Color And COD Removal From Textile Wastewater Using Combination Of Electro-Coagulation Process And Sequencing Batch Reactor

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Abstract- *Wastewater quality from the textile industries have been increasing together with the growing demand for products. Wastewater from textile dyeing and finishing factories is a significant source of environmental pollution. During dyeing process in textile industries, large amount of water was consumed and generates a substantial amount of wastewater. The major environmental problem associated with the use of the reactive dyes is their loss in the dyeing process. Coagulation is mainly used for removal of the waste materials in suspended or colloidal form that do not settle out on standing or may settle. SBR technology depends upon the great potential provided by the possibilities of influencing the microbial system in the SBR and also upon the fact that SBR process are comparatively easy to operate and are cost efficient. The results obtained for optimum voltage for Iron and aluminum electrodes COD removal efficiency for the voltage 16V found to be 63.21% and 71.37%, respectively, with the electrolysis time of 90 min, color removal efficiency was obtained to be 98.24% and 99.61% by EC process. Where as in the case of biological treatment using sequencing batch reactor the COD removal efficiency using iron electrode found to be 76.9% and 73.6% for 8 hrs and 12 hrs respectively and the COD removal efficiency using aluminum electrode found to be 86.43% and 84.13% for 8 hrs and 12 hrs respectively. Electro-coagulation process and sequencing batch reactor using aluminum electrodes found to be more efficient than iron electrode. By the combination of Electro-coagulation and Sequencing batch reactor leads to be most efficient treatment, and gives best removal efficiency.*

Keywords- Textile Wastewater, COD, Biodegradability, EC, SBR, Electrodes (Iron and Aluminum)

I. INTRODUCTION

The textile industry is one among the sources of water pollution. Wastewater quality from the textile industries have been increasing together with the growing demand for products. Source of environmental pollution is from textile wastewater during dyeing. In textile industries during process large amount of water will be consumed and generates substantial amount of wastewater. The textile industry wastewater when released into the environment can cause serious health and environmental problems. Textile wastewater contains strong color, high pH, temperature and COD and poor biodegradability. (Sathian et al., 2010). Textile wastewater which is been treated by chemical coagulation contains of the addition of chemicals to alter the physical state of dissolved and suspended solids which makes easier in removal of sediments. In some cases, the alteration is slight, and removal is affected by entrapment within a voluminous consisting mostly of the coagulant itself. Electro-Coagulation is used for removal of the waste substances in suspended or colloidal form that do not settle out on standing or may settle. (Akshaya Kumar Verma et al.,2012). Sequencing Batch Reactor processes are cost efficient it saves more than 60% of expenses required for conventional activated sludge process in operating cost. Sequencing Batch Reactor depends upon the great potential provided by the possibilities of influencing the microbial system in the Sequencing Batch Reactor and also upon the fact that Sequencing Batch Reactor process are comparatively easy to operate and are economical. (Talouizte H et al., 2013)

II. MATERIALS AND METHODS

The materials used in the Electro–coagulation process and sequencing batch reactor on the treatment of textile wastewater are discussed in the following sections.

2.1 Wastewater Sampling

The spent wash effluent sample was collected from textile wastewater industry, mysuru, karnataka, India. The containers are very important for the collection of the samples, usually collected in 20L polyethylene container. Certain precautions should be taken, that the container should be rinsed with water before collecting the samples. The sample have been collected by grab sampling method from the effluent treatment plant at equalization tank, three sets of samples have been collected in a day. The collected effluent was immediately brought to the laboratory and stored in the refrigerator at 4°C until further use in order to avoid any deterioration in the physico-chemical property of the spent wash. The major physiochemical characteristics of the raw spent wash at the time of collection.

2.2 EC Reactor

The reactor employed in the Electro–coagulation process is made up of perspex glass material of thickness 0.8mm. The volume of the reactor is found to be 1700ml and effective volume is 1000ml. The reactor is rectangular shape having dimensions of 100 mm × 100 mm × 170 mm.

2.3 Electrodes

The electrodes used in Electrochemical cell are made of Iron, Aluminum material. The dimensions of each electrode are 120 mm × 100 mm and the thickness of the electrode is 20 mm.

