

Decolorized of Textile dye waste waters by Hydrogen peroxide, UV and Sunlight

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Abstract: In this study solar light and UV radiation were used to compared for efficiency of decolorization of textile wastewater containing of C.I. Direct Blue 177 (DB-177) dye. The effect of solution pH, temperature and present of H₂O₂ on percentage of decolourization were studied. The experimental results showed that decolorization percentage with UV radiation at 30 minutes in presence of 0.03M H₂O₂ and ambient temperature of 50°C was 99.8. For the same sample using solar light, the presence of hydrogen peroxide at a concentration of 5 times more and 3 times more time, a similar percentage was decolorization. Therefore, it is suggested that the decolorization of dye DB-177 is performed in the presence of ultraviolet radiation.

Key words: Decolorization of textile wastewater, Direct Blue color, Ultraviolet radiation.

Introduction

Azo dyes are used extensively in textile dyeing operations and contribute to problems associated with disposal of the wastewater generated from such operations. The industrial manufacturing of azo dyes and textile finishing processes generate wastewater streams contaminated with azo dyes. Some of the azo dyes are difficult to treat by conventional wastewater treatment methods¹⁻³. Usually, dye wastewater can be decolorized through conventional treatment such as coagulation with hydrolyzing metals followed by flocculation and filtration (or sedimentation plus filtration). But this conventional process produces a large amount of sludge which needs further disposal. On the other hand, adsorption onto activated carbon is also an effective method for color removal. However, activated carbon may have a very short life, depending on the initial color level and the nature of dyestuff. Regeneration of activated carbon is inefficient and very expensive. The other treatment method such as membrane filtration is also effective but very expensive⁴. The operating cost of disinfection of secondary effluent (99.9% faecal coliform reduction) by membrane filtration was much higher than ozone, UV or chlorine.

Conventional methods for water treatment (activated carbon adsorption, coagulation, flocculation, reverse osmosis and ultrafiltration) are non-destructive and just transfer contaminants from one phase to another and form secondary waste⁵. Recently, advanced oxidation processes (AOPs) have been used as techniques which are alternative to physico-chemical phase transfer methods. These techniques are successfully applied for the complete mineralization of organic pollutants in water⁶⁻⁸. AOPs involve different processes, such as H₂O₂/UV,

O₃/UV, H₂O₂/O₃/UV, TiO₂/UV, H₂O₂/Fe²⁺, UV/H₂O₂/Fe²⁺, H₂O₂/Fe³⁺, Fe²⁺/oxalate/ UV, H₂O₂/Fe³⁺/oxalate, H₂O₂/Fe³⁺/oxalate/UV, Mn²⁺/oxalic acid/O₃ and H₂O₂/Fe²⁺/Fe³⁺/UV. In these processes, a complex set of reactions occur, which imply generation of oxidizing species, such as OH• radicals and hydroperoxyl radicals⁹. These species, especially radicals that have an oxidation potential of 2.8 V, are powerful oxidizing agents able to degrade a variety of organic water contaminants¹⁰. Some of the advantages of use of UV/H₂O₂ in comparison to other AOPs are a considerably safe and easy operation, a reduction of the chemical oxygen demand (COD) and a short reaction time¹¹. The reaction of hydroxyl radicals, generated by photolysis of H₂O₂, with organic contaminant includes three different mechanisms: hydrogen abstraction, electrophilic addition, and electron transfer¹⁰.

The objective of this study was to investigate the efficiency of decolorization of the widely used textile azo dye C.I. Direct Blue 177 (DB177) with Solar light or UV radiation in the presence of H₂O₂ in a laboratory reactor. The decolorization rate of this process depends on many parameters, such as initial pH, initial azo dye concentration, initial H₂O₂ concentration, UV light intensity, which were varied in order to determine the optimal operating conditions.

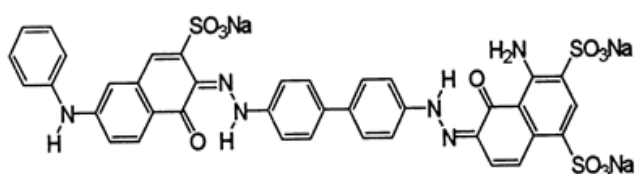
Experimental

Material

Hydrogen peroxide (30% w/w) was obtained from Merck Co (Germany). The dye Direct Blue 177 was obtained from Jasynt (India) and used without further purification. The characteristics of azo dye displayed in Table 1 and The chemical structure of the azo dye is shown in Fig. 1.

