مجلة المثنى للعلوم الصرفة
AL-Muthanna Journal of Pure Sciences (MJPS)
VOL.(3)...NO.(1) ….2016

Photo Degradation Technologies of Direct Violet Dye in Aqueous Solution by Using H_2O_2/UV Process

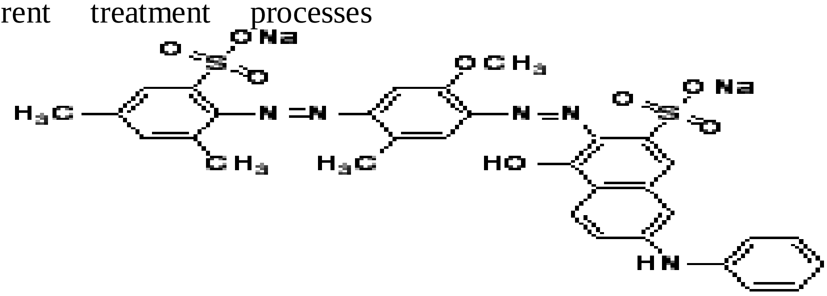
Ennas Abdul Hussein
Chemistry Department, College of Science for women ,
Baghdad University

Abstract

The degradation of Direct Violet dye in aqueous solution under UV irradiation was investigated by using advanced oxidation processe . The aim of this study was to show the parameters the effects of initial dye concentration, hydrogen peroxide dosage and pH. The degradation is fast with UV/H_2O_2system. It has been found that the removal rate increased as the initial concentration of H_2O_2 increase to optimum value. The decolourization reaction was found to follow, first order kinetics with respect to the dye concentration.

1. Introduction

Textile industry is one of the most complicated industries among manufacturing industry(1).There are more than 100,000 different synthetic dyes available on the market, produced in over 700,000 tons annually worldwide(2) . Advanced Oxidation Processes (AOPS) refer to a set of chemical treatment techniques procedures designed to remove organic and inorganic materials in water and waste water by oxidation (3). Major pollutants in textile wastewaters are high acidity, heat and other soluble substances main pollution in textile wastewater came from dyeing and finishing processes(4-5).Different treatment processes included physical , chemical, and biological have been employed to treat various municipal and industrial wastewaters for example chemical (6). Biological, food(7). The hydroxyl radicals is high and the oxidation is unselective they are able to oxidize and finally mineralize nearly all organic compounds yielding CO2 and inorganic ions in the end which again means a remedy of the pollution problem (8-9). The present study was carried out to investigate the removal of color of azo dye Fig(1) using various advanced oxidation processes various reaction conditions under UV light.



Fig(1): Structure Formula of Direct Violet dye

2- Experimental

1. Materials

In this study , all chemicals were used without further purification. Hydrogen peroxide (H2O2 30% w/v) , sodium hydroxide (NaOH) and hydrochloric acid (HCl) were supplied from BDH. Direct Violet 50% content was purchased from Aldrich. All the solution were prepared using double distillation water.

2.Instruments

UV-Visible 1650 spectrophotometer (Shimadzu , Japan)was used to recording the absorption spectra of aqueous solutions of dye. UV-Visible 7804C spectrophotometer (Sunny, China)was used to measured of absorbance of dye solutions at (545nm).The pH was measured by using microprocessor pH meter 211, (Hanna ,Romania) instruments. The Temperature was adjusted by used regulator water bath WB(Optima).

3.Experimental procedures

The operating irradiation time for all experiments were fixed at 90 min ,due to the primary experiments indicated that the most of dye molecules are degraded and the dye solution become colorless at the time near to this period. The pH was adjusted to the desired value using 0.1N of sodium hydroxide and hydrochloric acid(10). Within this time samples were taken by syringe for measuring the dye absorption at λmax = 545nm and then determination of dye concentration by using the calibration curve shown in Fig(2). Fig(3) shows the UV-Visible absorption spectrum of dye.

