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PHOTODEGRADATION OF DYE REACTIVE BLUE160 (RB160) IN PRESENCE OF STRONTIUM CHROMATE

MONIKA DADHEECH AND B. V. KABRA

Department of Chemistry, M. L. V. Government PG College, Bhilwara 311 001 (Rajasthan)

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ABSTRACT

The textile industries produce wastewater containing toxic synthetic organic compounds like dyes. In this work the photodegradation of dye Reactive Blue160 in aqueous solution with $SrCrO_4$ as a photocatalyst has been investigated using visible light. The effect of various parameters such as pH, concentration of Dye solution, catalyst loading. Degradation has been determined by spectrophotometer at 560 nm. A tentative mechanism also has been proposed for the photocalaytic degradation of Dye.

KEY WORDS : Reactive Blue160, Strontium Chromate and Photocatalysis.

INTRODUCTION

Water is as essential component as air in our life. Now a days we are suffering from water pollution. The main reason of pollution is industrial effluents. Industries generate waste water that contain some organic and inorganic compounds. Effluents from textile industries contain dyes. Most synthetic dyes are aromatic compound having Azo bond. The annual consumption is around 7×10^5 tons worldwide (Fu, 2001, Akhtar, 2005). The dyes are toxic and carcinogenic (Camargo, 2013).

Many treatment methods have been reported for dye degradation such as flocculation, coagulation (Couto Junior, 2013), ultrafiltration, reverse osmosis (Ramesh, 2011), biodegradation (Birmole, 2014) etc. Photo catalytic degradation is the best process for degradation of organic pollutants like dyes. Visible light is used in this process and it is environment friendly as well as cost effective method (Mirkhani 2009). A lot of work has been performed on various photo catalyst materials such as TiO_2 (Mehta, 2010), ZnO (Tabatbaee, 2011) etc. Some work has been done on $SrCrO_4$ as photo catalyst. Photo oxidation of organic compounds like pollutants, Dyes etc by $SrCrO_4$ is alternative method because this is low cost, less time consuming and easy operative method.

Bhardwa*j et al* suggested use of a new nano sized photocalatyst BaO_3TiO. SrO_3Tio for degradation of Azure-B and ecofriendly process. Jangid *et al* worked on photocatalytic activity of $SrCrO_4$ for the Photo degradation of Azure - A Dye (Jangid, 2018).

MATERIALS AND METHOD

For the present phtocatalytic degradation studies Reactive Blue160 was used

RB160 is diazo dye containing Sulphonate groups. It was Procured from Sanwariya processors private limited Bhliwara (Raj). The photocatalyst was obtained from CDH. All laboratory reagents were of analytical grade.

Experimental Procedure

The degradation of Reactive Blue 160 was studied in presence of photo catalyst $SrCrO_4$ at different pH level, catalyst loading and dye concentration. 1 × 10-3 M dye solution was prepared by dissolving 1.309g of dye in 1000 mL of distilled water. The initial absorbance of dye solution was observed with the help of Spectrophotometer. The maximum absorbance value was recorded at 560 nm (λmax). The reaction mixture was prepared by taking 3 mL of dye solution (1×10^{-3} M), 0.20 g of Strontium Chromate in a round bottom flask. The total volume

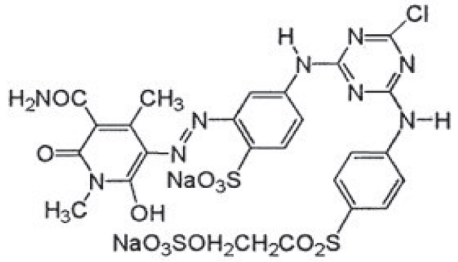

Fig. 1. Structure of Reactive Blue 160 (Molecular formula of RB160 is $C_{38}H_{23}Cl_2N_{14}Na_5O18S5$

of the reaction mixture was made 100 mL by adding double distilled water. The concentration of dye in the reaction mixture was 3×10^{-5} M. To carry out the photooxidation, the reaction mixture was irradiated under light source (2 × 200 W Tungsten lamps). Water filters were used to cut off thermal radiation. The pH of the solution was measured by pH meter (Systronics, 106). The desired pH of the solution was adjusted by the addition of standard 0.1N Sulphuric Acid and 0.1N Sodium hydroxide solutions. The progress of the reaction was observed at definite time intervals by measuring absorbance at 560 nm (λmax).

RESULT AND DISCUSSION

The photo-catalytic degradation of RB160 was observed at 560 nm. The optimum conditions for the photooxidation of dye were [Dye] = 3×10^{-5} M, pH= 8, amount of catalyst = 0.20 g/100 mL dye solution.

