

Photo-Bleaching of Amcot Red 3 Blf Using in Situ Chemical Oxidation by Fenton's Reagent

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ABSTRACT

The oxidative decolourization of AMCOT Red 3BLF in aqueous medium has been studied using photo Fenton process. Fenton's reagent ($\text{H}_2\text{O}/\text{Fe}^{3+}$) was used to generate hydroxyl radical ($\text{OH}\cdot$). A visible light source was used to provide radiation for photo Fenton process. The experimental parameter such as pH, air, light, time and catalyst strongly influenced the dye removal rate in photo Fenton process. The result shows that the AMCOT Red 3BLF bleaches upto 70% within 4 hrs and degrades into CO_2 and H_2O . The proposed mechanism for the reaction of $\text{OH}\cdot$ with AMCOT Red 3BLF dye molecules is summarized.

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Introduction

Pollutant from household waste, agriculture and industries are accumulating in natural water and polluting it. Industries are the major consumers of water. Textile, dyestuff and dyeing industries are one of the largest groups of industries causing intense water pollution. A very small amount of dye in water (10-20 mg / L) is highly visible and affects water transparency and gas solubility of water bodies¹. Triphenyl methane, Malachite green, Basic yellow-2, AMCOT Red 3BLF and many other dyes are toxic and potentially carcinogenic²⁻³. Various traditional removal methods like coagulation/ flocculation, ultra filtration, reverse osmosis and adsorption are based on a phase transfer of the pollutant. Recently Advanced Oxidation Processes (AOPs) have been employed to oxidize the organic compound into CO_2 , H_2O and inorganic ions or biodegradable compounds⁴. Among the most promising AOPs for water contaminated by organic molecules, application of Fenton's reagent (an aqueous mixture of Fe^{2+} and H_2O_2 that produce $\text{OH}\cdot$ radical) stand out due to its high oxidation power, rapid oxidation kinetics, inexpensive and easy to operate⁵⁻⁷. The hydroxyl radical is a powerful oxidant that can rapidly and selectively oxidize organic contaminants into CO_2 and water⁸⁻⁹. Mogra et al reported the photochemical degradation of P-dichlorobenzene and Chlorobenzene by the photo-Fenton's reagent¹⁰⁻¹¹. Khandelwal et al studied the photo degradation of Basic yellow-2 using photo-Fenton's reagent¹². Fenton process has been used for decoloration of solution of Acid Red-14 dye, Indigo Carmine, direct Orange-61, Malachite Green, Methylene Blue and other dyes¹³⁻²¹.

The present work studied the photobleaching of AMCOT RED 3BLF dye using chemical oxidation by Fenton's reagent. AMCOT RED 3BLF dye is a direct azo dye and used for coloring lather, paper etc. It is a product of Amrit Lal Chemoux Ltd. Mumbai.

Materials and methods

AMCOT RED 3BLF dye (Amrit Lal Chemoux Ltd.) Photocatalyst FeSO_4 (Merck) and H_2O_2 (6%) were used in the present investigation. For the photo bleaching process 5×10^{-3} M stock solution of AMCOT RED 3BLF dye was prepared in double distilled water and diluted as required. Stock solution of FeSO_4 (0.05M) was prepared and H_2O_2 (6%) in round bottom flask. Total volume of reaction mixture was made up to 100ml by adding double distilled water. AMCOT RED 3BLF dye solution containing catalyst was exposed to visible light from tungsten filament lamp (2x200W, Philips). Water cell of 15cm thickness was used to cutoff thermal radiations. The pH of solution was measured and maintained within a range of 3.0 to 6.5 by addition of previously standardized H_2SO_4 and NaOH solution. Air was continuously purged through the dye solution with help of aerator (Aqua air). The controlled experiments were performed in absence of (i) Light (ii) Air and (iii) Catalyst. Progress of Photobleaching reaction was observed at different time intervals by measuring absorbance using spectrophotometer (systronics model-112).

Result and Discussion

The photochemical degradation of AMCOT RED 3BLF dye was observed in the presence of air,

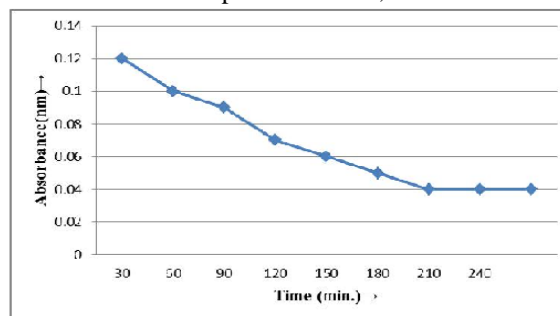


Figure 1. Variation of absorbance with time when air, light and catalyst are present.