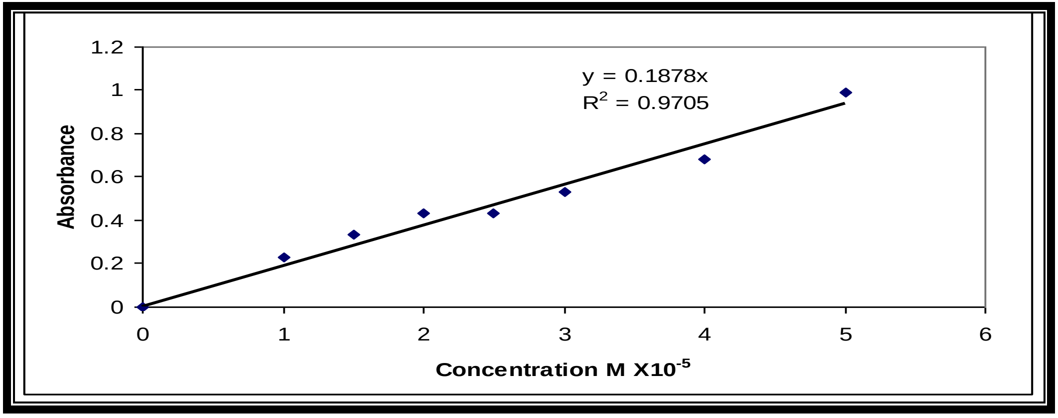
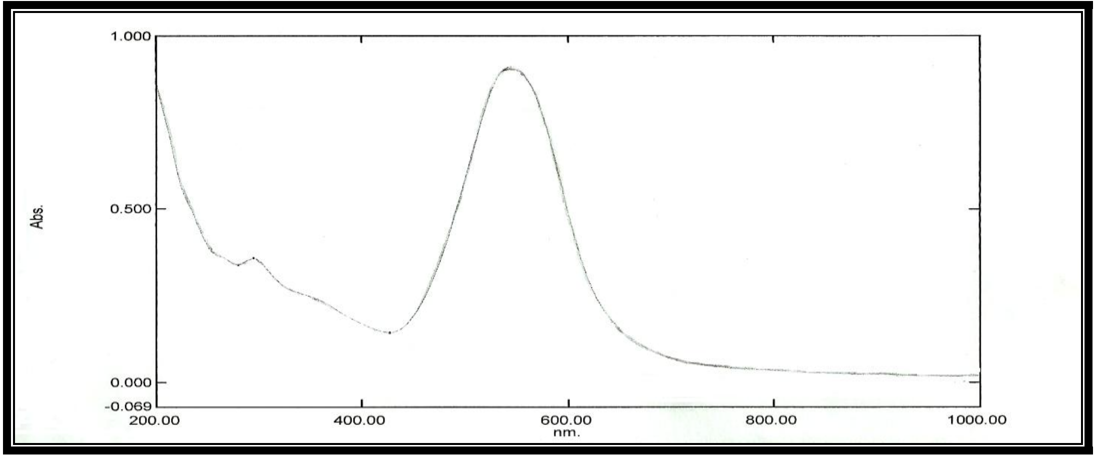


Fig (2): Calibration curve for DV dye at pH=6,T=298K .



Fig(3): UV-Visible spectrum of aqueous solution of DV dye.[DV]=1x10^{-5} M pH=6, at 298K .

3- RESULTS AND DISCUSSION

1.Effect of initial dye concentration

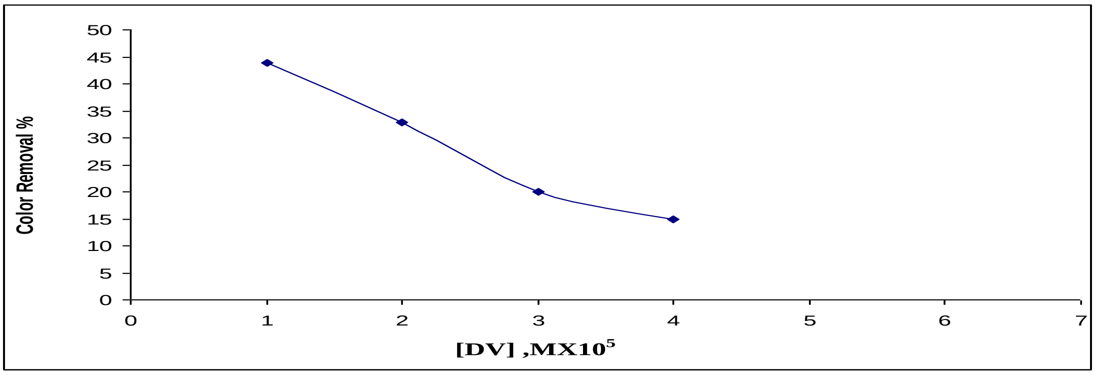
Various initial dye concentration ranged (1x10-5- 4x10-5M) were used by exposure a solution to UV irradiation. The results are shown in Fig (4). It has found the increasing in the initial concentration of dye lead to decreasing the color removal because of the decreases penetration of rapidity of reaction can be related with the absorption of the dye and can be calculated by using the law is called empirical method(12). Figure(5) shown relationship between Log R and Log C to produced order reaction.

