Nature Environment and Pollution Technology *An International Quarterly Scientific Journal*	Vol. 8	No. 2	pp. 373-376	2009

Original Research Paper

Decolorization of Textile Wastewater by Solar Light and Ultraviolet Radiation

H. Tavallali, E. Asrari and S. Zarifian Hoveida
Payame Noor University (PNU), Shiraz, 71365-944, Iran

Key Words:
Decolorization
Textile wastewater
Dyes
Solar light
UV radiation

ABSTRACT

In this study solar light and UV radiation were used to decolourize textile wastewater samples that were green, purple and orange. The effect of them has also been investigated in presence of H_2O_2. The percentage of colour removal in maximum wavelength of each mixed dyes, that were made by using blue, red and yellow dyes, have been measured. The results have shown that purple and green dyes have maximum and minimum of decolorization percentage of 99.0 and 96.0 respectively with UV light at 90 minuets in presence of 0.5 M H_2O_2. By using solar radiation for these samples it can be seen that the maximum percentage of decolorization was 99.5 in presence of 0.5 M H_2O_2 which also happened for green dye after 4 hours. The colour removal of orange dye was the minimum under the above conditions.

INTRODUCTION

Many industries, such as dyestuffs, textile, paper and plastics use dyes in order to colour their products and also consume substantial volumes of water. As a result, they generate a considerable amount of coloured wastewater. It is recognized that public perception of water quality is greatly influenced by colour. Colour is the first contaminant to be recognized in wastewater (Banat et al. 1996). The presence of very small amounts of dyes in water (less than 1 ppm for some dyes) is highly visible and undesirable (Pearce et al. 2003). Over 100,000 commercially available dyes exist and more than 7×10^5 tones per year are produced annually (McMullan et al. 2001). Due to their good solubility, synthetic dyes are common water pollutants and they may frequently be found in trace quantities in industrial wastewaters. An indication of the scale of the problem is given by the fact that two percent of dyes that are produced are discharged directly in aqueous effluents (Robinson et al. 2001). Due to increasingly stringent restrictions on the organic content of industrial effluents, it is necessary to eliminate dyes from wastewater before it is discharged. Many of these dyes are also toxic and even carcinogenic and this poses a serious hazard to aquatic living organisms (O'Neill et al. 1999). However, wastewater containing dyes is very difficult to treat, since the dyes are recalcitrant organic molecules, resistant to aerobic digestion, and are stable to light, heat and oxidizing agents (Sun & Yang 2003). During the past three decades, several physical, chemical and biological decolorization methods have been reported and chemical oxidation was very effective but the efficiency strongly influenced by the type of oxidant.

Removal of synthetic dyes from wastewaters by photocatalytic depolarization of synthetic and real textile wastewater containing benzidine-based azo dyes has been studied by Erick et al. (2008). They found that depending on the wastewater type and effluent application after the photoassisted process, the effluents with the characteristics of synthetic wastewater tested in this work can be completely decolourized using 4 m^2 in 1 h of solar irradiation.

Bleaching and photodegradation of textile dyes by H_2O_2 and solar or ultraviolet radiation has been studied by Francisco et al. (2004). The efficiency of photooxidation was compared using hydrogen peroxide (30%) as a bleaching reagent, solar and ultraviolet radiation, common glass borosilicate, quartz assay tubes, and no solid catalysts. The colour of blue dye and a mixture of blue and red dyes were almost completely removed after 3 h, either by solar or ultraviolet radiation. The best results of colour removal (93%) for the red and yellow dyestuffs were obtained only after 6 h, using quartz tubes, hydrogen peroxide and ultraviolet radiation. This present paper deals with the decolourization of textile dyes by use of solar light and ultraviolet radiation with and without the presence of hydrogen peroxide.

MATERIALS AND METHODS

Samples of main textile dyes, that the mixed dyes made by them, were collected from wastewater of Shadilon Industry in Mashhad, North West city in Iran. The main dyestuffs were collected directly at the dye machines, located before the mixture of several effluents, and also before discharging of effluents into a small stream at the back yard of the textile industry.