Table 1: The characteristics of azo dye studied in this study

Azo dye	Formula	λ max (nm)	MW	Dye contents (%)
C.I. Direct Blue 177	C ₃₈ H ₂₅ N ₆ Na ₃ O ₁₁ S ₃	586	906.81	95



C.I. Direct Blue 177

Fig. 1. The molecular structure of the azo dye (C.I. Direct Blue 177)

Sodium hydroxide and chloridric acid were purchased from Merck Co. All stock solutions were refrigerated and stored in the dark. All solutions were prepared with deionized water.

Apparatus

Instruments were pH meter (Methrom827 PH Lab), UV-Visible Spectrophotometer (VARIAN CARY 100) and Reactor for photo oxidation experiments. Investigations with ultraviolet irradiation were carried out inside 60 x 40 x 30 cm (length, height and width) constructed homemade wooden box reactor, using one UV lamps of 30 W, with main irradiation wavelength of 254 nm (Fig. 2).



Fig. 2: UV radiation constructed reactor box

The experiments of solar irradiation were carried out using quartz tubes that contained 3 mL of wastewater. The tubes were kept at an angle of approximately 45° in all experiments. The experiments have been done under sunshine between 12:00 a.m and 4:00 p.m in May 2013 (temperature between 40-45 °C). The efficiency of the processes was evaluated by monitoring the dye decolorization and photo degradation as can be seen in Fig.3 at the maximum wavelength of absorption 586 nm. The percentage of color removal was calculated with the equation:

$$\text{Percentage of decolorization} = 100 - (\text{absorbance at } \lambda \text{ max of dye in certain time / initial absorbance at } \lambda \text{ max of dye}) \times 100$$

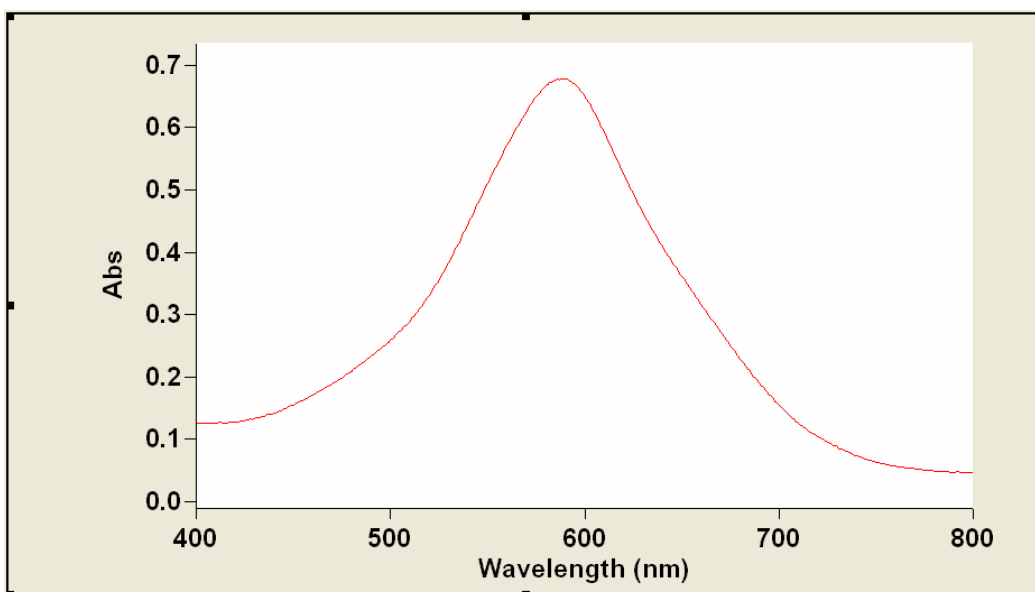


Fig. 3: Spectra of dye (C.I.Direct Blue 177)

Procedure

Optical absorption spectra on azo dye were determined by a Cray 100 spectrophotometer. The wavelength of maximum adsorption for azo dye were selected for quantitative analysis.

