Solids (TDS), Chemical Oxygen Demand (COD) and current intensity was studied for different samples collected. The process has done in a Batch wise at a regular time intervals, by varying the parameters such as pH, Voltage and electrode material. An appreciable change in color and odor is observed for each run. Due to its effectiveness and ease in operation, this technique can be applied for treatment of a large volume and industrial scale of textile wastewater.

Key Words: **Textile Dye Effluent, Electrochemical Treatment, Copper and Zinc electrodes, COD and TDS**.

1. INTRODUCTION

With ever increasing industrialization and use of newer materials, increasing quantities of liquid and gaseous pollutants are finding their way on to the land into rivers and atmosphere. The systematic pollution of our environment is one of the biggest hazards that humanity faces today [1]. People are becoming increasingly aware of the threat posed by pollution and governments are enacting legislations aimed at protecting the environment. With a growing population, the demand for fresh water is steadily increasing, but as with all resources, there is a limit to fresh water supply [2]. In addition, the availability of high-quality water is dwindling because of misuse, waste and pollution.

Various constituents of waste water are potentially harmful to the environment and to human health. In the environment the pollutants may cause destruction of animal and plant life as aesthetic nuisance. Drinking water sources are often threatened by increasing concentration of pathogenic organisms as well as by many of the new toxic chemicals disposed of by the industry and agriculture [11].

Dyes pollutants from the textile industry are an important source of environment contamination. They pose serious problems because of their strong color, high COD and low biodegradability [3, 5]. These effluents usually contain dyes such as indigo, a well known Non-biodegradable dye, which causes environmental concern. Therefore, most of traditional methods of waste water treatment are becoming inadequate. Electrochemical technology and its application on wastewater treatment have become increasingly interesting, because of its advantage especially for color removal [4]. Electrolytic effect could be influenced by pH, electrolyte concentration, current density, etc. Consequently, it is imperative to study these factors and to find how to operate Electrochemical Oxidation more effectively [7, 8].

In recent times, there has been some interest is renewed in water treatment plants based on electro-chemical treatment technology for treatment of some difficult wastewaters like spent wash, removal of heavy metals, bleach effluent of pulp and paper industries and rubber wastewaters and textile dye effluent etc. for which the alternative technologies are not feasible[5,6].

1.1 Electrochemical Treatment

Electrochemical treatment is a technique in which the wastewater is treated by applying electric current through electrodes in a reactor. The electrodes generate the positive and negative ions which combine to form metal hydroxides flocs. These metal hydroxide flocs combine with pollutant particles and settled down. Application of electric current also generates oxidizing groups like HOCl which destroy or oxidize the organic pollutants (dyes etc.). Along with ions generation, gas bubbles are also generated from the cathode in the form of hydrogen gas. These gas bubbles stick to the pollutant particles and float them to surface of the water [14]. This technology is used for removal of metals, colloidal solids and particles, and soluble inorganic pollutants from aqueous media by introducing highly charged polymeric metal hydroxide species.

It includes a reactor where the wastewater is subjected for actual electrochemical treatment. This reactor may be preceded by a pretreatment unit for making the wastewater compatible for electrochemical treatment. The reactor may be followed by a post treatment unit where in the pollutants after the electrochemical treatment conversions are removed. Electrochemical treatment system demands a regulated supply of DC power to the reactor so a power system is provided for transforming AC power to DC [11].

1.2 Effluent Collection

Wastewater from textile industry was worked in the present study. For dyeing of cloths different types dyes and coloring agents and modifiers are used for the dyeing process. In this dyeing process produces the colorized water having the higher COD values and also present the heavy metals. This water can be treated by using electrochemical treatment in order to remove the color and COD of the effluent water.

Table 1: Characteristics of Textile Dye Effluent before Treatment

S.no	Parameters	Values of Effluent
1	pH	6.4
2	Total Dissolved Solids	4400(ppm)
3	BOD	200(ppm)
4	COD	472(ppm)
5	BOD_5/COD	0.423
6	Color	Blue
7	Odour	Pungent

2. EXPERIMENTAL PROCEDURE

A laboratory scale unit was used to conduct the experiments in the present study. The unit includes two components: The Reactor and the Power system. The reactor is made up of glass beaker and its capacity is of 500 ml. it includes two electrodes (a cathode and an anode). Two types of electrodes copper and zinc are used in the present study. In any single experiment, both the electrodes used were of same metal. A schematic of the experimental set-up is shown in fig. Spacing between the two electrodes was 12 mm. Provisions were made in the reactor for the change of electrodes. Polarity of current was reversed at regular intervals in order to minimize the deposition on the electrodes. The power system was used to supply Direct Current (DC) at desired voltage to the electrodes. The system converted the input Alternating Current (AC) into Direct Current (DC) of desired voltage. Provisions were made in the power system to regulate voltage of the output and to display it on a handy multi meter. An Ampere of 0-8A range was fitted in the power system to display the amperage of the power supplied. There was also a provision for polarity change in the power system at desired intervals.