The experiments of solar irradiation were carried out using quartz tubes that contained 0.5 mL of H_2O_2 and 2 mL of wastewater. The tubes were kept at an angle of approximately 45° in all experiments. The experiments have been done under sunshine between 8:00 a.m. and 4:00 p.m. in July 2007 (temperature between 30-40°C). Investigations with ultraviolet irradiation were carried out inside 60 × 40 × 30 cm (length, height and width) constructed wooden box reactor, using three parallel UV lamps of 30 W, with main irradiation wavelength of 254 nm (Fig. 1). The quartz tubes were also kept at an angle of 45° inside the reactor, and aluminium foils were used to cover the entire reactor internal wall. For the economic reason of textile industry, the experiments with solar irradiation were performed without temperature control.

The dyestuffs from the dyeing machines were mixed for making new colour, diluted with distilled water (1:10) before the absorbance measurements at the maximum wavelengths. The efficiency of the processes was evaluated by monitoring the dye decolorization and photodegradation as can be seen in Fig. 2 at the maximum wavelength of absorption: 605 nm (green), 550 nm (purple) and 520 nm (orange**)**. The photodegradation processes at certain wavelength of all dyestuffs, with a Perkin Elmer (lambada 2) spectrophotometer were also performed. The percentage of colour removal was calculated with the equation:

Percentage of decolorization = 100 **-** (absorbance at λ_{max} of dye in certain time/initial absorbance at λ_{max} of dye) × 100

RESULTS AND DISCUSSION

Variations of pH in presence of UV light can be seen in Fig. 3. Maximum percentage of decolorization was 94.1% in presence of 5 mL H_2O_2 at pH 2 for green dye. At the same conditions, down trend variation of pH caused increasing percentage of colour removal for orange dye from 54.3 to 81.5%. This variation happened for purple dye from 1.1% to 87.0%.

Fig. 4 has shown the effect of colour removal with solar light and it happened when pH was 2. The percentages of colour removal were 93.7, 90.2 and 87.2 for green, purple and orange dyes, respectively.

Colour removal of orange and purple dyes was almost complete after 90 minutes of UV irradia-

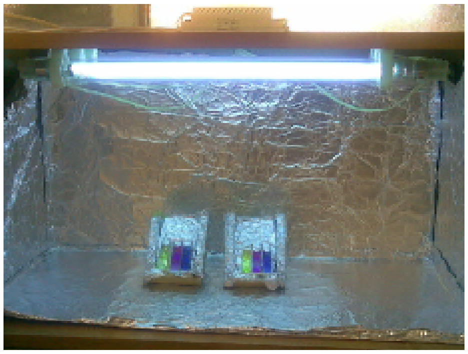

Fig. 1: UV radiation constructed reactor box.

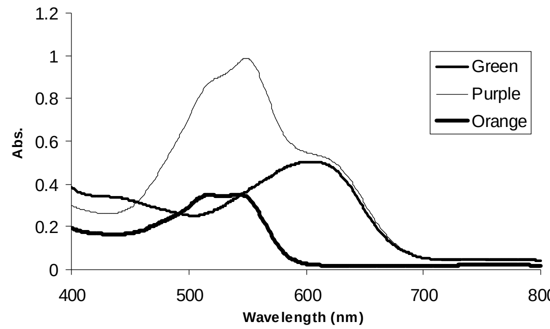

Fig. 2: Spectra of three mixed dyes.

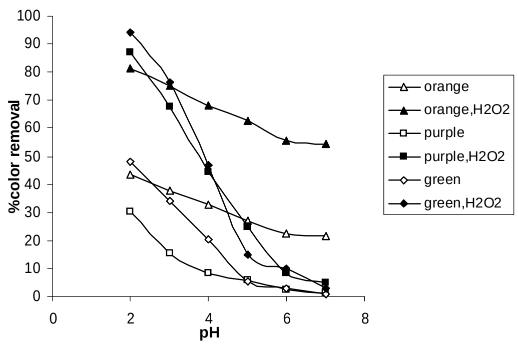

Fig. 3: Effect of pH on color removal percentage of dyes by UV radiation in 90 minutes.

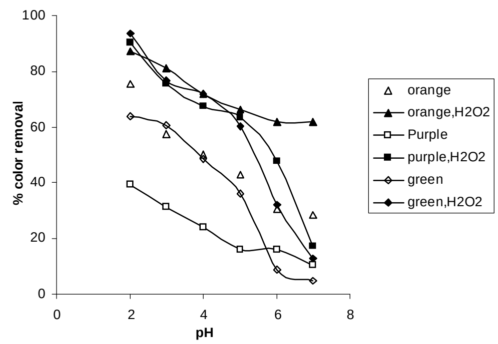

Fig. 4: Effect of pH on color removal percentage of dyes by solar light in 4 hours.

