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Comparison of Degradation Phenomenon of Reactive Dye Direct Red 80 by Fenton, Photo Fenton and H_2O_2+UV-C Processes

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Abstract **- Fenton, Photo Fenton and H_2O_2+UVC experiments were conducted on a reactive dye Direct Red 80. The influence of different parameters like initial pH, initial concentration of H_2O_2, Fe (II) dosage was found on it. The optimum pH value using Fenton degradation is in between 2.5 and 3.0. As H_2O_2 was increased, the rate of degradation was found to increase up to 10mM and thereafter it decreased. As Fe (II) was increased, the rate of degradation was found to increase up to 35mg/L and then it decreased. Comparisons of final degradation by Fenton, Photo Fenton and H_2O_2+UV C methods were done.**

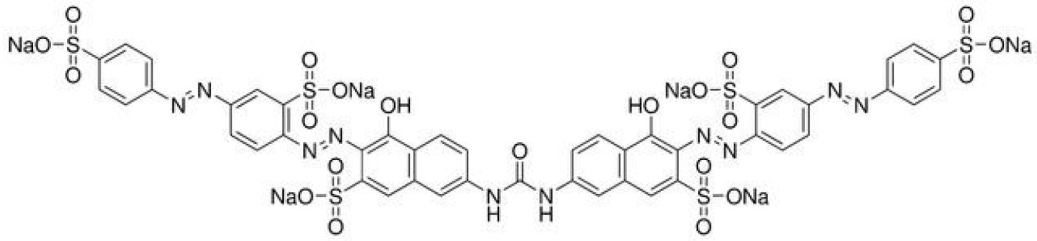
Keywords: **Fenton, photo Fenton, *H_2O_2+UV-C, Direct red80,* colour degradation.**

I.INTRODUCTION

Present scenario water pollution is one of the major problems in the world. Dyeing industries are one of the sources for this water pollution. Dyeing industries produces waste water with different colours. In the dyeing process, textile industries generate huge quantity of toxic effluent containing colours, sodium sulphate, sodium chloride, sodium hydroxide and traces of other salts. These are generated after dyeing and after washing of garments fabrics. After dyeing the waste water produced is called Dye Bath water and after washing the waste water generated is called wash water. Dye Bath contains higher solids in the range 4-5% whereas wash water contains only 0.5-1% solids. We can remove these colours economically from the water by various AOP's (Advanced Oxidation Process). This process includes number of methods like Fenton, Photo Fenton, Electro Fenton, Sono Fenton etc.

II.EXPERIMENTAL

Dye solution: A reactive dye DIRECT RED 80 is purchased from SIGMA ALDRICH COMPANY. From that stock solution of 50mg/l were prepared, from that working solutions were prepared by dilution.



Chemical structure of Direct Red 80

Empirical Formula (Hill Notation) $C_{45}H_{26}N_{10}Na_6O_{21}S_6$
Molecular Weight 1373.07

Chemicals used:

For pH adjustment, concentrated H_2SO_4 and NaOH of Merck make and AR grade are used. For Fenton reaction H_2O_2, 30%$^{W}/_{V}$ and Fe (II) of AR grade from Merck are used.

Fenton, Photo Fenton

In the Fenton reaction the iron reacts with H_2O_2 and produces the OH(hydroxyl radicals),these OH radicals actively participate in the reaction and during this reaction the state of Fe changes from +2 to +3(reaction 1). In the second reaction Fe consumes H_2O_2 & changes it's state from +3 to +2 and generates superoxide radical and proton.

III.RESULTS AND DISCUSSION

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^{2+} + OH^{-} \quad \ldots\ldots (1)$$

$$Fe^{3+} + H_2O_2 \rightarrow Fe^{2+} + OOH^{2+} + H^{+} \quad \ldots\ldots (2)$$

Photo Fenton is same like Fenton but in this case UV light (UV-C &wavelength 254nm) is added externally. In Photo Fenton reaction H_2O_2 reacts with UV light and it produces more number of OH radicals than Fenton. The same method is followed like Fenton but UV light is added. This OH radicals degrades the organic molecules present in the solution and it forms H_2O

$$H_2O_2 + h\nu \rightarrow HO^{2+} + HO^{2+} \quad \ldots\ldots (3)$$

$$Fe^{3+} + H_2O + h\nu \rightarrow Fe^{2+} + HO^{\square} + H^{+} \quad \ldots\ldots (4)$$

Effect of Ferrous sulphate (II)

In present study, for Fenton process the Fe dosage varied from 20 mg/l to 80mg/l and is found that Fe dosage increases degradation rate increases up to 35mg/l, after that decreases & same thing was observed for photo Fenton and optimum dosage observed at 35mg/l. Fig 1 shows the variation of degradation for different Fe dosage values in different processes.

