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DECOLORIZATION OF ACID ORANGE 7 AND ACID BLUE 113 BY ADVANCED OXIDATION PROCESS USING FENTON'S REAGENT

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Abstract
Textile industries uses enormous amount of process water and chemicals. Dyes are chemically stable, toxic and non-biodegradable substance which pollutes our environment. Dyes cannot be destroyed by primary or secondary treatment methods. Hence tertiary treatment methods such as Advanced Oxidation Process play a vital role in dye degradation. Acid Orange 7 and Acid Blue 113 were decolorized as part of this research project using Fenton's reagent in the presence of direct sunlight and photo reactor i.e. Fe^{2+}/H_2O_2/UV and Fe^{2+}/H_2O_2/Solar. The effects of operating conditions such as effect of initial concentration of the dye, effect of iron dosage, effect of H_2O_2, effect of pH, effect of time were measured. The optimum conditions obtained were Fe^{2+} = 0.15mM, H_2O_2 =1.5mM, pH=5. Maximum decolorization was achieved by Fe^{2+}/H_2O_2/UV method for both the dyes.

Keywords: Dyes, Advanced Oxidation Process, Fenton Reagent, Decolourization.

1. Introduction

Our environment is being polluted continuously, by domestic and industrial wastes. The water, air and land which are essential for living beings should be in their pure state. Modern civilization, increasing population and growth of industries have altered the natural environment. There are two types of pollutants. Biodegradable pollutants(the pollutants are said to be bio-degradable when it decomposes rapidly by natural processes) and Non biodegradable pollutants (the pollutants are said to be non-biodegradable when it does not decompose rapidly in the environment.

During the last fifty years, the number of industries in India has grown rapidly. Industrial waste water usually contains specific and readily identifiable chemical compounds. Recent studies indicate that toxic and refractory organic compounds including dyes and waste water could be destroyed by the most advanced oxidation process (4). Since water pollution is caused by domestic sewage and industrial waste any abatement of water pollution depends mainly on the efficiency of waste water treatment.

2. Methodology

All the chemicals used were of commercial grade and they were used without further purification. The experimental procedure was carried out using the dye sample solution containing different concentrations of Acid Orange 7 and Acid Blue 113. The solution was taken in a clean, dry conical flask. pH was adjusted to a desired level using sulphuric acid and sodium hydroxide. The reagents namely hydrogen peroxide, ferrioxalate were added to the solution. Then 5mL of aliquot sample was taken as a reference.

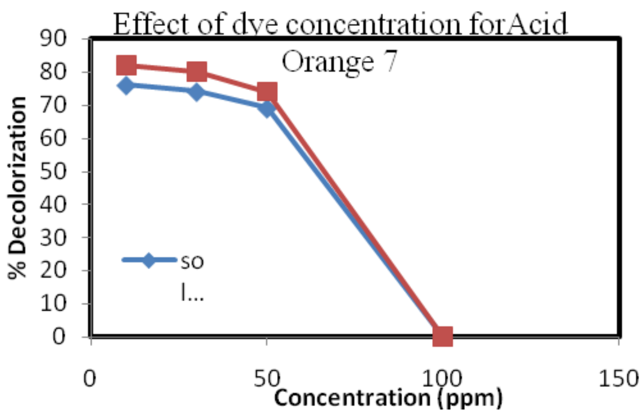
The remaining solution was kept under the solar light in the case of solar method and kept inside the photo reactor (UV method). For every 15 minutes interval the sample was taken and analyzed using UV-Visible spectrophotometer (Shimadzu model 160 A). The UV visible spectra of the samples were recorded in the wavelength range from 200nm to 800nm. The absorption maximum is observed at 485nm for Acid Orange 7 and at 565nm for Acid Blue 113. The difference in absorbance of the reference and sample gives the percentage of decolorization of the dyes.

3. Result

3.1. Effect of dye concentration

It is evident from the Fig 1 and 2 that the decolorization of Acid Orange 7 and Acid Blue 113 were decreased with increase in concentration. The concentration of Ferrioxalate and H_2O_2 were kept constant for all the experiments.Hence the same quantities of hydroxyl radicals were generated in all the experiments. When the concentration of dye is low, sufficient decolorization was obtained.

