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COMPARISON OF DECOLORIZATION OF INDUSTRIAL WASTE-WATER BY H_2O_2 AND SOLAR OR ULTRAVIOLET RADIATION

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Key words :

ABSTRACT

The degradation of the dye in coating metal manufacturing wastewater was investigated in laboratory-scale experiments, using photooxidation techniques in the effect of pH; contact time and H_2O_2 concentration were investigated. The efficiency of photooxidation were compared using hydrogen peroxide (30%) as a bleaching reagent, solar and ultraviolet radiation, common glass borosilicate, quartz tubes, and no solid catalysts. Thus, this appears aimed to propose the method for remedying industrial effluent by UV/H_2O_2, solar/ H_2O_2, UV and solar without H_2O_2.

INTRODUCTION

With the increase of industrialization and urbanization, the requirement of removal of toxic pollutants in the ppm or ppb level from industrial wastewater and contaminated groundwater is increasingly becoming significant. It is necessary to develop novel and cost-effective technologies to treat this wastewater (Dutta*et al.* 2001). During the some manufacturing processes, a large amount of wastewater containing dyestuffs with intensive color and toxicity can be introduced into the aquatic systems. It also contains high concentrations of organic matter, non-biodegradable matter, toxic substances, detergents and soaps, oil and grease, sulfide, sodas and alkalinity (Francisco *et al.* 2004). A variety of physical, chemical, and biological methods are presently available for treatment of wastewater discharged from various industries. Biological treatment is a variety technology and cost-effective, but it suffers from a number of disadvantages. Physical methods such as liquid–liquid extraction, ion-exchange, (Manahan, 2000), adsorption, (Gode and Pehlivan, 2006) air or steam stripping, etc, are also ineffective on pollutants which are not readily adsorb able or volatile, and have further disadvantage that they simply transfer the pollutants to another phase rather than destroying them. In contrast, chemical oxidation methods can result in almost complete mineralization of organic pollutants and are effective for wider range of organics. Recently, there has been considerable interest in utilization of advanced oxidation processes (AOPs) for destruction of organic compounds (Legrini *et al.* 1993 and Neamtu *et al.* 2004). The hydroxyl radicals produced by AOPs as oxidizing agents are capable of mineralize many synthetic organic chemicals (Shu *et al.* 1994 and Galindo and Kalt, 1999). Hydrogen peroxide is increasingly favored as an environmentally acceptable bleaching agent both in domestic and industrial situations. The combination of hydrogen peroxide as a bleaching agent, and solar or ultraviolet radiation were used for photochemical degradation of dyes (Francisco *et al.* 2004).

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MATERIALS AND METHODS

Reagents sample of coating metal manufacturing were collected from Shiraz Industrial State which is located in the south of Iran.

Apparatus

Instruments were pH meter (Jenway3510), UV-Visible Spectrophotometer (Perkin Elmer Lambada2) (400-1000nm), Spectrophotometer (Jenway6305) and Reactor for photooxidation experiments. Batch tests were set for every experiments and performed in the laboratory at room temperature. The steps of the experiments were described below:

Photocatalytic decolorization and oxidation of dyes

Some dyes are designed to resist photodegradation, so the selection of optimal photocatalytic conditions for the decolorization of dyes requires considerable expertise.

Because of the significant commercial and environmental interest the efficacy of a large number of catalysts and irradiation conditions has been established for the decolorization of various dyes.

Photocatalysis and oxidation with hydrogen peroxide

The goal of any AOPs design is to generate and use hydroxyl free radical (HO) as strong oxidant to destroy compound that can not be oxidized by conventional oxidant. Advanced oxidation processes are characterized by production of OH* icals and selectivity of attack which is a useful attribute for an oxidant (Ganesan *et al.* 2008). Hydrogen peroxide has been frequently applied to the decolorization of dyes in waters, (Legrini *et al.* 1993) also a UV/H_2O_2 oxidation process has been used for the decolorization of coating metal manufacturing wastewaters. UV irradiation combined with hydrogen peroxide treatment was used for the decolorization of the coating metal manufacturing dyes.

First we determined λ_{max} with UV-Visible Spectrophotometer of coating metal manufacturing wastewater. Diluted solutions because absorbance were bigger than 1. Experiments ultraviolet irradiation were carried out using quartz tubes, 1 mL of H_2O_2 (30%.0.5), 1 mL of wastewater and 1mL of water, and although all experiments with UV do without H_2O_2 (1 mL of wastewater and 2 mL of water) in various times intervals from 30 min until 150 min. The final concentrations of hydrogen peroxide of approximately 0.5, 0.7, 1, 1.5 M in various times intervals from 10 min until 70min.The quartz tubes were also kept at an angle of 450 inside the reactor and aluminum foils were used to cover all the reactor internal wall (Fig 1).