In the case of samples without hydrogen peroxide, 20 ml of distilled water and 10 ml of dye solution mg / L, 90 (ratio 2: 1) mixtures, by using 1 M hydrochloric acid, pH was adjusted. Then 3 ml of the above solution poured into a quartz cell and irradiated with UV light or sunlight. In samples containing hydrogen peroxide, 10 ml of distilled water and 10 ml of dye solution mg / L, 90 and 10 ml of hydrogen peroxide 5/0 M (ratio 1:1:1) mix and by using interest 1 M hydrochloric acid, pH was adjusted. The amount of solution in 3 ml quartz cell and irradiated with UV light or sunlight and the absorbance was measured at 586 nm.

Results and Discussion

Determining optimum operating conditions of UV/H₂O₂ reactor

The samples were irradiated with UV light of changing pH, changing decolorized percent decolorized. The samples without hydrogen peroxide under UV radiation, the highest percentage in the decolorized 90 minutes, approximately 50% was observed in Ph 12(Fig.4). Adding hydrogen peroxide to the rays of UV, decolorized approximately 95% was achieved in 60 min pH 7,10 (Fig.5). Bleaching the same percentage in both pH 7 and 10, pH= 7 due to neutral pH=7 was considered as the optimal pH. Another factor is the amount of decolorized hydrogen peroxide concentration in the tests at pH 7 with different concentrations of hydrogen peroxide was carried out under the same conditions. Our results indicate that in the presence of 0.014 M hydrogen peroxide solution in the sample at 60 min, approximately 99 percent will be decolorized (Fig. 6).

Other parameters of the bleaching temperature environment .In order to obtain the optimum temperature tests in the same test above pH 7(in the absence of oxygen and in the presence of hydrogen peroxide in the presence of light at the end UV) was performed in which other parameters were fixed. Our results indicate that temperature alone has little impact on the decolorized samples Rngbrydr maximum of 90 minutes to 2 percent and the temperature is 50°C (Fig.7). Increases with increasing temperature and oxygen concentration at the same time, the percentage of decolorized samples increases. Drsdrngbry maximum at 90 min., which corresponds to 25% at 70 °C in the presence of 3/0 M is hydrogen peroxide (Fig.7). UV light in the presence of 014/0 Mm hydrogen peroxide, a maximum of 30 minutes Drsdrngbry 8/99 percent when the temperature is 50°C (Fig.8).

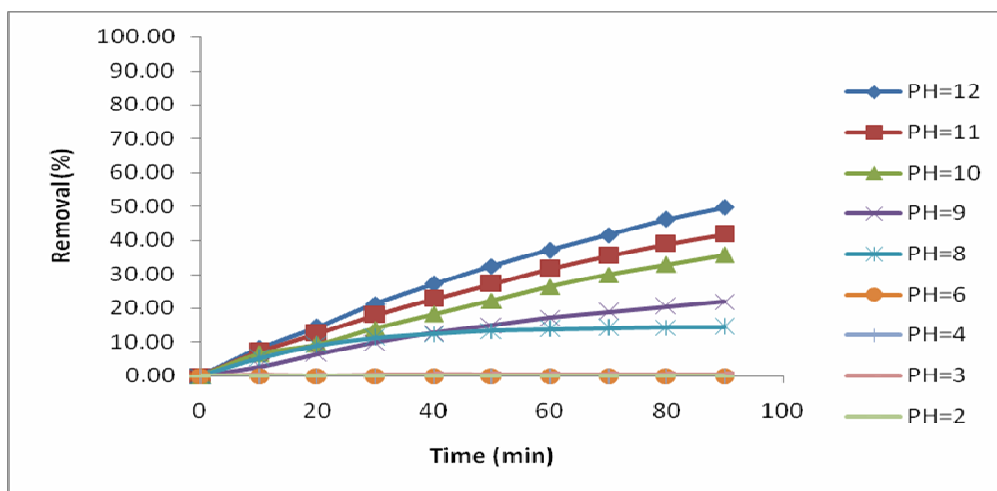


Fig.4: Diagram of UV irradiation decolorized without the presence of hydrogen peroxide at different pH