Table 1.

Time (minutes)	Absorbance in the presence of catalyst, air and light (nm)	Absorbance in absence of catalyst (nm)	Absorbance in absence of air (nm)	Absorbance in absence of light (nm)
Initial	0.12	0.12	0.12	0.12
30	0.10	0.11	0.12	0.11
60	0.09	0.11	0.12	0.10
90	0.07	0.11	0.12	0.10
120	0.06	0.11	0.11	0.09
150	0.05	0.11	0.11	0.09
180	0.04	0.11	0.11	0.09
210	0.04	0.11	0.10	0.09
240	0.04	0.11	0.10	0.09

catalyst and light at $\lambda_{\max} = 500\text{nm}$. The results are depicted in table-1. The optical density decreases with increase in the time of exposure of radiation. The plot of optical density against time suggested that initially the rate of photobleaching is high and then reduced with time.

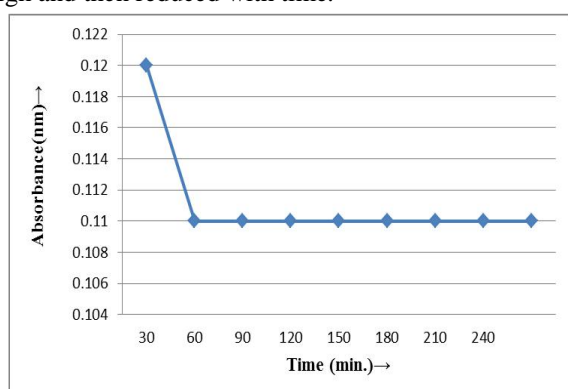


Figure 2. Variation of absorbance with time in absence of catalyst.

The absorbance of solution is almost same for all time intervals. This was confirmed that photobleaching is negligible in absence of Fenton's reagent. Hence presence of Fenton's reagent is necessary for photobleaching of dye solution.

Photobleaching in absence of air: - The process of photobleaching of dye has been studied in absence of air and results were depicted in table-1 and figure-3.

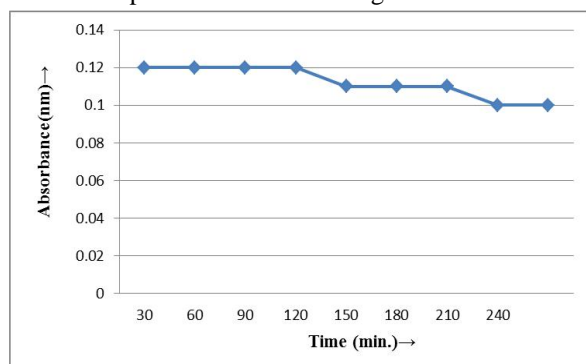


Figure 3. Variation of absorbance with time in absence of air.

The plot shows that the absorbance at all time intervals are almost equal and suggested that air is one of the necessary conditions for photobleaching.

Photobleaching in absence of light: - A very minute and irregular decreases in absorbance with time in absence of light (table-1 and figure-4) are suggested that the light is one of the necessary condition for photobleaching of dye solution.

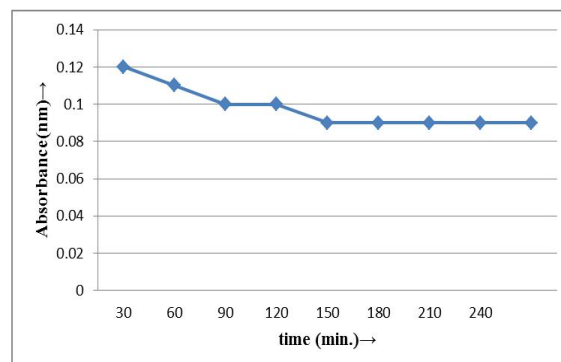


Figure 4. Variation of absorbance with time in absence of light.

Mechanism

The "Photo Fenton" reagent has been found to act as an antioxidant. Ferrous ions (Fe^{2+}) of Photo Fenton reagent are react with hydrogen peroxide to form Fe^{3+} ions, a hydroxyl radical and a hydroxide anion. The hydroxyl radical react with substrate to give the product. This can be shown in figure 5.