2.4 Power supply

A DC power supply was used as the source to supply current across the electrodes by means of copper wires.

2.5 Sequencing Batch Reactor Setup

A sequencing batch reactors (SBR) of 1L working volume were used for treating textile wastewater. Cow dung was used as a seed material which was added to reactor in the form of slurry. Cow dung was used as a seeding material since; cow dung is rich in heterotrophic bacteria which are responsible for de-nitrification purpose. The 300 ml of cow dung was mixed in 1000 ml of water to get slurry and then this slurry seeded into the reactor. The reactor consisting of sample and cow dung were kept in aerobic and anaerobic conditions.

2.6 Experimental Methodology of Electro Coagulation Process

The experimental set up employed consisted of an electrochemical cell with two iron electrodes on a magnetic stirrer. The electrodes used for the experiment were iron electrodes and aluminum electrodes respectively, with electrode size were in 5cm×5cm, were suspended in an electrochemical cell containing the contaminated water sample parallel to each other at a distance of 1cm apart. The electrodes were connected to the positive and negative terminals of DC power supply unit. The experiments were carried out on batch modes at varying Cell voltage and current density. Initial characterizations of water sample were carried out. Samples were retrieved at regular intervals of time.

2.7 Batch EC Apparatus

Before beginning the treatment of textile mill wastewater sample, the reactor was washed first with tap water and then with distil water in order to remove any contaminants present, then it is dried under sun or with vacuum drier. The electrodes were washed with 15 % of Hcl, to remove the pollutants present on the surface of the electrode. A volume of 1200 ml of wastewater sample was placed in the reactor. Experiments were carried out at room temperature and the wastewater during electrocoagulation treatment was magnetically stirred at a moderate rate in order to ensure complete mixing of wastewater. Experiments were performed in a two iron electrode (anode and cathode) and were connected to DC power supply. Experiments were conducted for uncoated iron and aluminum electrodes respectively. The DC power supply was turned on with a voltage kept at a desired value of 4, 6, 8, 10, 12, 14 and 16V. The volume of the solution each batch was 1L. EC experiments were performed for 90min for each run, samples were retrieved at every 15min.

2.8 Batch EC using Iron and aluminum electrodes

The electrochemical cell in all the processes was a perplex glass reactor with containing 1000mL textile wastewater. A magnetic stirrer was used for mixing the solution during electrolysis at 200rpm. The electrodes were positioned vertically and initially washed thoroughly with 15% HCL and then rinsed with distilled water before each experiment. Electricity was supplied by connecting the electrode to a direct current using a digital DC Power supply. Dimensions of iron and aluminum electrodes in electrochemical processes were 5cm × 5cm × 1mm that in the electrolyte and the spacing between electrodes was 1mm.The electrodes in mono-polar connection mode. The current density of the EC reactor was set to a desired value through adjustment of the direct current power supply, by varying the voltage and the run was started at room temperature. The duration of the experiment was 90mins and samples were taken every 15min intervals. The collected samples were filtered using a waltsman filter paper. COD, color and initial and final pH for every sample were measured. At the end of the experiment, the electrodes were washed thoroughly with water to remove any solid residues on the surfaces, dried and reweighed.

2.9 Anaerobic-Aerobic Sequencing Batch Reactor

An Anaerobic-Aerobic Sequencing batch reactor of working volume 1L was used to treat the textile wastewater. Textile wastewater, cow dung as a seed material was added to the reactor. The reactor was kept under anaerobic condition for 5 hours. Anaerobic condition was followed by aerobic condition for 2 hours. After aerobic condition the reactor was allowed to settle for 1 hour. Then 50% of the reactor working volume was decanted and the same volume was added as feed. The samples were collected to analyze COD.

III. RESULTS AND DISCUSSION

The results of experimental investigations were carried out at bench scale Electro-coagulation method. The electro-coagulation run was carried at varied voltages and by adopting various combinations of electrodes such as Iron and Aluminum electrodes. The results of experimental runs are discussed in the following sections.

