ADVANCED TREATMENT OF TEXTILE WASTEWATER AND ITS COST BY H_2O_2/UV OXIDATION PROCESS

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ABSTRACT

Different parameters were investigated to evaluate their effect on the process removal efficiency of COD and color, by using different H_2O concentration, UV power, multi-step addition of H_2O_2, and air bubbling. As a result, the color can be removed completely within 20 minutes, and the COD removal of approximately 90% can be achieved within 40 minutes of UV illumination. This process favors the H_2O_2 addition in one step rather than in four steps. Supply of oxygen does not enhance the process removal efficiency. The overall result indicates that the operating cost (chemical and electricity) to reduce the COD to below 80 mg/ l is 0.93 US$/m^3.

الخلاصة

يهدف البحث الى دراسة ومعرفة العوامل المؤثرة على كفاءة ازالة الـ (COD) واللون من المياه الصناعية لمعامل النسيج .

تم استخدام تراكيز مختلفة في بيروكسيد الهيدروجين وكذلك دراسة تأثير قدرة الاشعة الفوق البنفسجية المستخدمة ودراسة تأثير استخدام الفقاعات الهوائية على كفاءة الاكسدة وازالة اللون .

تم الحصول على نتائج جيدة في ازالة اللون حيث تمت ازالة اللون بصورة تامة في مدة (20) دقيقة وتحقيق نسبة ازالة للـ COD بمقدار 90% في حدود (40) دقيقة من التعرض للـ UV . كذلك وجد ان استخدام الهواء لا يعزز كفاءة الازالة وان كلفة عملية الازالة وتقليل الـ COD الى اقل من 80 mg/lit هو 0.93 $/m^3 .

KEYWORDS

COD, oxidation, photoreactor.

INTRODUCTION

The environmental concern of textile wastewater discharges is mainly on their high chemical oxygen demand (COD) as well as high strength of color content [Liao and other, 1997]. according to the new discharge standards of 1998, textile industries are required by Ministry of Environment standard to comply with the COD less than 100 mg/l and color less than 400 in American dye Manufacturer institute (ADMI) units. Typical processes for textile wastewater treatment includes biological activated sludge oxidation and post coagulation, followed by chemical oxidation of the final affluent by sodium hypochlorite (NaOCL) for color removal purpose [Liao and other, 1997], [Liao and other,]. According to our preliminary investigation, such processes were inadequate in

compliance with the COD discharge requirement. Although color can meet the discharge standard after hypochlorite oxidation, the toxicity of chlorinated oxidation products might pose a threat to aquatic life [Liao and other, 1997].

In this study, H_2O_2/UV oxidation process was employed to see how it resolves the above issues of concern. This photochemical process can generate hydroxyl radicals of very strong oxidizing power, leading to complete destruction of organic contaminants into innocuous products such as carbon dioxide, water, and other non – hazardous halide ions. As reported, this process has been successfully applied in the treatment of dye manufacturing wastewater (Liao et al., 1997) and n-chlorobutane contaminated natural waters (Liao and Gurol, 1995). It appears very attractive to use H_2O_2/UV process as an advanced treatment of textile wastewater as well. Therefore, the purpose of this study was emphasized on the capability as well as on the operating cost of H_2O_2/UV process to meet the discharge standards. The textile wastewater samples used in this study were taken from biologically treated effluent of Al-Koot textile company. Different parameters were investigated to evaluate their effect on the process removal efficiency of COD and color, including H_2O_2 concentration, UV power, multi-step additional of H_2O_2, and air bubbling.

EXPERIMENTAL WORK AND PROCEDURE

In this study, a recirculated photoreactor was used for the removal of COD and color from textile wastewater samples, as shown in **Fig. (1),** the photoreactor system consist of reactor chamber (single reactor and 6 reactors in series), wastewater sample tank, and air/water pumps. The single UV lamp of 14 watts located centrally in the single reactor and a high wavelength of 245 nm primarily. Not that the volume for each reactor was 0.68 liter.