Log R= log k + n logC

photons entering into the solution and lowering the formation of hydroxyl free radicals in the solution(11). The obtained results proved that the Photooxidation reactions of the DV dye is reactions of first order, the coincident of the

Where:

C: concentration of dye, n: order reaction, R: reaction rate, K: reaction rate constant. It is clear that the dye concentration decreases as long as the time increases .



Fig(4):Effect of dye concentrations on the color removal at pH=6,T=298K.

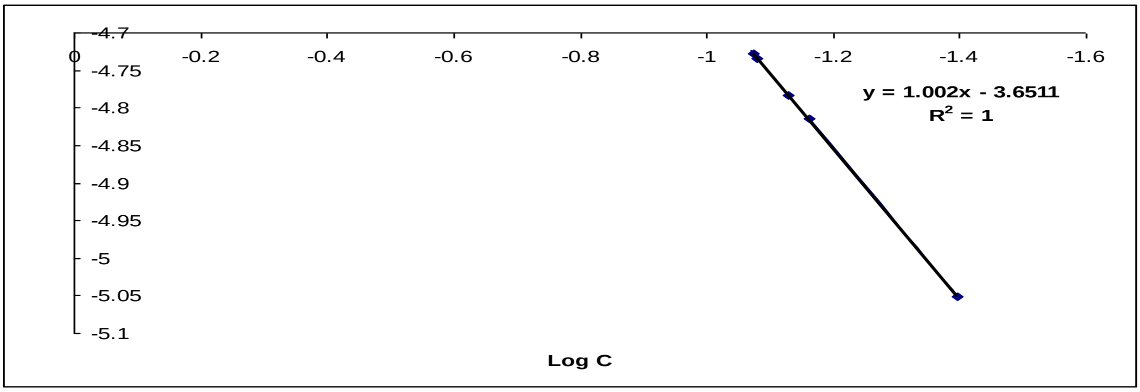


Fig (5): Relationship between Log R and Log C of oxidation of DV dye =1x10^{-5} M , pH=6, T=298K.

2. Effect of Initial Hydrogen Peroxide Concentration

The effect of varying of the initial H2O2 concentration is shown in Fig(6). Color removal is decreased over time in the presence of UV/H2O2 light. The results are showed the highest ratio decolorization of DV was 97.2% using 500mg/L of H2O2 and the ratio decreased from 97.2% to 93.4% when H2O2 concentration was reduce from 500-100mg/L respectively(13).

