DECOLOURIZATION OF METHYL ORANGE DYE BY USING ELECTROCHEMICAL OXIDATION AND PHOTOCATALYSIS

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ABSTRACT

In the present study, the electrochemical oxidation and the photocatalysis experiments were conducted for the decolourization of methyl orange dye. Synthetic effluent was treated with electrochemical oxidation having the stainless steel as an anode and the copper as a cathode. Effect of dye concentration (2, 5, 7, 9, 11 ppm) and effect of pH (2, 4, 6, 8, 10, and 12) on the decolourization of Methyl Orange was studied at optimistic condition i.e. 30V. It was observed that highest decolourization (99%) was achieved for 2 ppm concentration of Methyl Orange. In case of photocatalysis C doped TiO_2 (Kronos) suspension was used under visible light irradiation. The optimum loading of the photocatalyst (0.2 g/lit) showed 78.6 % of decolourization of in 4 hours. It was observed that the electrochemical oxidation required less time compared to that of by photocatalysis.

Keywords: ***C doped TiO_2, Decolourization, Electrochemical Oxidation, Methyl Orange, Photocatalysis, Textile Effluent***

I. INTRODUCTION

The textile industry require large amount of water for different processing thereby producing large amount of wastewater. Dye released to the environment impart colour to water and decreases the reoxygenation capacity of water, which directly affects the aquatic life [1]. The textile effluent is carcinogenic, mutagenic or teratogenic to living life [2].

The many researchers observed that the conventional treatments like biological treatments, coagulation/ flocculation treatment do not give satisfactory results [3-8]. Membrane separation and adsorption techniques have the limitation for the effective treatment of textile effluent [9, 10].

Advance oxidation process photocatalysis is effective and attractive treatment for the treatment of textile effluent. TiO_2 is most often used photocatalyst which is environment friendly, nontoxic and photostable [11, 12]. TiO_2 has band gap 3-3.2 eV can be excited under the UV light which is 5-6% present in solar light which limits the applicability of the TiO_2 [11]. TiO_2 doping is the promising way to increase the photocatalytic activity under the visible light and so many effort to increase the photocatalytic activity of TiO_2 under the UV and visible light for the effective treatment of textile effluent [13- 27]. In this study we have used C doped TiO_2 (commercial) to study the photocatalytic decolourization of Methyl Orange dye under visible light source.

Electrochemical oxidation is also promising method for the textile effluent [28- 31]. Electrochemical treatment offers high efficiency and also prevents the production of unwanted by products [28]. Many researchers worked on the different electrodes like platinum copper, zinc, lead, nickel, stainless steel, lead acid battery, graphite, titanium, Ti/PbO_2, to get higher degradation efficiency [28-36].

In this work we have worked on the photocatalysis and electrochemical oxidation in the rector configuration for the degradation of Methyl Orange dye.

II. MATERIAL AND METHOD

2.1 Material

Methyl orange dye (Merck C.I. No 13025), C doped TiO_2 (Kronos), H_2SO_4, NaOH, salt were used for the experimentation.

2.2 Apparatus

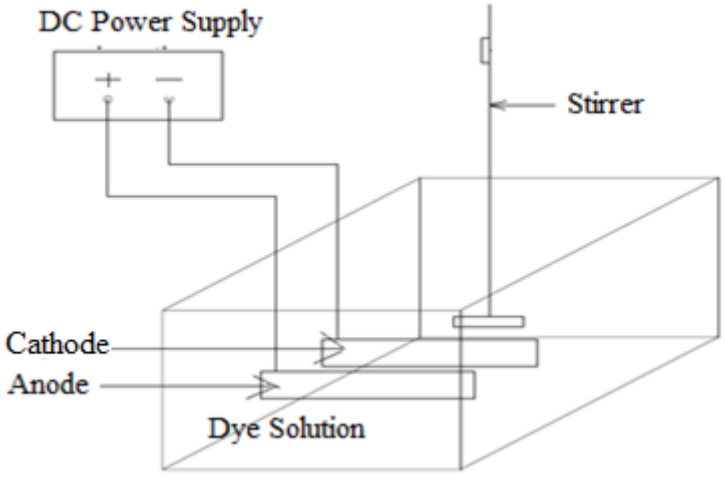

Fig. 1 Schematic Diagram of Electrochemical Oxidation

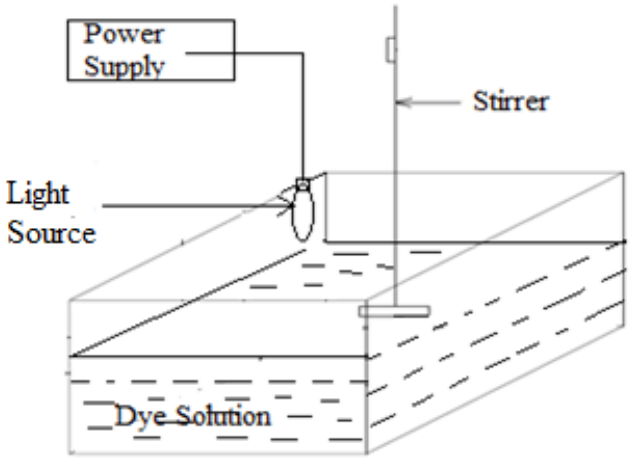

Fig. 2 Schematic diagram of Photocatalysis

The reactor was fabricated by using acrylic sheet. The dimensions of the reactor were 25 cm× 25 cm × 15 cm. The stainless steel (18 cm × 2.5 cm × 0.1 cm) as an anode and copper (18 cm × 2.5 cm × 0.2 cm) as a cathode were placed 6cm apart which were attached to DC supply (Testronix 32C, Make: India).