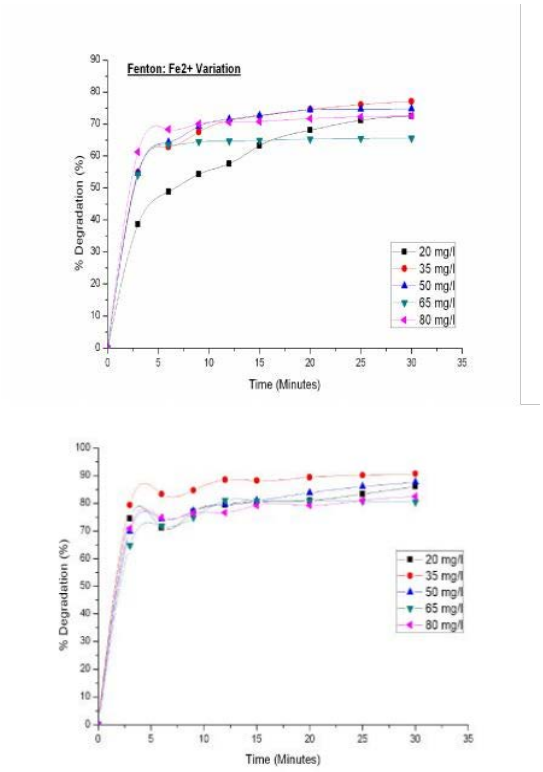


Fig.1. Variation of Fe2+ dosage Vs. % degradation in Fenton and Photo Fenton processes

H_2O_2 variation

H_2O_2 act as an oxidizing agent in the Fenton reactions, As concentration of H_2O_2 increases the rate of degradation increases due to the formation of OH radicals in all the above three processes. In the present study the dosage was varied from 4mM to 12mM. But up to the optimum level only H_2O_2 can produces maximum number of OH radicals. If the concentration exceeds optimum level it produces HO_2 radicals which are not efficient as that of OH radicals, there by reduction in degradation occurs. The optimum dosage observed at 10mM, 8mM, 8mM for Fenton, Photo Fenton & H_2O_2+UV-C processes respectively. At the optimum values 90% degradation observed for Photo Fenton, 80% degradation observed for Fenton and 55% degradation observed for H_2O_2+UV-C process (after 30 minutes for all the above methods) as shown in Figure 2.

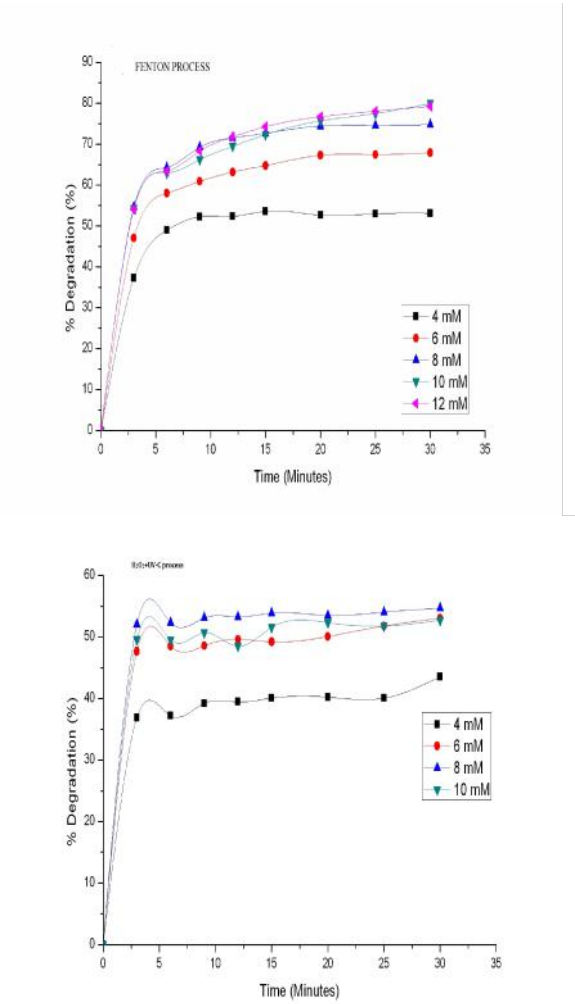


Fig.2. Variation of H_2O_2 dosage Vs % degradation in Fenton, Photo Fenton & H_2O_2 + UV-C processes

pH Variation:

The pH plays an important role in dye degradation. For direct red80 dye, for the three AOP's, i.e Fenton, Photo Fenton & H_2O_2+UV-C, pH was varied from 2 to 4. The optimum pH was found to be 2.5 for Photo Fenton & H_2O_2+UV- C. In Fenton processes, when the pH was increased (>3), degradation gets decreased due to the generation of complex compounds of iron [3]. However when pH was reduced below 2.0, the Hydrogen ions start acting as OH radical scavengers. This reduces degradation. Furthermore, higher concentration of H^+ ions results in oxonium ion production from peroxide. The peroxide gets more electrophilic with production of oxonium ions, this in turn reduces peroxide's reactivity with fe^{2+}ion. For Fenton process, the optimum pH observed at 3. The degradation rate is more in Photo Fenton and followed by Fenton & H_2O_2+UV- C.Up to 90% degradation (after 30 minutes) observed in case of Photo Fenton as shown in Fig 3.

IV.CONCLUSIONS

The degradation rate was observed for Dye (DIRECT RED 80 Initial dye concentration of 20mg/l) with all above three processes Fenton, Photo Fenton & H2O2+UV-C. Maximum degradation 90% (after 30 minutes) observed for Photo Fenton, 80% degradation observed for Fenton & 55% degradation observed for H2O2+UV-C. So Photo Fenton process is more efficient than other two (Fenton, H2O2+UV-C) processes.

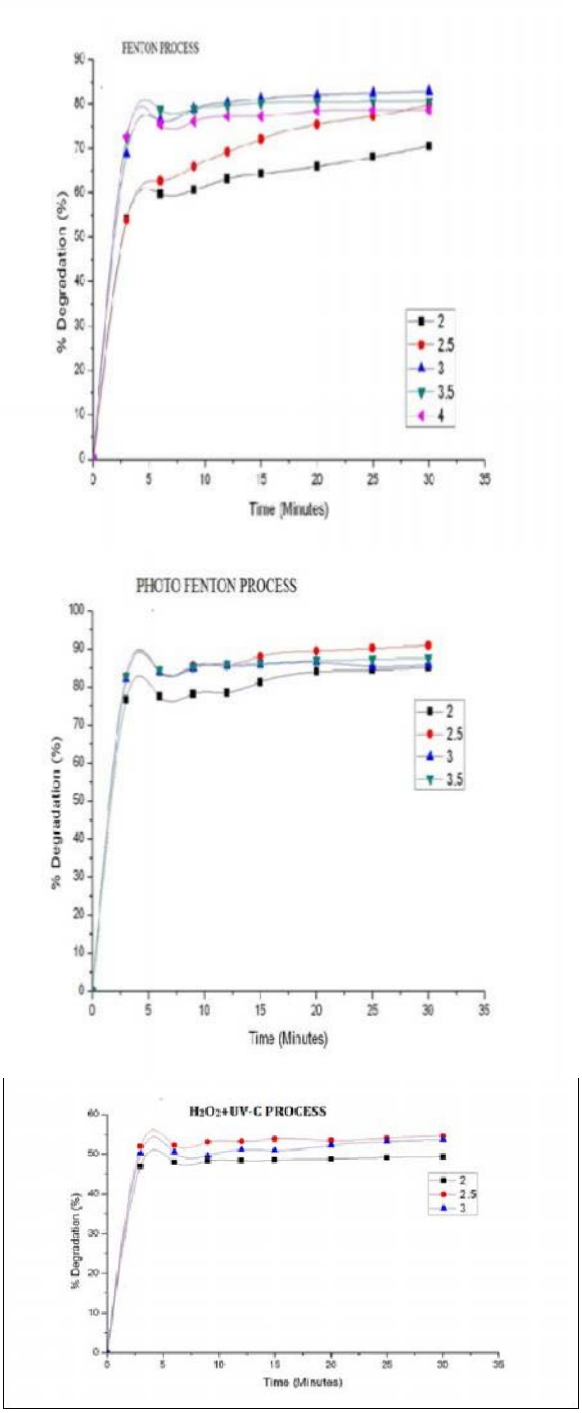


Fig.3. Variation of pH Vs. % degradation in Fenton, Photo Fenton and H_2O_2 + UV-C processes

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