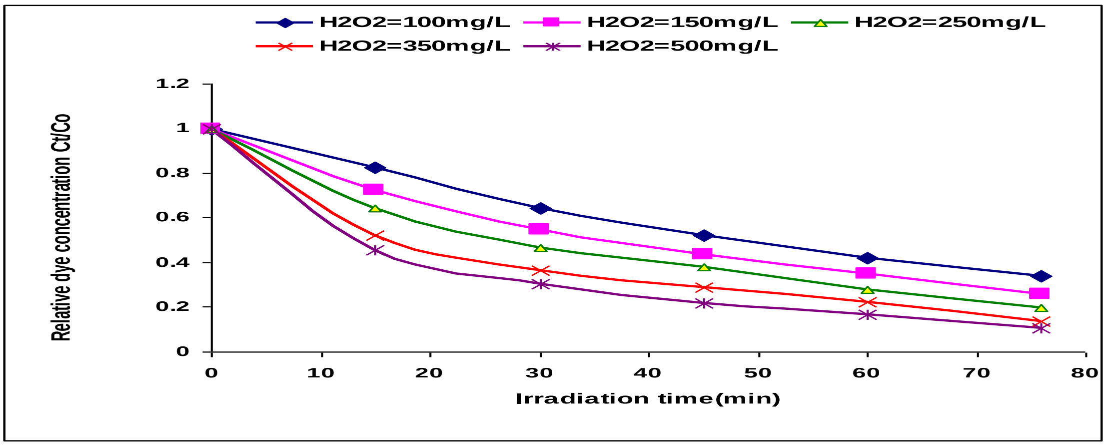


Fig (6): Effect of different initial H_2O_2 concentration on the color removal from[DV] dye =1x10^{-5}M using UV / H_2O_2 method, pH= 6, T=298K .

The UV/H2O2 method offers several advantages include stable organic compounds with high molecular weights are broken down into smaller structures, which are more biodegradable (14). A disadvantage of H2O2/UV method is that it cannot utilize solar light as the source of UV light due to the fact that the required UV energy for the photolysis of the oxidizer is not available in the solar spectrum (15-16).

2-2. Effect of initial pH

The higher ratio color removal of DV dye was obtained under acidic media at pH=1 under UV light and decreasing ratio in basic media. The fastest degradation reaction rate is observed at pH =1 after 90 min of decolorization already 95% of color is removed. and low value was obtained in basic media because of the increase of the rate of removing the color in low pH value due to more .OH radical generation changes in the structure of the molecule because of having a free hydrogen atom which makes the dye molecule exposed for attack by the hydroxyl radical in acidic conditions (17) and hydrogen peroxide undergoes decomposition in alkaline medium. Fig (7) refers the relation dye concentration Ct/Co was decreased as the pH value increased under UV irradiation

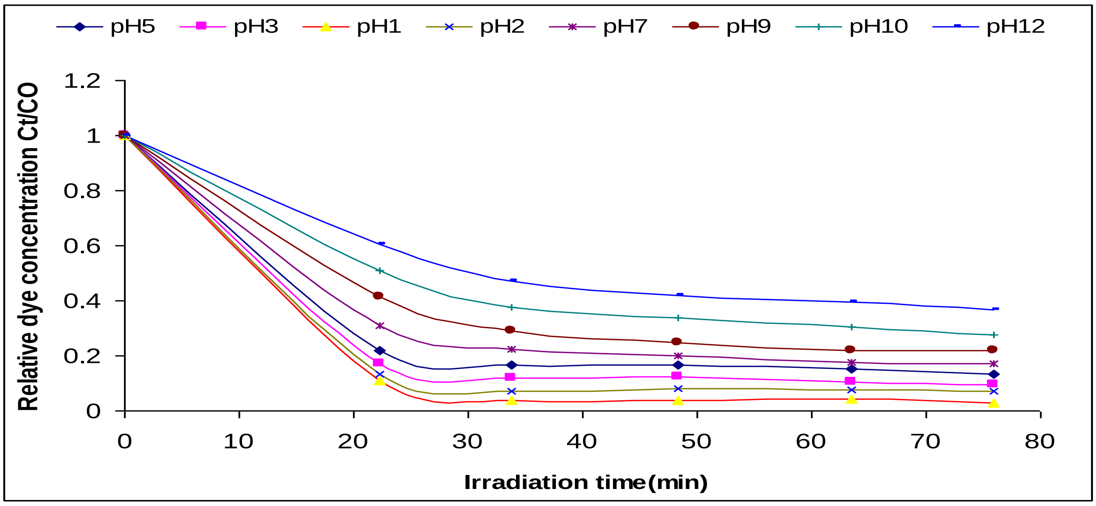


Fig (7):Effect of different pH value on color removal of DV dye as function of irradiation time using UV/H2O2/ method, [DV]=1X10-5 ,[H2O2]=(500mg/L), T=298K .

3-Effect of Temperature

Temperature is an important kinetic factor on enhancing the color removal percentage . The dye removal rate by using the UV method increased with increasing temperature of the system as shown in Figures (8). Also, high temperature increases the generation rate of •OH or directly affects the reaction rate with the dye molecule(18). The Arrhenius equation is used to describe the relationship between rate constants and temperature and draw this the relationship as show in Fig (9) .