2.3 Method

With the help of this experimental setup two different scheme of experiment were conducted. For each experiment 2 lit. of aqueous dye solution was prepared. The pH of the synthetic effluent was adjusted to desired

level using 1N NaOH and 1N H_2SO_4. The pH values were measured by using pH meter (Labline Auto digital pH meter).

2.3.1 Electrochemical Oxidation

Prior each experiment electrodes were dipped into dilute HCl for few minutes and then washed with distilled water. 1 gm of common salt was added as a supporting electrolyte. In this system first we have optimized the voltage for the decolourization of dye. In this work the effect of initial dye concentration and effect of pH on the decolourization was evaluated.

2.3.2 Photocatalysis

In this work, photocatalytic decolourization of dye was carried out using the suspension of C doped TiO_2 under external visible light source (Orphas 125W). The reactor was provided with a stirrer to keep the photocatalyst in suspension and to provide surface aeration. The efficiency of the decolourization was studied by varying the amount of C doped TiO_2 in suspension (0.1, 0.15, 0.2, 0.25 g/lit).

2.4 Analysis

The efficiency of dye decolourization was evaluated by monitoring at maximum absorption wavelength (464 nm) with UV Spectrophotometer (LABINDIA UV 3000^+ UV/ VIS spectrophotometer).

III. RESULT AND DISCUSSION

The effect of parameter such as voltage, dye concentration, pH, and amount of TiO_2 on the rate of dye decolourization from the effluent was investigated depending upon the processes such as electrochemical oxidation, photocatalysis.

3.1 Electrochemical Oxidation

3.1.1 Voltage variation

The experiments were carried out by varying the voltage from 10 V to 50 V at 5 ppm dye concentration. It was observed that with increase in the voltage dye decolourization was also increased. It was found that at 30 V the highest decolourization of methyl orange was achieved.

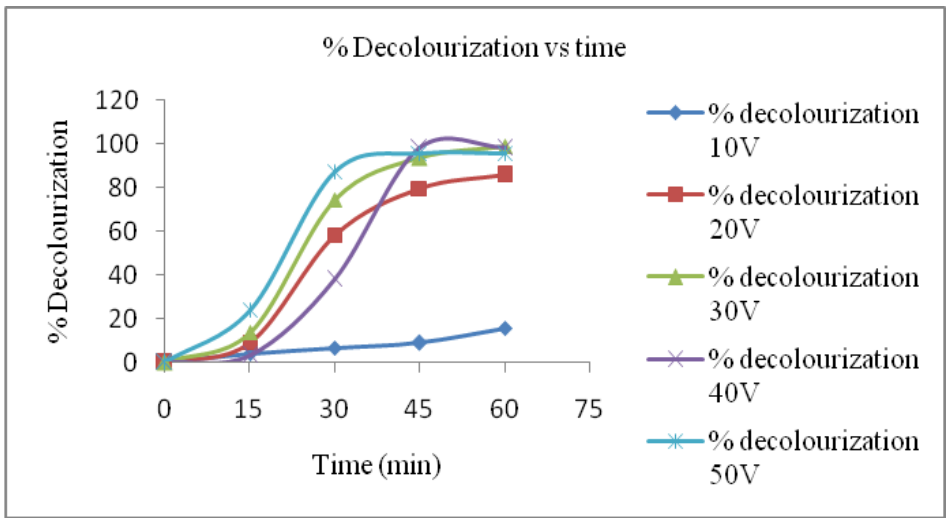

Fig. 3 Variation of voltage

3.1.2 Effect of initial Dye Concentration

Effect of initial dye concentration was evaluated by using the optimized voltage 30V. Fig. 4 shows the decolourization of methyl orange at different dye concentration. It was observed that with the increase in the initial dye concentration the decolourization was decreased. It was observed that at 2 ppm the highest decolourization was observed.