However when the concentration of the dye was increased to 100ppm the hydroxyl radicals were insufficient to decolorize dyes in the desired time of one hour.For the high dye concentration, the penetrations of photons are difficult, thereby decreasing the hydroxyl concentration which results in low decolorization.



3.2 Effect of pH

The experiments were carried out at different pH ranges 3,5 and 10 , for the dye concentration of 30ppm,Hydrogen peroxide dosage 30%(V/V) of 1.5mM and Iron dosage of 1.5mM.At low pH of 3, very low decolorization was obtained. At pH 5, the highest value of decolorization was achieved. At pH 10, the color removal capacity was decreased. This is due to the formation of ferric hydroxo complex during the reaction, which blocks the decomposition of hydrogen peroxide, catalyzed by the ferrous ion.

Table 1.Effect of pH for Acid Orange 7

[1] pH	[2] Solar [3] (% decolorization)	[4] UV [5] (% decolorization)
[6] 3	[7] 82	[8] 86
[9] 5	[10] 92	[11] 98
[12] 10	[13] 86	[14] 89

3.3 Effect of Hydrogen Peroxide dosage

The objective of this method is to select the best operational dosage of H_2O_2 for the decolorization of dyes. The addition of H_2O_2 between 1mM and 2mM, decolourization increases and maximum decolorization was obtained at 1.5mM concentration. However an increase in the peroxide dosage, decolorization decreases. This is due to the scavenging of hydroxyl radical.

Table 3.Effect of peroxide dosage for Acid Orange 7

[15] Concentration of Peroxide (mM)	[16] Solar [17] (% decolorization)	[18] UV [19] (% decolorization)
[20] 1	[21] 72	[22] 76
[23] 1.5	[24] 85	[25] 97
[26] 2	[27] 73	[28] 85

Table 4.Effect of peroxide dosage for Acid Blue 113

[29] Concentration of Peroxide (mM)	[30] Solar [31] (% decolorization)	[32] UV [33] (% decolorization)
[34] 1	[35] 70	[36] 74
[37] 1.5	[38] 87	[39] 94
[40] 2	[41] 74	[42] 85

3.4 Effect of Iron dosages

The results indicate that the extent of decolourization increases with higher iron concentration.

Table 5. Effect of Iron dosage for Acid Orange 7

[43] Concentration of Fe^{3+} (mM)	[44] Solar [45] (% decolorization)	[46] UV [47] (% decolorization)
[48] 0.1	[49] 62	[50] 66
[51] 0.15	[52] 85	[53] 92
[54] 0.2	[55] 81	[56] 87

Table 6.Effect of Iron dosage for Acid Blue 113

[57] Concentration of Fe^{3+} (mM)	[58] Solar [59] (% decolorization)	[60] UV [61] (% decolorization)
[62] 0.1	[63] 64	[64] 68
[65] 0.15	[66] 87	[67] 95
[68] 0.2	[69] 81	[70] 85

3.5 Effect of Time

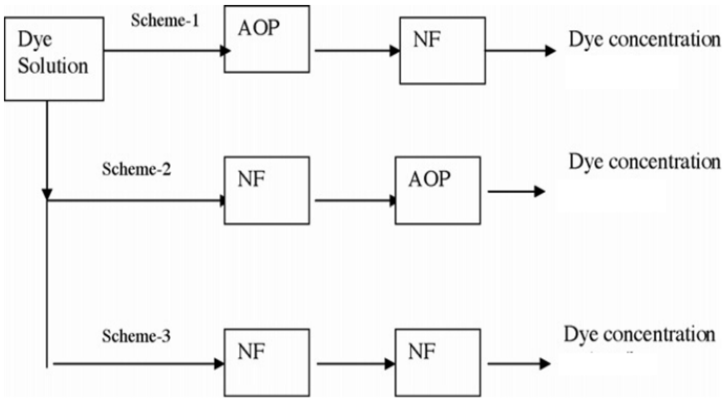
It is evident from all the above graphs and tables that the reaction time is very important in decolorization. As the reaction time increases decolorization also increases.

4. Conclusion

The decolorization of dyes is studied by Solar and UV methods using Ferrioxalate/H_2O_2. From the above study it can be concluded that these methods are highly efficient for the decolorization of dyes. These act as effective oxidizing agents by generating hydroxyl radical which plays an active role in decolorization.

5. Future work

In future studies, aim at combining advanced oxidation process with membrane separation process for effective degradation of dyes.



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