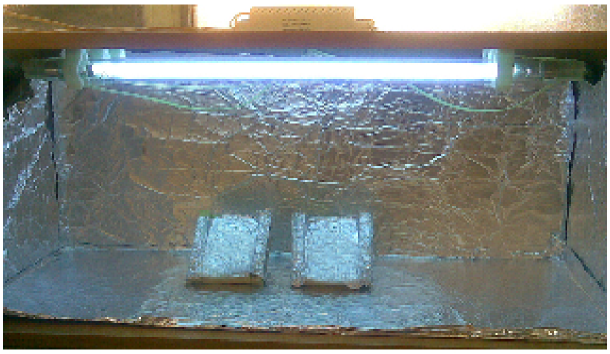

Fig. 1 Reactor used for photooxidation experiments

The experiments of solar irradiation were carried out using glass tubes, 0.5 mL of H_2O_2 (30%, 0.5M), 2 mL of wastewater, 0.5 mL of water, although all experiments with solar do without H_2O_2 (2 mL of wastewater and 1mL of water) in various times intervals from 60 min until 180 min. The final concentrations of hydrogen peroxide is approximately 0.5, 0.7, 1, 1.5 M in various times intervals from 0 min to 180 min. The tubes were kept at an angle of approximately 450 in all the intensity of solar light was measured using a spectrophotometer UV (Perkin Elmer) various time intervals between 11:00 a.m. and 4:00 pm, in April/2009 at the Laboratory, Payame Noor University, Iran.

RESULTS AND DISCUSSION

Effect of contact time

From an economical point of view, the contact time required to reach equilibrium is an important parameter in the wastewater treatment. The efficiency of dye removal was increased as the contact time increased. The adsorption of coating metal manufacturing wastewater dyes by UV/H_2O_2 ,UV without H_2O_2 and solar irradiation/ H_2O_2 , solar irradiation without H_2O_2 studied as a function of contact time in order to determine the equilibrium time. The amount of decolorization, increases with contact time. In 30, 60, 90, 120 and 150 min of reaction time, 70, 72, 78, 81 and 85% of decolorization were achieved while hydrogen peroxide of 0.5M, respectively for UV. Although all experiments with UV do with H_2O_2 and without H_2O_2. Indeed in 60, 90, 120, 150 and 180 min of reaction time, 45, 50, 55, 59 and 63% of decolorization were achieved while hydrogen peroxide of 0.5M, respectively for solar irradiation. Although all experiments with solar irradiation do with H_2O_2 and without H_2O_2. UV irradiation was better than solar radiation in effect of contact time for decolorization.

Fig. 2 Effect of contact time on the decolorization of coating metal wastewater

Effect of initial pH

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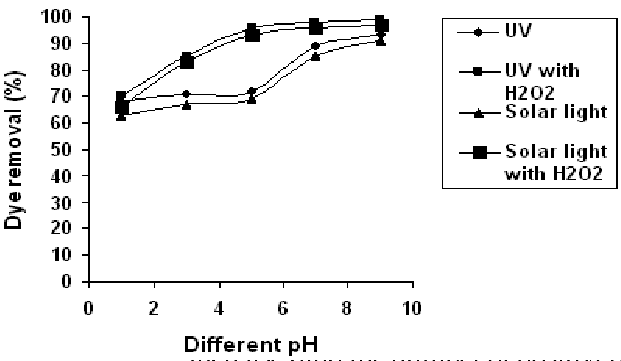

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Fig. 3 Effect of pH on the decolorization of coating metal wastewater

The effect of hydrogen peroxide concentration on decolorization

Based on previous studies of the authors, the optimal hydrogen peroxide concentration was obtained for the dye decolorization of various dyes in laboratory scale by UV/H_2O_2 process and solar irradiation ter (Dutta*et al.* 2001). The maximum absorption wavelength (λ_{max}) for coating metal manufacturing wastewater dye was determined to be 960 nm. At regular time intervals samples were collected and analyzed by UV-vis spectrophotometer to determine the decolorization rate. When hydrogen peroxide is applied simultaneously with UV irradiation there is a drastic increase in the decolorization reaction rate. In our recent work we have reported the effect of initial H_2O_2 dosage on the decolorization of the coating metal manufacturing wastewater dye. The rate of dye degradation increases with increasing concentrations of H_2O_2 up to a threshold value, above which it declines, exhibiting typical inhibition. This phenomenon could be explained by considering the two opposing effects of H_2O_2 in the photo oxidation reaction. When increasing quantities of H_2O_2 are added to the solution, the fraction of light absorbed by the photo-decomposition increases, and consequently, so does its photolysis rate. More hydroxyl radicals are available for dye oxidation reactions (Dutta*et al.* 2001) and (Francisco *et al.* 2004).