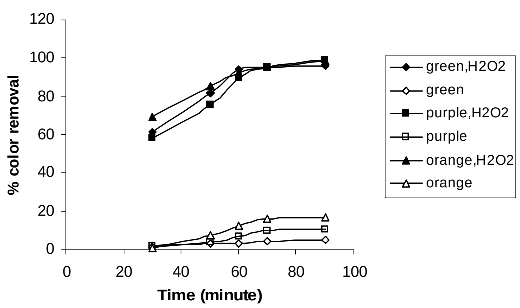

Fig. 5: Effect of time on color removal percentage of dyes by UV radiation.

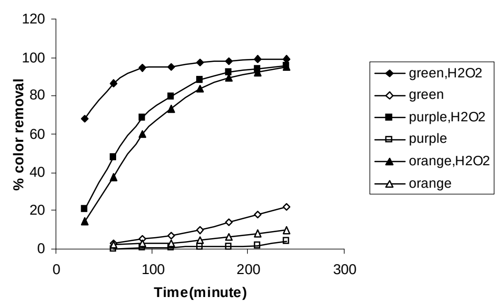

Fig. 6: Effect of time on color removal percentage of dyes by solar light.

tion using 0.5 M hydrogen peroxide as reagent (Fig. 5). Decolorization of them was 98.1% and 99% respectively. The efficiency of colour removal of green dye was 96.0% under same conditions. Decolorization of dyes by UV radiation in absence of hydrogen peroxide can be seen in Fig. 5.

Using the best experimental conditions by solar light, presence of 5M 0.5 mL H_2O_2 made the colour removal of green complete after 4 hours with the best result achieved as 99.5% of decolorization. On the other hand, orange and purple dyes decolourized with the maximum efficiency of 95.3% and 95.8% respectively as shown in Fig. 6.

Ultraviolet and solar radiation with hydrogen peroxide as a bleaching reagent, proved to be efficient to complete decolorization of the dyes investigated. Orange and purple dyes required 4 h for colour removal by solar light, and efficiency was around 95%. This time reduced to 90 minutes when using UV radiation and efficiency increased to 98 percent.

Although less efficient than solar light, UV radiation was capable of removing the colour of green dye after 90 min to the level of around 95.0%.

REFERENCES

Banat, I.M., Nigam, P., Singh, D. and Marchant, R. 1996. decolorization of textile-dye-containing effluents: A review. Biores. Technol., 58: 217-127.

Erick, R. Bandala, Miguel, A. Pel´aez, A. Javier Garc´1a-L´opez, Maria de J. Salgado, Gabriela Moeller 2008. Photocatalytic decolorization of synthetic and real textile wastewater containing benzidine-based azo dyes. Chemical Engineering and Processing, 47: 169-176

Francisco, A.P., Costa, A., Edson, M., dos Reis A., Julio C.R. Azevedo B. and Jorge Nozaki, 2004. Bleaching and photodegradation of textile dyes by H_2O_2 and solar or ultraviolet radiation. Solar Energy, 77: 29-35.

McMullan, G., Meehan, C., Conneely, A., Kirby, N., Robinson, T., Nigam, P., Banat, I.M., Marchant, R., Smyth, W.F. 2001. Microbial decolorization and degradation of textile dyes. Appl. Microbiol. Biotechnol., 56: 81-87.

O'Neill, C., Hawkes, F.R., Hawkes, D.L., Lourenco, N.D., Pinheiro,H.M., Dele´e, W. 1999. Color in textile effluents - sources, measurement, discharge consents and simulation: A review. J. Chem. Technol. Biotechnol., 74: 1009-1018.

Pearce, C.I., Lloyd, J.R. and Guthrie, J.T. 2003. The removal of color from textile wastewater using whole bacterial cells: A review. Dyes Pigments, 58: 179-196.

Robinson, T., McMullan, G., Marchant, R. and Nigam, P. 2001. Remediation of dyes in textile effluent: A critical review on current treatment technologies with a proposed alternative. Bioresour. Technol., 77: 247-255.

Sun, Q. and Yang, L. 2003. The adsorption of basic dyes from aqueous solution on modified peat-resin particle. Water Res., 37: 1535-1544.