3.1 Characteristics of Textile Wastewater

The wastewater samples (grab) were collected in polyethylene cans and were stored immediately in refrigerator at 40°C. The characterization of wastewater was made as per the standard methods (IS: 2490-1982). The characteristic values of wastewater analyzed is shown in Table 4.1. It is observed from the table that the wastewater is characterized by high COD and low BOD, the BOD/COD ratio being 0.36 indicating wastewater is rich in recalcitrant. From several visits made to industry it was observed that the fluctuations in flow and pollutant loading was found and it may be attributed to the reason that production process depends on the order of the product and the number of orders. The presence of high COD, color and low BOD/COD ratio, the samples clearly indicate that biological treatment of is difficult and presence of excess dye in the treated effluent is also poor resulting in poor effluent quality with almost all the parameters studied. Since the initial analysis of the samples obtained from equalization basin showed clearly the recalcitrant nature of the wastewater, further research on treatment of wastewater was done using physiochemical process alone. The studies were done using combination of Electrochemical and Sequencing Batch Reactor was made in terms of removal efficiency and quality of the effluent treated. Batch EC studies for typical textile industrial wastewater were carried out initially using iron and aluminum as electrodes. In the present study plate type monopolar are used.

3.2 Electro-Chemical Treatment

3.2.1 Effect of Electrolysis time and Voltage on COD removal using Iron electrode

The removal efficiency increases with an increase in the electrolysis time. For a fixed current density, the number of generated metal hydroxide increases with an increase in the electrolysis time. However, at longer electrolysis time, there will be an increase in the generation of flocks resulting in an increase on the efficiency of pollutant removal. In order to determine the optimal electrolysis time laboratory experiments were conducted for 90 minutes at varied voltages and the samples were collected at 15 mins intervals of time to determine the COD concentrations. In the present study, a plot of final effluent COD against electrolysis time for varied voltages were made and shown in Figures. Figure 4.1 shows the percentage removal of COD for 4V,6V,8V,10V,12V,14V and 16V. In this graph indicates there is a increase trend of COD removal in about 30 minutes of electrolysis time. This may be due to the increase in time. After 60 minutes, there was an increase in COD value in the reactor. This may be due to the maximum generation of the metal hydroxides.

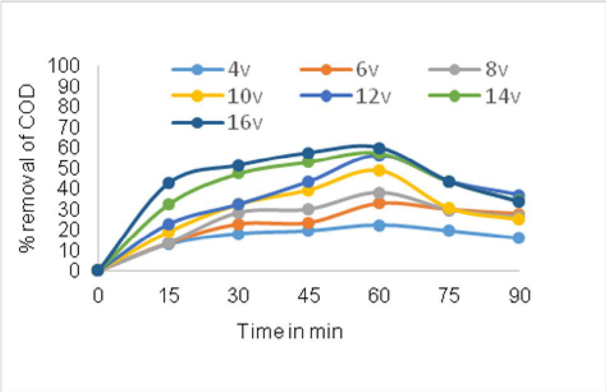

Fig 4.1 Percentage removal on COD

3.2.2 Effect of Electrolysis time and voltage on COD removal using Aluminum electrode

The removal efficiency increases with an increase in the electrolysis time. For a fixed current density, the number of generated metal hydroxide increases with an increase in the electrolysis time. However, at longer electrolysis time, there will be an increase in the generation of flocks resulting in an increase on the efficiency of pollutant removal. In order to determine the optimal electrolysis time laboratory experiments were conducted for 90 minutes at varied voltages and the samples were collected at 15 mins intervals of time to determine the COD concentrations. In the present study, a plot of final effluent COD against electrolysis time for varied voltages were made and shown in Figures. Figure 4.2 shows the percentage removal of COD for 4V,6V,8V,10V,12V,14V and 16V. In this graph indicates there is a increase trend of COD removal in about 30 minutes of electrolysis time. This may be due to the increase in time. After 45 minutes, there was an increase in COD value in the reactor. This may be due to the maximum generation of the metal hydroxides.