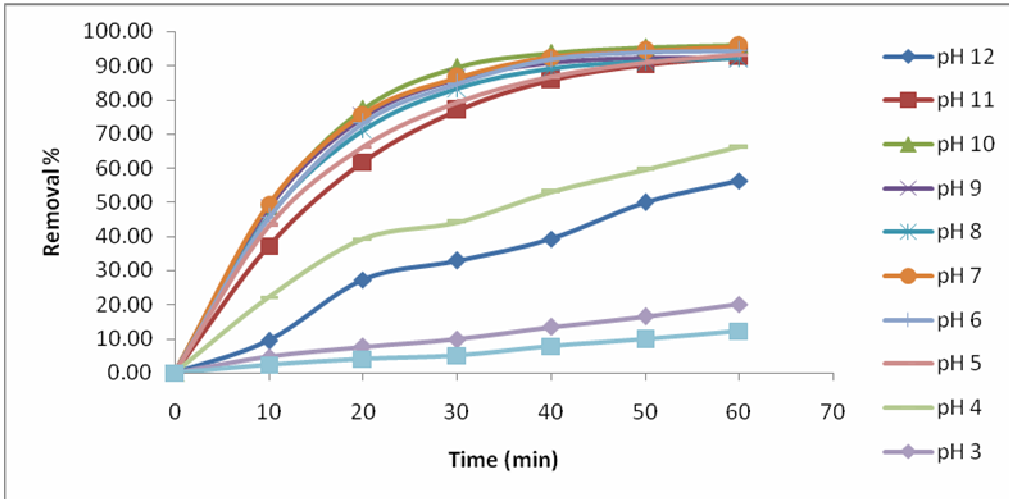


Fig.5: Diagram of the decolorized by UV radiation with the presence of hydrogen peroxide at different pH

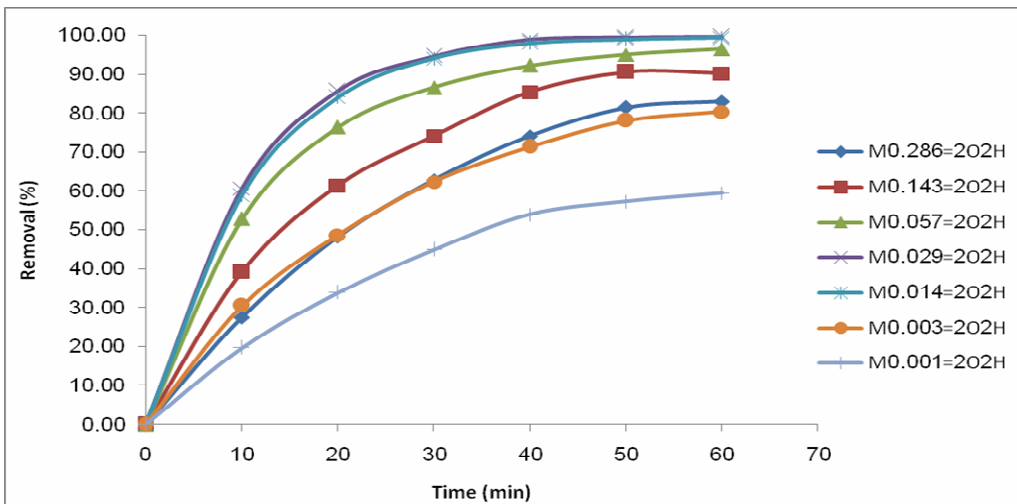


Fig.6: Diagram of the decolorized by UV radiation at pH = 7 and different concentrations of hydrogen peroxide