Figure 1: Electrochemical Cell

Fig-2: Copper Electrodes

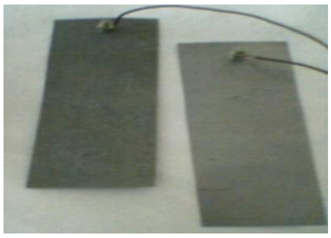

Fig-3: Zinc Electrodes

3. RESULTS & DISCUSSION

The Electrochemical Treatment of the textile effluent was studied by conducting different experiments initial characteristics of the effluent sample-1 is studied and is noted. A laboratory scale of electro-chemical treatment unit to use copper electrode as both anode and cathode was used in the study. Spacing between the electrodes was 12mm. electrochemical treatment of the wastewater was carried at different pH values for different time intervals and with different voltages. For the pH adjustment of the wastewater sulfuric acid (H_2SO_4) or sodium-hydroxide (NaOH) was used. All the experiments were conducted on 300 ml of wastewater using the copper electrode. For avoiding fouling of the electrodes, current polarity reversals were practiced at each run. During the treatment, current measurements were made. Wastewater after the electro-chemical treatment was allowed to settle for 10 min and in the supernatant COD and TDS was measured for assessing the treatment efficiency. The experiment run at different time intervals and all remaining parameters kept as constant

RAW 10min 30min 45min 50mi

Fig -4: **Treated samples of effluent using copper electrode**

Table 2: Physical Changes of Effluent using Electrodes

Parameter	Before Treatment	After Treatment
Color	Blue	Colorless
Odour	Pungent	Odourless

3.1 Effect of Time

Textile Effluent of 300 ml is taken into glass beaker having copper as electrode. Experiment was carried out at constant parameters like voltage (30v) and pH (6.5). Procedure is done for different time intervals i.e., 15,30,40,50 min. The treated sample is collected and filtered and estimates the COD and TDS of the sample. Same procedure is repeated for Zinc electrode. A plot is drawn between time verses % COD removal for two different electrodes as shown in graph, it was clearly known that as time increases the percentage of COD removal also increases upto 30min and then decreases for both the electrodes.

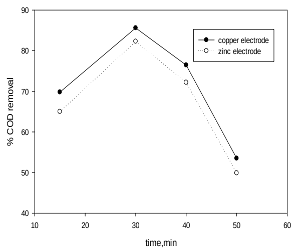

Chart -1: Effect of time on % removal of COD

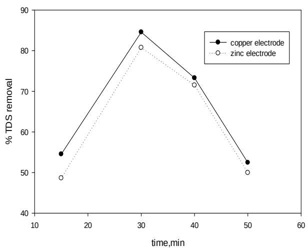

Chart-2: Effect of time on % removal of TDS

Results obtained from the electrochemical treatment experiments on the effluent at different time intervals are shown. The results indicate that the optimum electrolysis time is 30 min for both the electrodes. Best removal efficiencies of copper electrodes were obtained at 30 min, COD and TDS are 85% and 84% respectively. Similarly the removal efficiencies of zinc electrodes of COD and TDS are 82% and 80% respectively

3.2 Effect of voltage

In this analysis also 300 ml of effluent is taken in glass beaker. The respective electrodes (say copper and zinc) are placed in the beaker. The DC power supply is connected to these electrodes. The treatments are done for 30 min and vary the voltages i.e., 30, 10,5v. The treated sample is collected and filtered and estimates the COD and TDS of the sample. The results obtained are shown.

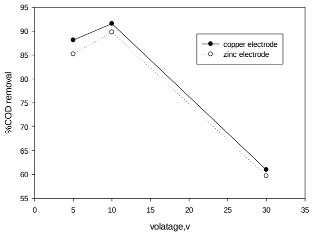

Chart-3: Effect of voltage on % removal of COD

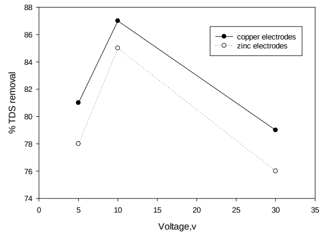

Chart-4: Effect of voltage on % removal of TDS

At pH 6.5 and time 30 min for different values of voltage, from the results it was observed that duration at 10V voltage the removal efficiency was maximum for copper electrodes i.e., COD and TDS was reduced by 92% & 87% respectively.

3.3 Effect of pH

In this analysis the respective electrodes (copper / zinc) are placed in the beaker. By varying the pH 6.5 & 7.5. The treated sample is collected and filtered and estimates the COD and TDS of the sample. The obtained results are shown in the graphs.