Table 1. A typical run of photocatalytic degradation of Reactive Blue160

Time (min)	Abs	1+log abs
0	0.666	0.824
15	0.622	0.794
30	0.585	0.762
45	0.540	0.733
60	0.501	0.700
75	0.486	0.687
90	0.428	0.632
105	0.382	0.583
120	0.352	0.547
135	0.322	0.508
150	0.287	0.458

The result of photodegradation of RB160 is graphically presented in Fig. 2.

A plot of 1+logA versus time was linear following pseudo-first order kinetics. The rate constant was calculated by using the expression k = 2.303 × Slop.

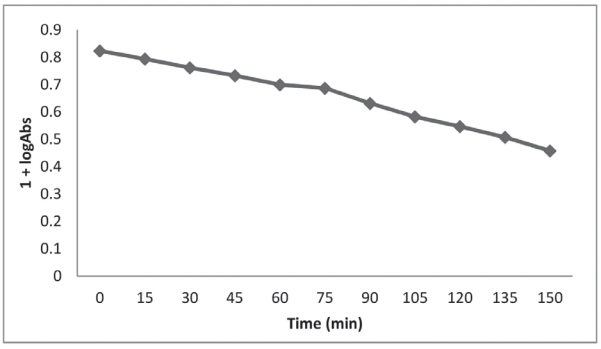

Fig. 2. Plot of 1 + log abs verses time for a typical run

$k = 6.63 \times 10^{-5}$ sec^{-1}

Effect of parameter's

Effect of pH variation: The effect of pH range 6.5-9.5 Strontium Chromate respectively. All other parameters were kept to be identical. The result are given in Fig. 3.

It was observed that with an increase in pH the rate of reaction increases. At pH 8.0 rate of Degradation was maximum.

Effect of variation in dye concentration: The effect of variation of concentration of dye on its photodegradation has been observed in the range

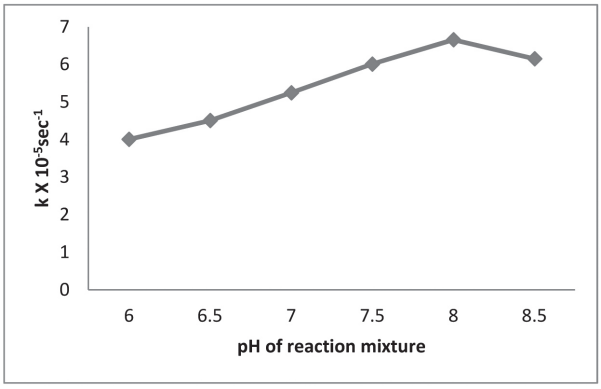

Fig. 3. A plot showing effect of variation in hydrogen ion concentration on the rate of decolorization of the dye

from 1.0×10^{-5} to 5×10^{-5} M for $SrCrO_4$ keeping all other parameters to be the same. The results are given in Fig. 4. It has been observed that the of degradation increases with increasing concentration of dye up to 3×10^{-5} M for Strontuim Chromate. Then further increasing the concentration of dye catalyst surface gets saturated. That why intense colour of dye does not permit light to reach photocatalyst. As a result rate of degradation decrease. Dye molecules adsorb on catalyst surface and degradation occurs.

Effect of variation in Catalyst concentration: The effect of amount of photocatalyst on the photo bleaching of Reactive Blue 160 was monitored by varying amount of Strontium Chromate from 0.05g to 0.40g/100 mL keeping all other factors identical, It has been observed that with an increase in the amount of catalyst, the rate of degradation increases to 0.20g/100 mL for $SrCRO_4$. Then after increase in the amount of catalyst the rate of reaction becomes almost constant or decreases. This behaviour may be explained by the fact that with an increase the amount of catalyst the active sites on surface area of catalyst will increases. After a certain level of catalyst (0.20g/100mL) rate of reaction decrease because substrate dye molecules are not available for adsorption on active sites of semiconductor.

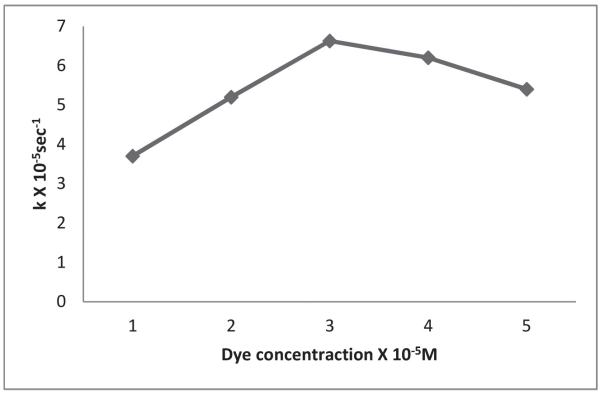

Fig. 4. A plot showing effect of variation in dye concentration on the rate of decolorization of the dye

Mechanism: On the basis of the experimental observation a tentative mechanism has been proposed for degradation of RB160 in the presence of $SrCrO_4$. Dye absorbs visible light radiation of suitable wavelength and convert singlet to triplet excited state through Inter System Crossing.