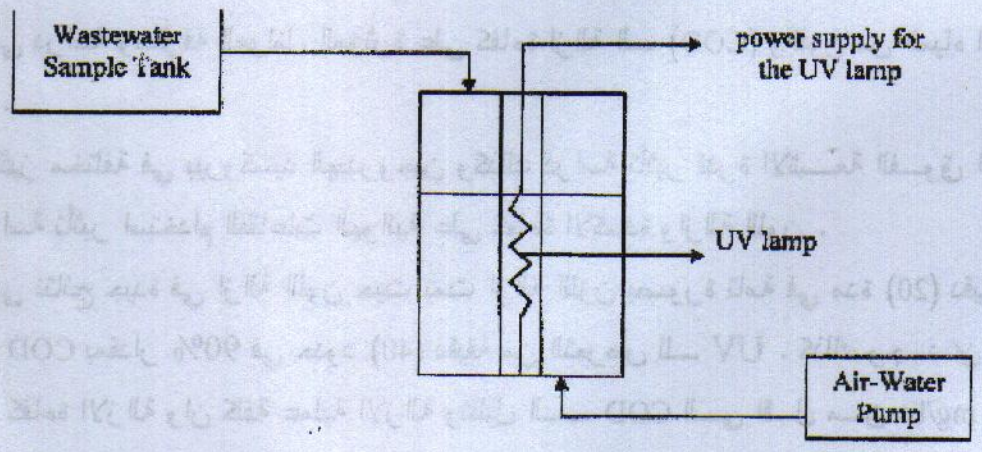

Fig. (1) Experimental Set-up of recirculated photoreactor

The textile wastewater samples used in this study were taken from biologically treated effluent. These samples after analysis presented PH = 7.2, COD = 168 mg/l, color = 420 in ADMI unit. In order to fulfill the goal of this study, parameters investigated for their effected on the process removal efficiency of COD and color from the above samples included H_2O_2 concentration, UV power, multi-step addition of H_2O_2, and air bubbling. The process efficiency of different operating conditions. Note that the operating cost defined in this study consist of costs of both H_2O_2 and electricity consumption for UV irradiation.

The detection of DMI color value was based on ADMI Tristimulus Filter Method (Method 2120E in Standard Methods, 1995). The light transmittance at three different wavelengths of 590, 540, and 438 mm were measured for further ADMI value calculation, using pre-installed

computing software. The COD was measured according to the procedure described in method 5220C in standard method (1995). The H_2O_2 concentration was determined by potassium (IV) oxalate method (Sellers, 1980).

RESULTS AND DISCUSSION

Effect of [H_2O_2] on COD Removal

Fig. (2) shows the COD removal under three different H_2O_2 dosages of 187, 374, 561 mg/l and two control conditions of UV alone and H_2O_2 alone. As can been seen the COD present in the textile wastewater sample can resist to H_2O_2 oxidation as well as to UV irradiation. It can only be removed when H_2O_2 and UV light photons are simultaneously existent in the solution. It was observed that the COD removal increase with the increasing H_2O_2 dosage, which ranges, which ranges from 187 to 561 mg/l. the maximum removal efficiency of approximately 90% was obtain at sampling time of 120 min. Hence, this time represent the optimum sampling time to achieve the highest efficiency degree which corresponds to 40 min of UV irradiation.

Concerning the color removal, **Fig. (3)** presents the removal profiles under the identical conditioned above. It was interesting to find that there appeared a single color decrease of approximately 20% at sampling of 120 min when the textile wastewater sample was irradiated by UV alone, without the presence of H_2O_2. Again, the color removal was affected significantly by the H_2O_2 dosage, the higher the H_2O_2 dosage, the higher the color removal. As illustrated in **Fig. (3),** complete color removal can be achieved within a short time period, which occurred at sampling time of approximately 60 min or UV irradiation time of 20 min.

Comparison of Process Efficiency between Different Process Conditions

According to the above result, further experiments were designed to compare the process removal efficiency under different conditions. As depicted in **Table (1),** six different process conditions were employed, including the combinations of one or six UV lamps, presence or absence of air supply, and one or four step addition of H_2O_2.

As shown in **Fig. (4),** it was found that all process conditions except C and F succeed to reduce COD to below 100 mg/l at sampling time of 120 min. this result indicates that step addition of H_2O_2 does not enhance the removal of COD at all. In addition, process conditions A and B (single UV reactor) depicts significant decrease of COD removal efficiency in the presence in the removal of COD whether air, whereas conditions D and E (six UV reactor in series) show no difference in the removal of COD air was supplied or not.