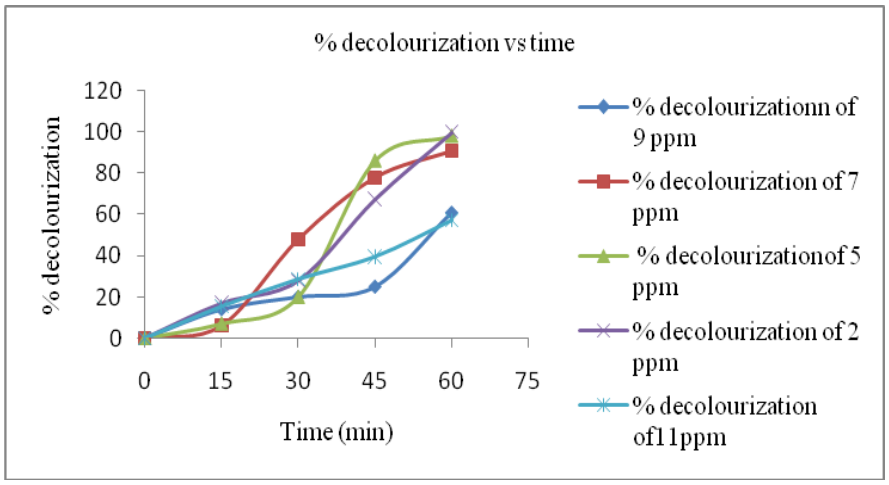

Fig. 4 Effect of initial dye concentration

3.1.3 Effect of pH

Solution pH varied from 2 to 12 in order to determine the effect on the electrochemical decolourization of methyl orange. Fig. 5 shows the percent decolourization at different pH values.

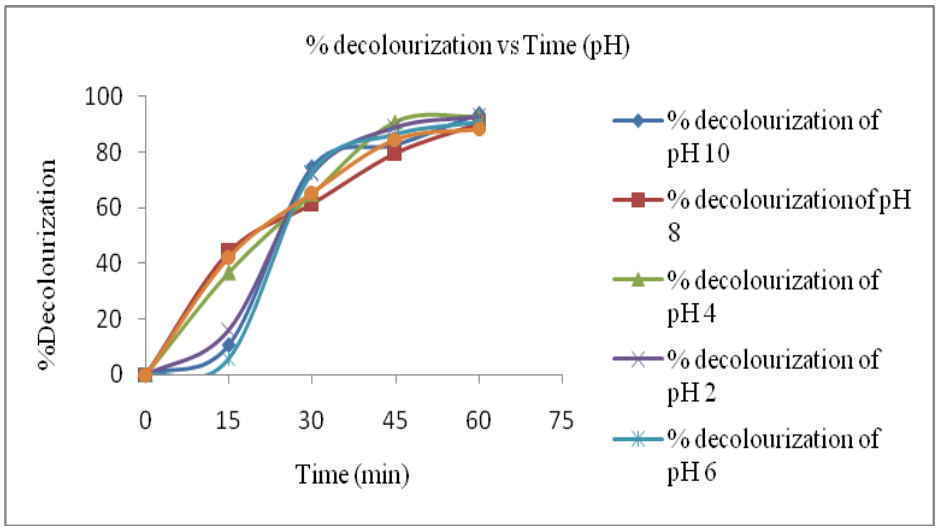

Fig. 5 Effect of pH

3.2 Photocatalytic Reaction

For 0.2 g/lit of loading maximum decolourization (78.6 %) was observed in 2 hours however further increase in the catalyst loading the % decolourization is reduced due to the shielding effect.

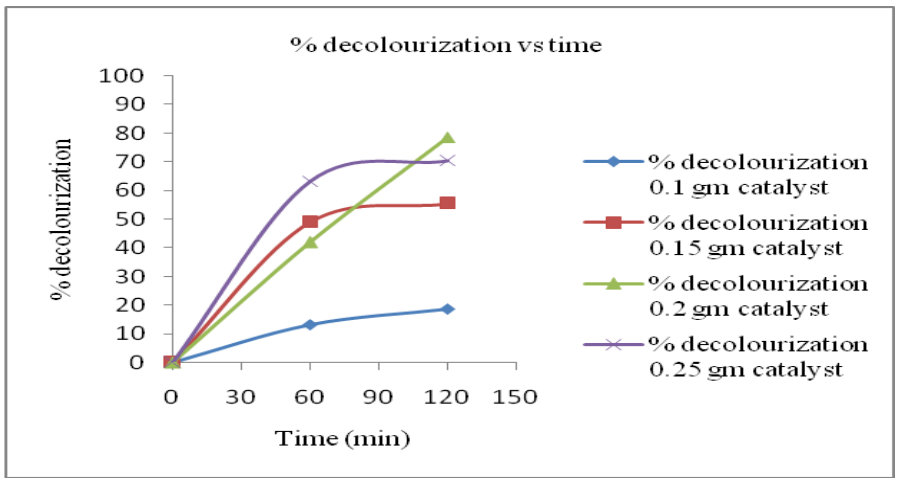

Fig. 6 Photocatalytic decolourization of MO

IV. CONCLUSION

The results of the present studied showed the electrochemical oxidation and the photocatalysis could be the effective treatment for the decolourization of methyl orange. The initial dye concentration shows the significant effect on the methyl orange dye decolourization while it was observed that there was no significant effect of pH variation on decolourization. From the study we proposed that the combination of electrochemical oxidation and photocatalysis could be the best solution for the effective treatment of textile wastewater.

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