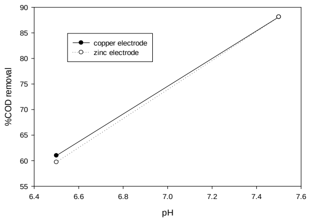

Chart-5: Effect of pH on % removal of COD

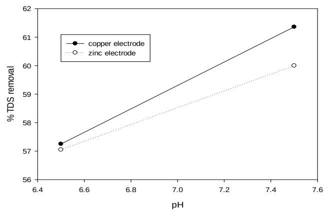

Chart-6: Effect of pH on % removal of TDS

3. CONCLUSIONS

The increasing demand of high quality water initiated investigators to show considerable attention towards the low cost waste water treatment and re-use. Copper & Zinc electrodes plays a prominent role in various parameters like effect of time ,voltage and pH .The optimum conditions for the removal of organic compounds for both the electrodes at pH 7.5, voltage of 10V and time 30 min using both electrodes, but copper electrode shows more removal compared to zinc electrode.

The percentage removal of COD and TDS at constant voltage 10 V is 92% & 87% respectively for copper electrodes and similarly for zinc it is observed that 89% and 85%. The results showed that the copper electrodes had more % removal of COD and TDS than the zinc electrodes. Hence, the above results end up with a conclusion that copper electrodes are effective electrodes for the treatment of textile effluent.

REFERENCES

[1] Alinsafi, A.,Khemis, M.,Pons, M.N, Leclerc, J.P., Yaacoubi, A., Benhammou, A., Nejmeddine, A.,"Electro-coagulation of reactive textile dyes and textile wastewater; Chemical engineering and processing", 44 (2005) 461 – 470.

[2] Can, O.T., Kobya, M., Demirbas, E., Bayramoglu, M. , "Treatment of the textile waste water by combined electro coagulation ;Chemosphere" 62 (2006) 181-187.

[3] Daneshvar, N., Oladegaragoze, A., Djafarzadeh, N. , "Decolorization of basic dye solutions by electro coagulation: An investigation of the effect of operational parameters; Journal of Hazardous Materials" B129 (2006) 116-122.

[4] Fernandes, A.,Morão, A.,Magrinho, M.,Lopes, A.,Gonçalves, I., "Electrochemical degradation of C. I. Acid Orange 7; Dyes and pigments" 61(2004) 287-296

[5] Ghalwa, Abu, N.M., Abdel, L.M.S., "Electro-chemical degradation of acid green dye in aqueous wastewater dyestuff solutions using a lead oxide coated Titanium electrode"Journal of the Iranian Chemical Society, Vol. 2, No.3,(2005) 238-243.

[6] Gotsi M., Kalogerakis N., Psillakis E., Samaras P., Mantzavinos D.,"Electrochemical oxidation of olive oil mill wastewaters; water research" 39 (2005) 4177 – 4187.

[7] Gurses, A., Yalcin, M., Dogar, C. , "Electro coagulation of some reactive dyes: a statistical investigation of some electrical variables; Waste management" 22 (2002) 491-499.

[8] J Hussain, I Hussain, and M Arif."Characterization of textile wastewater", Journal of Industrial Pollution Control,2004, Vol. 20(1").

[9] Karlis, P.K. Zorpas, A.A. (2000) "Electrochemical oxidation of Indigo Journal of Chemical Technology and Biotechnology". Vol. 80, 916-923.

[10] Kim T.H., Park C., Shin E. B., Kim S. , "Decolorization of disperse and reactive dyes by continuous electro coagulation process; Desalination" 150 (2002) 165-175.

[11] Kobya M., Can O. T., Bayramoglu M. , "Treatment of textile waste waters by Electro coagulation using iron and aluminum electrodes" Journal of hazardous Materials, B-100 (2003) 163-178

[12] Kobya M., Senturk E., Bayramoglu M. ," Treatment of poultry slaughter house wastewaters by electro coagulation" Journal of hazardous materials, xxx (2005) xxx.

[13] Mollah M. Y. A., Schennach R., Parga J. R., Cocke D. L. , "Electro- coagulation (EC) — science and applications" journal of hazardous waste material, B84 (2001)29-41.

[14] Rajkumar D., Palanivelu K., "Electrochemical treatment of industrial wastewater" journal of hazardous waste materials (2004).

[15] Roessler, A., Jin, X. "State of the art technologies and new electrochemical methods for the reduction of vat dyes; dyes and pigments" 59 (2003) 223-235.

[16] W. Miled, A. Haj Said and S. Roudesli" Decolorization of High Polluted Textile Wastewater by Indirect Electrochemical Oxidation Process" Volume 6, Issue 3, Spring 2010.

BIOGRAPHIES

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