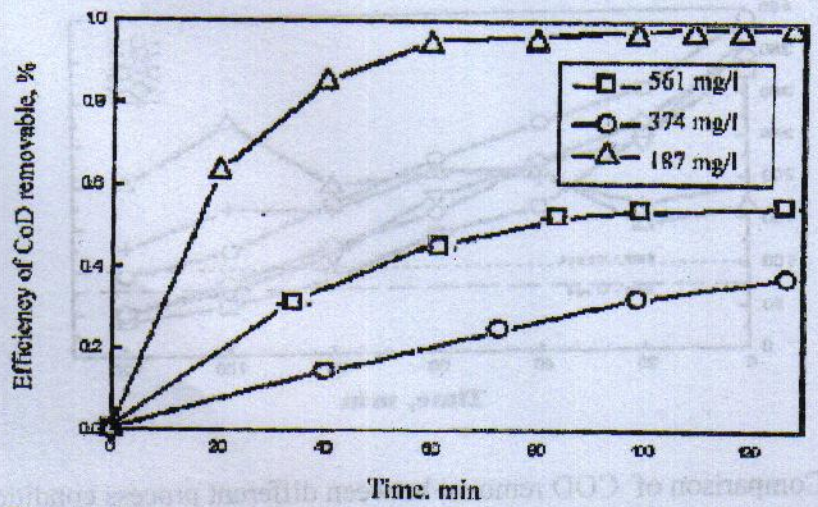

Fig. (2) Effect of H_2O_2 dosage on COD removal (single UV lamp)

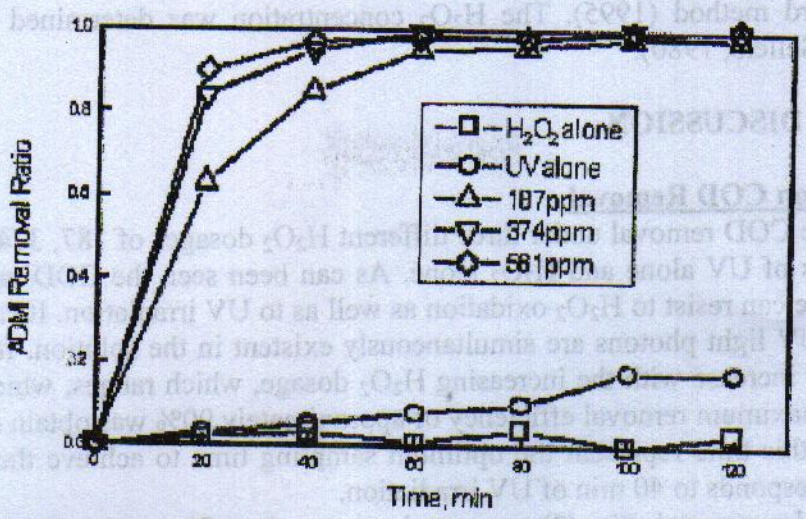

Fig. (3) Effect of H_2O_2 dosage on color removal (single UV lamp)

Table 1 description on different process condition

Process Condition	No. of UV Power	Air Bubbling	Step Addition of H_2O_2	Time of H_2O_2 Addition (min)
A	1	No	1x561 ppm	0
B	1	Yes	1x561 ppm	0
C	1	No	4x140 ppm	0,30,60,90
D	6	No	1x561 ppm	0
E	6	Yes	1x561 ppm	0
F	6	No	4x140 ppm	0,30,60,90

Note

The sample volume for the reactor with single UV lamp volume for the 6 reactors in series was 10 liter, and the UV power per unit water volume was 21.5 watt/l.