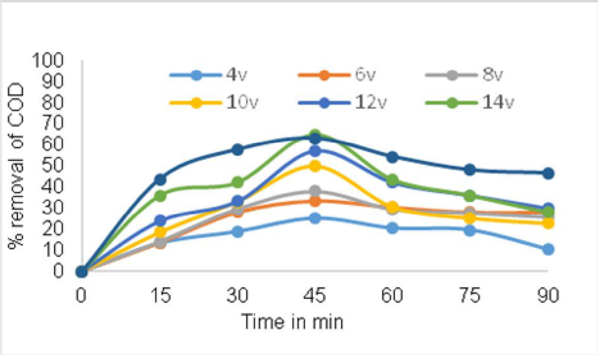

Fig 4.2 Percentage removal on COD

3.2.3 Effect of Electrolysis time and Voltage on Color removal using Iron and Aluminum electrode

Figure 4.3 shows the color removal efficiency at different voltages. At 15th min it start degrade the organic compound in electrolytic system, of about 70% of color will be removed in all the voltage. 91.87%, 92.67%, 94.45%, 95.67%, 96.98%,97.2%,98.24% was achieved at 4V,6V,8V,10V,12V,14V and 16V respectively using Iron electrode. Figure 4.4 shows the color removal efficiency at different voltages. At 15th min it start degrade the organic compound in electrolytic system, of about 80% of color will be, removed in all the voltage. 98%,94.74%,95.87%,96.44%, 97.41%,98.42%,99.61% was achieved at 4V,6V, 8V,10V,12V,14V and 16V respectively using Aluminum electrode.

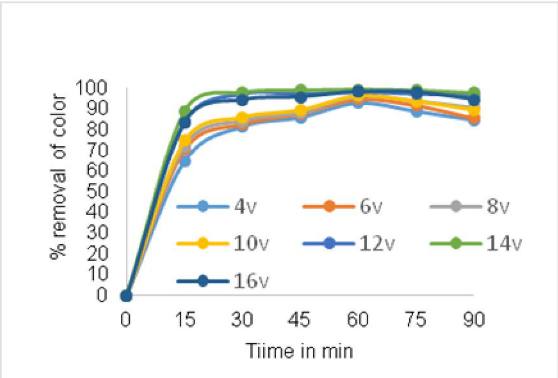

Fig 4.3 Percentage Removal on Color using Fe Electrode

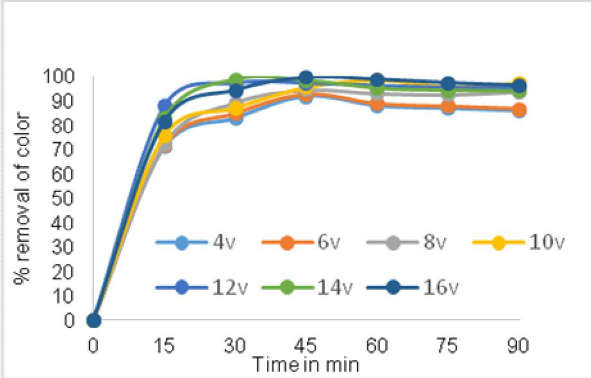

Fig 4.4 Percentage Removal on Color using Al Electrode

3.3 Sequencing Batch Reactor

3.3.1 Effect of Solids Retention Time using iron and aluminum electrodes

Figure 4.5 shows that the percentage removal of cod was 63 % on first day. There was increase in removal of cod during the eight day but however it slightly decreased to 75 % the very next day due to optimum conditions for 8 hr cycle using iron electrode. Figure 4.6 shows that the percentage removal of cod was 63 % on first day. There was increase in removal of cod during the eight day but however it slightly decreased to 75 % the very next day due to optimum conditions for 12 hr cycle using iron electrode. Figure 4.7 shows that the percentage removal of cod was 63 % on first day. There was increase in removal of cod during the eight day but however it slightly decreased to 75 % the very next day due to optimum conditions for 8 hr cycle using aluminum electrode. Figure 4.8 shows that the percentage removal of cod was 63 % on first day. There was increase in removal of cod during the eight day but however it slightly decreased to 75 % the very next day due to optimum conditions for 12 hr cycle using aluminum electrode.