$k = A\, e(-Ea/RT)$ …………(2)

where: k : rate constant, A : frequency factor, Ea : activation energy, R : ideal gas constant.

The activation energy calculated in plot was equal 61.14 KJ/mole with the presence of light and alone dye from DV dye .

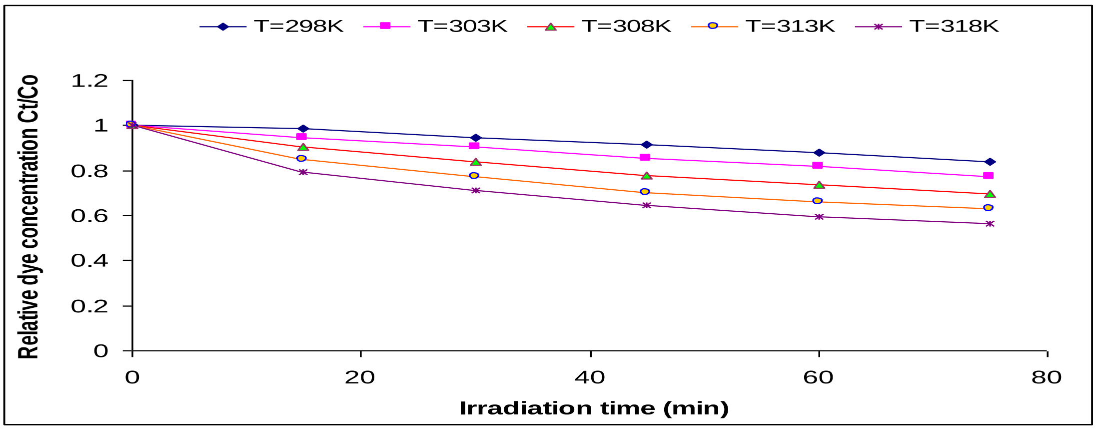


Fig (8): Effect of different temperature on the color removal of [DV]=1x10^{-5}M at pH=6 using UV method .

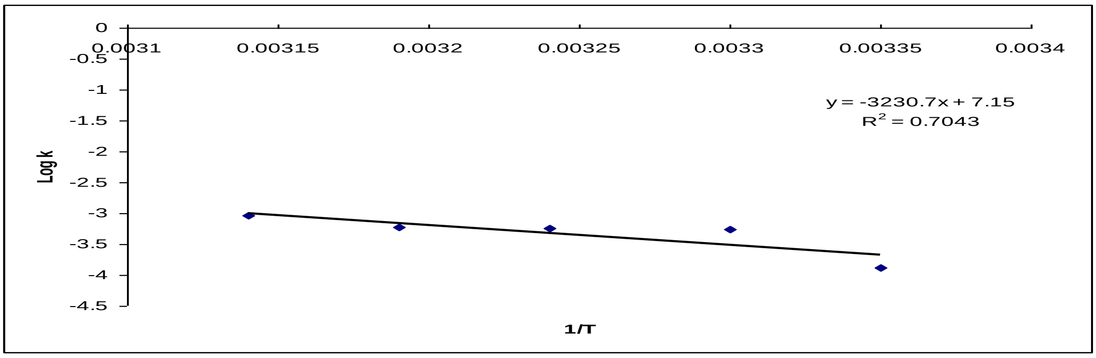


Fig (9): Arrhenius plot of color removal of dye.[DV]= $1x10^{-5}$ M, pH=6.

4-Conclusions

1- The degradation was strongly influenced by various parameters, particularly the initial H2O2 dosage, dye concentration, pH, temperature as well as irradiation time.

2- The study showed that increasing the concentration of the dye reduces the speed of degradation , because high concentrations of the dyes reduce the ability of light penetration lead to reduces the speed of the degradation and the color removal of dyes .

3- Faster degradation processes and higher color removal efficiency were observed at higher temperature.

References

1-Selcuk, H. (2005). Decolorisation and Detoxification of Textile Wastewater by Ozonation and Coagulation Processes, Dyes and Pigments, Vol.64, pp: 217-222.

2-Aleksander, P. (2004). Fungal Decolourization and Degradation of Synthetic Dyes Some Chemical Engineering Aspects, University of Ljubljana.