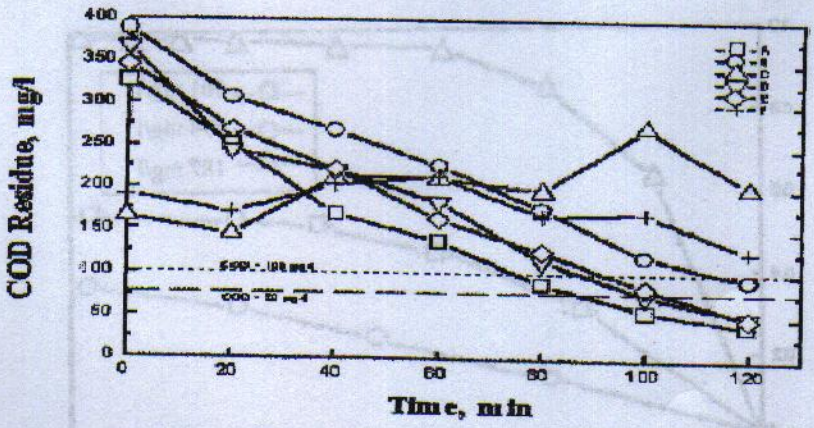

Fig. (4) Comparison of COD removal between different process conditions (process conditions, a, b, c, d, e, f, are illustrated in table (1)

Unit Operating Cost

Based on the above results, the H_2O_2/UV process can achieve the goal of discharge standards. The next issue, which concerns the textile industries, is the operating cost they have to spend if this process is used as their post wastewater treatment. In calculating the unit operating cost, the following unit prices were used: 0.42 US$ per kg of 35% H_2O_2 and per 0.06 US$ per KWh of electricity [Liao and other], [Seller, 1980]. Based on the data presented in **Fig. (4),** the unit operating cost to reduce COD to 80 mg/l is compared in **Fig. (5).**

The unit cost varies from 0.92 to 1.11 US$. Depending on the No. of UV reactor used and the Presence or absence of air supply. Without enhancing ant additional removal of COD, the presence of air supply (process condition E), leads to the increase of the unit cost from 1.06 to 1.11 US$, due to its power consumption. The cheapest unit cost was obtained under conditions of lamp, absence of air supply and one step addition of H_2O_2.

CONCLUSION

In conclusion, the H_2O_2/UV oxidation process demonstrated for its capability of simultaneous removal of COD and color in view of regulatory compliance. Specifically, the color can be removed much more easily than the COD. From the viewpoint of process operating conditions, chemical addition of H_2O_2 favors one step addition rather than multi-step addition, especially for the COD removal. Furthermore, it is suggested to void supplying air into the solution, due to its adverse effect on the process removal efficiency. As for the unit operating cost, it ranges from 0.92 to 1.11 US$ per cubic water treated to reduce the COD to 80 mg/l.

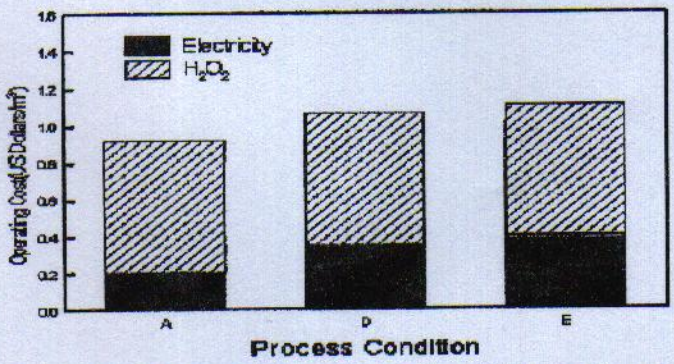

Fig. (5) the unite operating cost to reduce COD to 80 mg/l
(process conditions, a, d, and e, are illustrated in table 1)

REFERENCES

Liao C. H., Kang S. F, Hung H.P., and Po S. T., (1997), H_2O_2 / UV oxidation treatment of refractory dye manufactured process wastewater, Processings, the 22nd annual conference of wastewater treatment, Taiwan.

Liao C. H., and Gurol M. D. Chemical Oxidation by Photolytical Decomposition of Hydrogen Peroxide, Environ. Sci. & Techlinol, 29 (12) 3007-3014.

Seller R. M., (1980), Spectrophotometric Determination of Hydrogen Peroxide Using Potassium (!e) Oxalate, Analyst, 105 (10), 950-954.

Standard Methods for the examination of water and wastewater, (1995), 19th edn, American Public Health Association/American Water Works Association/Water Environment Federation, Washington DC, USA.