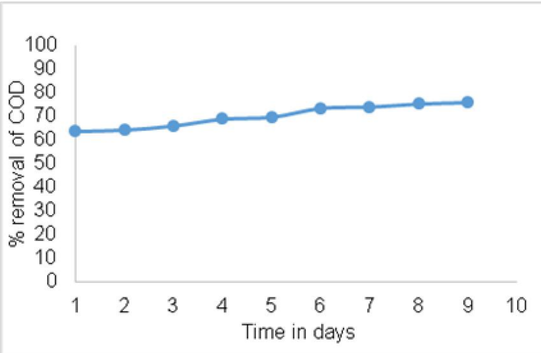

Fig 4.5 Percentage of COD removal for 8 hours cycle time using Fe electrode

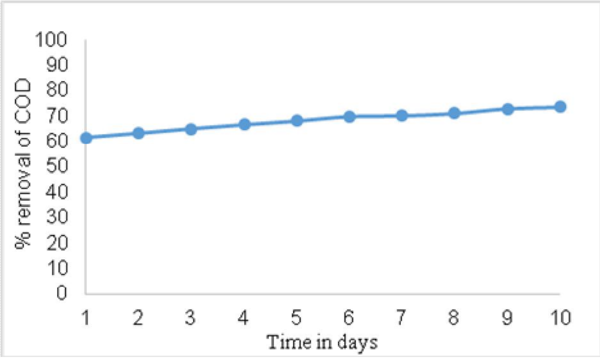

Fig 4.6 Percentage of COD removal for 12 hours cycle time using Fe electrode

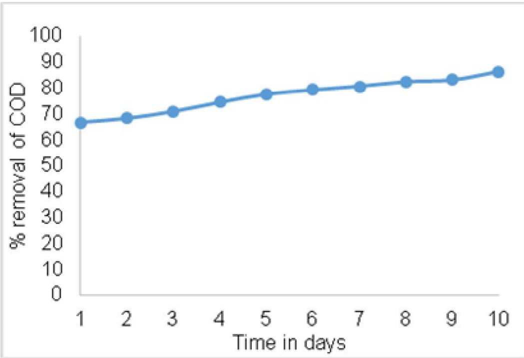

Fig 4.7 Percentage of COD removal for 8 hours cycle time using Al electrodes

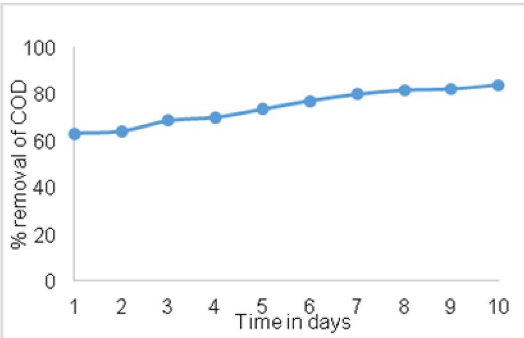

Fig 4.7 Percentage of COD removal for 12 hours cycle time using Al electrodes

IV. CONCLUSIONS

Based on the results and discussions as discussed in Chapter 4, following conclusions have been made:

- Batch EC studies for typical textile industrial wastewater were carried out initially using iron and aluminium as electrode material.
- The results obtained for optimum voltage for Iron electrode COD removal efficiency increase with the increase in the voltage (4V-16V) and found to be 22.26% and 63.21%, respectively, with a initial COD concentration and electrolysis time of 2120mg/L and 90 min, respectively, color removal efficiency was obtained to be 98.24% for EC process.
- Similarly, The results obtained for optimum voltage for aluminium electrode COD, removal efficiency increase with the increase in the voltage (4V-16V) and found to be 25.16% and 71.37%, respectively, with a initial COD concentration and electrolysis time of 1989mg/L and 90 min, respectively, color removal efficiency was obtained to be 99.61% by EC process.
- In SBR, of 8 hours and 12 hours cycle time the COD removal efficiency using iron electrode found to be 76.9% and 73.6% respectively.
- In SBR, of 8 hours and 12 hours cycle time the COD removal efficiency using aluminium electrode found to be 86.43% and 84.13% respectively.
- In SBR, of 12 hours cycle time less biodegradable than 8 hours cycle time. The lower the HRT the higher the removal rates. Therefore, 8 hours cycle time is very efficient.
- Electro-coagulation process using aluminium electrodes with sequencing batch reactor found to be more efficient than iron electrodes.
- By the combination of Electro- coagulation and Sequencing batch reactor leads to be most efficient treatment, and gives best removal efficiency.

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