3- GIaze, W.H. ,Kang, J.W. and Chapin ,D.H. (1987). The chemistry of water treatment processes involving ozone, hydrogen peroxide and UV-radiation, Ozone Sci .Eng. , 9,4, 335-352.

4- Karim, M.R., Ahmad, S.A. and Shahidullah, M.(2006). Nutritional status of children in arsenic exposed and non-exposed areas in Bangladesh. J. Health, Populat. Nut. Early Child Res. Q., 26: 237-246.

5- Venceslau, M.C., Tom S. and Simon J.J. (1994). Characterization of textile wastewaters- a review, Environmental Technology, 15:917-929.

6-Vandevivere, P.C. Bianchi, R. and Verstraete ,W.(1998). Treatment and reuse of wastewater from the textile wet-processing industry: Review of emerging technologies. J.Chem. Technol. Biot.,72 (4):289-302.

7- Gogate, P.R. and Pandit, A.B.. (2004).A review of imperative technologies for wastewater treatment I: Oxidation technologies at ambient conditions, Advances in Environmental Research, 8 (3-4): 501-551.

8- Stock, N.L., Peller, J., Vinodgopal, K.Kamat, P.V.,(2000). “Combinative Sonolysis and Photocatalysis for Textile Dye Degradation”. Environ. Sci. & Technol.,. 34(9), (1747-1750).

9- Hincapié M., and Maldonado M. I. (2005). “Solar photocatalytic degradation and detoxification of EU priority substances ”.Catalysis Today, , 101, (203-210).

10- Galindo, C. and Kalt , A. (1998). UV-H2O2 Oxidation of mono azo dyes in aqueous media: a kinetic study, Dyes and Pigm., 40,27-35.

11- Rezaee, A., Ghanaian, M. T., Hashemian, S. J., Moussavi, G., Khavanin, A. and Ghanizadeh, G.(2008). Decolorization of Reactive Blue 19 dye from textile wastewater by the UV/H2O2 process, J. App., Sci , 8,pp:1108-1122.

12- Keith J. Laidler , M. A., D.S.C., PH D., F.R.S.C. (1970). Reaction kinetics , (1): 16-18.

13- EPA, (1998). Handbook on Advanced Photochemical Oxidation Process,, US. EPA, Washington, DC.

14- EI- Dein, A.M., Libra, J. A. and Wiesmann, U.(2003). Mechanism and kinetic model for the decolorization of the azo dye Reactive Black 5 by hydrogen peroxide and UV radiation. Chemosphere ,52, 1069-1077.

15- Feuerstein, W., (1981). Model Experiments for the Oxidation of aromatic compounds by Hydrogen Peroxide in Wastewater Treatment, Vom. Vasser, 56,35-54.

16-Kang,S.F., Liao, C.H. and Po, S.T.(2000) . Decolorization of textile wastewater by photo-Fenton oxidation technology ,Chemosphere, 41 ,8 , 1287-1294 .

17- Shu,H.Y. , Huang ,C.R. and Chang, M. C. (1994) Declorization of Mono-azo dyes in wasterwater by advanced oxidation process : a case study of Acid Red 1 and Acid Yellow , Chemosphere 29,12, 2597.

18-Obies, M.(2011). Photocatalytic Decolorization of Bismarck Brown R, MSc Thesis, Chemistry Department, College of Science, Babylon University, Iraq

تقنيات التجزئة الضوئية لصبغة البنفسجي المباشرة باستعمال طريقة H_2O_2/UV.

ايناس عبدالحسين
قسم الكيمياء - كلية العلوم للبنات
جامعة بغداد

الخلاصة

تمت تجزئة صبغة البنفسجي المباشرة من محاليلها المائية بوجود الأشعة فوق البنفسجية واستعمال طرائق الأكسدة المتقدمة. تم دراسة تأثير التركيز الابتدائي للصبغة ، وقيم pH ، درجة الحرارة ، زمن التشعيع ، التركيز الابتدائي لبيرو كسيد الهيدروجين . وقد وجد إن سرعة الإزالة تزداد بزيادة تركيز بيرو كسيد الهيدروجين H_2O_2 المستخدم. أوضحت نتائج التجارب الحركية إن تفاعل التحطم الضوئي بتأثير الأشعة فوق البنفسجية هو من الدرجة الأولى.