$_1Dye^0 \rightarrow {}_1Dye^1$

$_1Dye^1 \rightarrow {}_3Dye^1$

The catalyst also absorbs the radiation with energy equal to band gape or more than of catalyst. Electron moved from valance band to conduction band of catalyst. Thus a hole (h^+) is generated in valance band. Electron from conduction band will be abstracted by dissolved oxygen to generate O_2 radical. Hole react with OH^- and form OH. Radical.

$SrCrO_4 \rightarrow SrCrO_4^*$

h^+ (VB) + e^- (CB)

$O_2 + e^-(CB) \rightarrow O_2^-$

(Dissolved oxygen)

$h^+ + OH^- \rightarrow OH.$

$h^+ + H_2O \rightarrow OH^- + H^+$

OH^*, O^2.- are strong oxidizing species and react with dye molecule to oxidize them.

$_3Dye^1$ + radical → colourless end product

CONCLUSION

Strontium Chromate used as a photocatalyst for degradation of dye Reactive Blue 160. The experimental results indicated thet photodegradation of RB160 was affected by pH, concentration of Dye, amount of catalyst. It was observed optimum condition for photodegradation is at pH8, 0.2.g $SrCrO_4$/100 mL, 3×10^{-5} M dye concentration. It may be explored for water treatment of industrial effluents in future.

REFERENCES

Akhtar, S., Khan, A.A. and Husain, Q. 2005. Potential of immobilized bitter gourd (*Momordica Charantia*) per oxidases in the decolorization and removal of textile dyes from polluted waste water and effluent. *Chemosphere.* 60 : 291.

Bhardwaj, S., Nihalani, S. and Vijay, A. 2013. Use of a new nanosized Photocatalyst $BaO_3TiOSrO_3TiO$ an eco-friendly process for removal of coloring agent. *IJRCE.* 3 (3) : 89-93.

Birmole, R., Patade,S., Sirwaiya,V.,Bargirlf, V. and Aruna, K. 2014. Biodegradation Study of Reactive Blue 172 by Shewanella Halious DW01 isolated from lake sediment. *Ind. J. Sci. Res.* 5 (1): 139.

Camargo, B.C.V. and Morales, M.A.M. 2013. Azo Dyes: Characterization and Toxicity- A Review. *Text. Light Ind. Sci. Tech.* 2(2) : 85.

Couto Junior, O.M., Barros, M.A.S.D. and Pereira, N.C. 2013. Study on Coagulation and Flocculation for treating effluents of textile industry. *Acta Scientiarun Technology.* (35) 1: 83.

Fu, Y. and Viraraghavan, T. 2001. Fungal decolorization of dye wastewaters: A review. *Biores. Technol.* 79: 251.

Jangid, M., Ameta, R., Ameta, S.C. and Sharma, A. 2018. Use of $SrCrO_4$ as Photocatalyst for Degradation of Azure-A. *International Journal of Contemporary Research and Review.* 9(03): 20181-20187.

Jia,Y., Shen, S., Wang, D., Wang, X., Shi, J., Zhang, F., Han, H. and Li, C. 2013. Composite $Sr2TiO_4/SrTiO_3$ (La,Cr) Heterojunction based Photocatalyst for Hydrogen Production undervisible light irradiation. *J. Mater. Chem.* A1: 7905-7912.

Mehta, P., Mehta, R., Surana, M. and Kabra, B.V. 2010. Effect of transition metal ions on Photoassisted Bleaching of Reactive Yellow86 by TiO_2. J. *Chem. Pharm. Res.* 2(4) : 546-557.

Mirkhani, V.,Tangestaninejad,S., Moghadam,M., Habibi, M.H. and Rostami-Vartooni, A. 2009. $InCl_3$ as an

efficient catalyst for synthesis of Oxazolines under thermal, Ultrasonic and Microwave irradiations. *J. Iran. Chem. Soc.* 6(3) : 251-258.

Pamecha, K., Mehta, V. and Kabra, B.V. 2016. Photocatalytic Degradation of commercial textile Azo Dye Reactive Blue160 by Heterogenous Photocatalysis. *Archives of Applied Science Research.* 8(1) : 7-12.

Ramesh, M. and Saravanan, K. 2011. Textile dyeing Industry wastewater treatment with Reverse osmosis Membrane System. *Eur. J Sci. Res.* 53 (1): 6.

Tabatbaee, M. and Abolfazal, S. 2011. Photodegradation of dye Pollutant on Ag/ZnO Nanocatalyst under UV irradiation. *Orient. J. Chem.* 27 (1): 65.