$H_2O_2 \rightarrow 2\,OH^*$ (1)

Coating metal manufacturing wastewater $+OH^* \rightarrow$ products (2)

If additional of H_2O_2 is used, H_2O_2 acts as a scavenger of highly reactive OH* free radicals to form peroxyl radicals and oxygen (reactions (3) and (4)), which are much less reactive. In addition, OH* radicals, generated at high local concentration, will readily dimerize to H_2O_2 (reaction (5).

$H_2O_2 + OH^* \rightarrow 2OH^* + H_2O$ (3)

$OH^* + 2\,OH^* \rightarrow H_2O + O_2$ (4)

$OH^* + OH^* \rightarrow H_2O_2$ (5)

So that H_2O_2 in excess contributes to the OH*scavenging capacity and reduces the efficiency of the color degradation. When the relative quantity of H_2O_2 to that of the dye in the mixture is higher than the "most effective level", which yields maximum dye degradation, a competition for OH*is anticipated (Marco and Jose, 2007).

Fig. 4 Effect of H_2O_2 concentration on the decolorization of coating metal wastewater by UV process

Fig. 5 Effect of H_2O_2 concentration on the decolorization of coating metal wastewater by solar radiation process

In this study, in 0, 10, 20, 30, 50 and 70 min of reaction time, with hydrogen peroxide concentration (0.5, 0.7, 1, 1.5 M) was increased from 39 until 82% of decolorization for UV.

Indeed in this study, in 0, 60,120 and 180 min of reaction time, with hydrogen peroxide concentration (0.5, 0.7, 1, 1.5 M) was increased from 41 until 78% of decolorization for solar irradiation. UV irradiation was better than solar radiation in effect of H_2O_2 concentration for decolorization.

CONCLUSION

Ultraviolet and solar radiation with hydrogen peroxide as a bleaching reagent, using either glass or quartz tubes proved to be efficient to complete decolorization of the coating metal manufacturing wastewater investigated. When hydrogen peroxide is applied simultaneously with UV irradiation and solar radiation there is a drastic increase in the decolorization reaction rate. The efficiency of dye removal was increased as the contact time. The decolorization capacity for dyes increased when the initial pH was increased. UV irradiation exhibits very good decolorization from wastewater into solar radiation.

REFERENCES

Dutta, Kabita, Subrata Mukhopadhyay, Sekhar Bhattacharjee and Basab Chaudhuri, 2001. Chemical oxidation of methylene blue using a Fenton-like reaction. B84 : 57-71.

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

Manahan, S.E. 2000. *Environmental Chemistry*. 7th ed., CRC Press, Boca Raton,

Gode, F. and Pehlivan, E. 2006. Removal of chromium (III) from aqueous solutions using Lewatit S 100: the effect of pH, time, metal concentration and temperature. *J. Hazard. Mater*. 136 (2) : 330-337.

Legrini, O, Oliveros, E. and Braun, A.M. 1993. Photochemical processes for water treatment. *Chem Rev*. 93 : 671-98.

Mariana Neamtu, Ayfer Yediler, Ilie Siminiceanu, Matei Macoveanu, Antonius Kettrup, 2004. Decolorization of disperse red 354 azo dye in water by several oxidation processes-a comparative study. 60 : 61 - 68.

Shu, H.Y., Huang, C.R. and Chang, M.C. 1994.Decolorization of mono-azo dyes in wastewater by advanced oxidation process: a case study of Acid Red 1 and Acid Yellow 23. *Chemosphere*. 29 : 2597-2607.

Galindo, C. and Kalt, A. 1999. UV/H_2O_2 oxidation of azo dyes in aqueous media: evidence of a structure-degradability relationship. *Dyes Pigments*. 42 : 199-207.

Ganesan, R., Thanasekaran, K. and Latha, A. 2008. Treatment of textile wastewater by advanced oxidation process - a review. (ICENV 2008)

Esther Forgacsa, Tibor Cserha´tia, Gyula Orosb, 2004. Removal of synthetic dyes from wastewaters: a review. 30 : 953- 971.

Zümriye Aksu, 2005. Application of biosorption for the removal of organic pollutants: a review. *Process Biochemistry*. 40 : 997-1026.

Marco, S., Lucas, Jose´ and Peres, A. 2007. Degradation of Reactive Black 5 by Fenton/UV-C and ferrioxalate/ H_2O_2/solar light processes. 74 : 622e629.