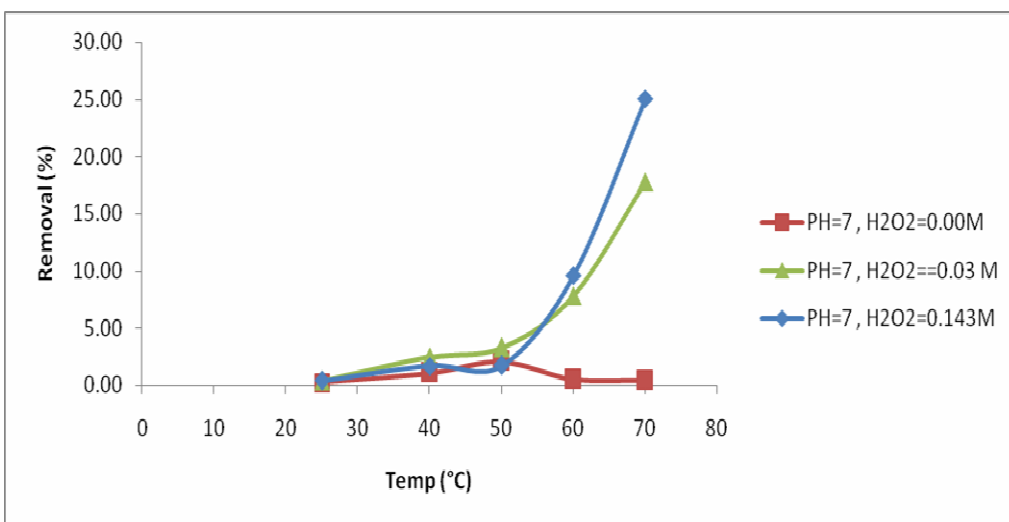


Fig.7: Diagram of the decolorized sample under UV irradiation changes according to temperature and oxygen concentration in the pH = 7 at 90 Minutes

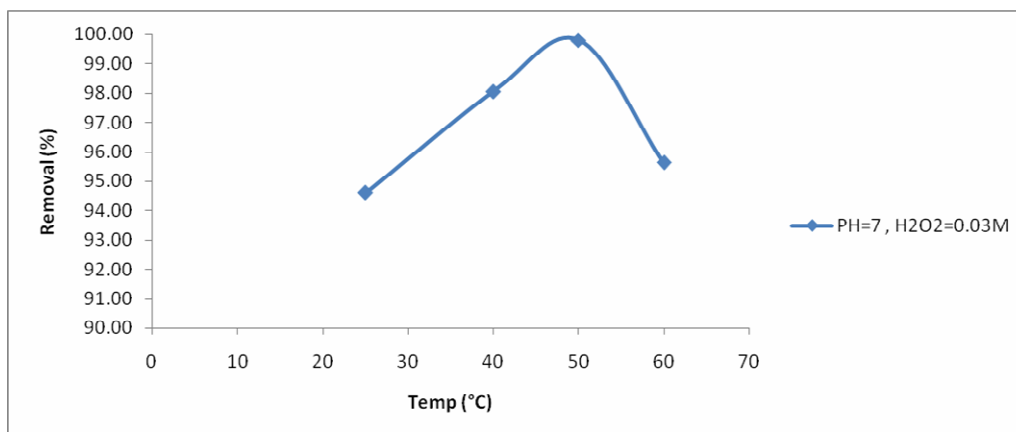


Fig.8: Diagram of the decolorized samples under UV irradiation in the presence of 0.014 M hydrogen peroxide according to changes in temperature in the pH = 7 at 30 Minutes

Determining optimum operating conditions of Solar light/H₂O₂

Decolorization by the sun, was not observed in any of the pH to the knockout. In the presence of 0.143 M solution of hydrogen peroxide, bleach after 90 minutes to a maximum of 1/97 at the pH = 4 and a minimum of 1/40 percent is at pH = 10. In order to obtain the optimal concentration of hydrogen peroxide, the tests were repeated at pH 4 and different concentrations of hydrogen peroxide. Bleaching achieved at 90 min and 0.143 M is hydrogen peroxide.

Conclusions

The solar light and UV radiation were used to compared for decolorization of textile waste water containing of C.I. Direct Blue 177 (DB-177) dye. The effect of solution pH, temperature and present of H₂O₂ on percentage of decolorization were studied. The experimental results showed that decolorization percentage with UV radiation at 30 minutes in presence of 0.03M H₂O₂ and ambient temperature of 50°C was 99.8. In this case, the presence of 0.143 M of hydrogen peroxid, caused maximum percent decolorization (97/1%).

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