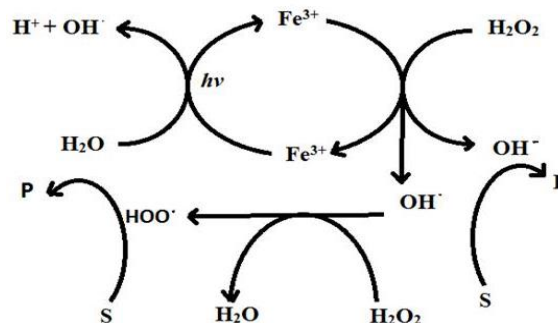
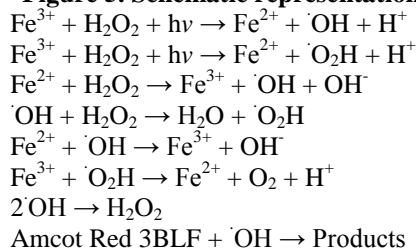


Figure 5. Schematic representation of Fenton's reaction.



Conclusion

Photo fenton's can decolorize the effluent water from industries. Photo bleaching of Amcot Red 3 BLF dye occurred gradually with time and it was bleach upto 70% within 4 hrs. Thus Photo Fenton's reagent can be used as a cost effective and eco-friendly potential chemical oxidant for the treatment of waste water of dyeing, printing and textile industries.

References

1. Chung K. T. and Stevens S. E., *Environ. Toxicol. Chem.*, 12(11),2121-2132,(1993).
2. Cisnerol R. L., Espinoza A. G. and Litter M. I., *Chemosphere*, 48(4), 393-399, (2002).
3. Chen Y. X., Wang K. and Lon L. P., *J. Photoch. Photobio. A.*, 163(1-2), 281-287, (2004).
4. Nogueira R. P. F., Silva M. R. A. and Trovo A. G., *Solar Energy*, 79, 384, (2005).
5. Chequer F. M. D., Dorta D. J. and Oliveira D. P., *Advances in Treating Textile Effluent, In Tech.*, 162p, (2011).
6. Kavitha V. and Palanivelu K., *Chemosphere*, 55, 1235-1243, (2004).
7. Selvam K., Muruganandham M. and Swaminathan M., *Solar Energy Materials and Solar Cell*, 89, 61-74, (2005).
8. Will I. B. S and Moraes J. E. F., *Sep. Purif. Technol.*, 34, 51, (2004).
9. Zheng H. and Xiang X., *Spectrosc. Spectr. Anal.*, 24, 726, (2004).
10. Mogra D., Ameta R., Mehta M. and Ameta S. C., *J. Indian Chem. Soc.*, 79, 593, (2002).
11. Mogra D., Ameta R., Chhabra N. and Ameta S. C., *Intl. J. Chem. Sci.*, 1, 211, (2003).
12. Khandelwal D. H. and Ameta R., *Res. J. Recent Sci.*, 2(1),39-43, (2013).
13. Wang A. M., Qu J. H., Ru J., Liu H. J. and Ge J. T., *Dyes Pigments*, 65(3), 227-233,(2005).
14. Flox C., Ammar S., Arias C., Brillas E., Vargas-Zavala and Abdelhedi R., *Appl. Catal. B-Environ.*, 67(1-2), 93-104, (2006).
15. Hammami S., Oturan N., Bellakhal N., Dachraoui. M and Oturan M. A., *J. Electroanal. Chem.*, 610(1), 75-84 (2007).
16. Oturan M. A., Guivarch E., Oturan N., Sires I., *Appl. Catal. B-Environ.*, 82(3-4), 244-254 (2008).
17. Xie Y. B. and Li X. Z., *Mater., Chem. Phys.*, 95(1), 39-50 (2006).
18. Guivarch E., Trevin S., Lahitte C. and Oturan M. A., *Environ. Chem. Lett.*, 1(1), 38-44 (2003).
19. Fatimah I., Sumarlan I. and Alawiyah T., *International Journal of Chemical Engineering* , 2015, Article ID 485463.
20. Sharma G., Tak P., Ameta R., Punjabi P. B., Sharma S., *Acta Chim. Pharm. Indica*, 5(1), 8-15, (2015).
21. Li M., Qianga Z., Pulgarinb C. and Kiwi J., *Applied Catalysis B: Environmental*, 187, 83–89, (2016).