*Eco. Env. & Cons. 28 (4) : 2022; pp. (2136-2139)*
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*ISSN 0971–765X*

**DOI No.: http://doi.org/10.53550/EEC.2022.v28i04.075**

# Treatment of Industrial wastewater containing dye Sulphur Black 1 in presence of semiconductor Strontium Chromate

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(Received 2 May, 2022; Accepted 18 July, 2022)

**ABSTRACT**

The paper reports a work done on photocatalytic degradation of an Industrial dye Sulphur Black 1 with the help of Strontium Chromate photocatalyst. The experiment was controlled by photocalayst, visible light and air. And also studied the effect of hydrogen ion concentration, dye concentration and quantity of catalyst on the photodegradation. The experiment observed by spectrophotometrically at definite time gape.

***Key words**: Sulphur Black 1, Strontium chromate, Photocatalytic Degradation.*

## Introduction

Life on earth mainly depends on air, water and food. As the population is increasing, the need is also raising, to fulfill all needs inventions are also expanded, due to which pollution is also increasing. Water pollution is a major problem for whole world. Industrial waste is the important cause of water pollution. Industrial effluents contains dyes, heavy metals, toxic chemicals. Out of them Sulphur Black 1 Dye is also a harmful colorant present in textile wastewater.

This special issue covered various AOPs used for the treatment of industrial wastewater sewage and land fill leachates (Swaminathan, 2013). Advanced oxidation process have been successfully applied for treatment of polluted water received from textile industries (Mirkhani, 2009).

The Photocatalytic degradation of dye Disperse blue 1 has been investigated under UV light irradiation in the presence of $TiO_2$ and $H_2O_2$ under a variety of condition and the photocatalyst Degussa P25 was found to be more efficient for the degradation of dye. (Ozyonar, 2020) Recently the coupling process of electrocoagulation process with ultrasound has been noticed useful for water and wastewater treatment. Under the optimum condition, the color and COD removal efficiencies for an aqueous solution of 100mg L-1 reached 100% for Disperse blue 60. (Mustafa, 2021).

Textile Disperse dye Coralene Dark Red 2B was degraded by a photocatalyst semiconductor CeFeO3 in visible light and observed spectrophotometrically (Pamecha, 2016). photocatalytic degradation of diazinic ring containing azo dye (Direct Yellow 12) has been studied in presence of homogenous photocatalyst Photo- Fenton reagent (Surana, 2010).

To degrade Eosin Yellow, Barium Chromate powder has been used as a photocatalyst. The effect of concentration of hydrogen ion and dye and quantity of Catalyst on photoreaction was also studied (Gupta, 2015). Lead Chromate has been used for

photocatalytic degradation of Methylene Blue at optimal Hydrogen ion concentration, dye concentration and catalyst loading (Ameta, 2014). The Yellow crystalline Nano-sheets of ZnCrO4 degrade almost 90% Methylene Blue in aqueous medium of 70 min of visible light irradiation (Thakre, 2020).

Nano sized photocalatyst $BaO_3TiO.SrO_3Tio$ for degradation of Azure-B and ecofriendly process (Bhardwaj, 2013). $SrCrO_4$ was prepared by precipitation method in a wet chemical process and used to degrade Evans Blue under visible light irradiation (Jangid).

## Materials and Methods

For the present photocatalytic degradation studies Sulphur Black 1was used. It was Procured from Sanwariya processors private limited Bhliwara (Raj). The photocatalyst Strontium chromate was obtained from CDH. All laboratory reagents were of analytical grade.

**Fig. 1.** Structure of Sulphur Black 1(Molecular formula is$C_{18}H_8N_4O_5S_2$)

### Experimental Procedure

For the preparation of stock solution, 0.424g dye Sulphur Black 1 was dissolved in one litre of double distilled water. Therefore, the concentration of stock solution was $1\times 10^{-3}$ M. This solution was further diluted according to requirement. The maximum absorbance of dye solution was recorded at 570nm by spectrophotometer. Control experiments confirm the necessity of light and presence of photocatalyst strontium chromate for degradation of dye Methylene Blue.

Strontium chromate (0.25g) and dye solution (3.5ml) were combined in a round bottom flask to make the reaction mixture. Adding double distilled water to the reaction mixture resulted in a volume of 100 mL. Reaction mixture was treated by visible light radiation with light source (2× 200 W tungsten lamp). Water filter is used for reducing the thermal radiation. Reaction was controlled by pH, dye concentration and the amount of catalyst. The pH of mixture was measured by pH meter and control by the addition of sulphuric acid and sodium hydroxide solution. The progress of degradation was observed spectrophotometrically (570 nm) at definite time interval.

## Results and Discussion

Sulphur Black 1's photo-catalytic degradation was detected at 570nm. To get the best results from dye photooxidation, the ideal circumstances were [Dye] = $3.5\times10^{-5}$ M, Hydrogen ion concentration= 7.5, amount of catalyst = 0.25g /100ml dye solution. The outcomes of photodegradation of Sulphur Black 1is graphically presented in Fig. 2.

**Table 1.** A common run of photocatalytic corruption of Sulphur Black 1

| Time | Abs | log abs +1 |
|---|---|---|
| 0 | 0.732 | 0.864 |
| 10 | 0.684 | 0.835 |
| 20 | 0.636 | 0.803 |
| 30 | 0.594 | 0.773 |
| 40 | 0.536 | 0.729 |
| 50 | 0.478 | 0.679 |
| 60 | 0.433 | 0.636 |
| 70 | 0.401 | 0.603 |
| 80 | 0.376 | 0.575 |
| 90 | 0.333 | 0.522 |
| 100 | 0.286 | 0.456 |

Following first order kinetics, a graph of 1+logA vs. time was linear. The expression was used to compute the rate constant.

$k = 2.303 \times Slop.$

$k = 1.690 \times 10^{-4}\ sec^{-1}$

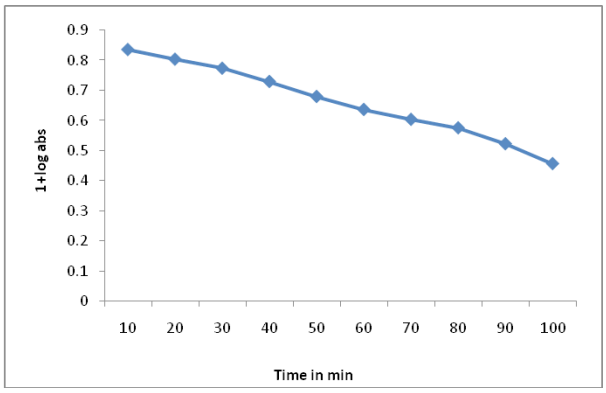


**Fig. 2.** A chart between log abs+1 verses time for a typical run

### Effect of different parameters

### Impact of pH Changes

We looked at the impact of pH on the bleaching rate of dye solution in a pH range (4.5-8.5). Figure 3 illustrates the findings. Sulphur Black 1 photocatalytic debasement was demonstrated to be generally proficient at a pH of 7.5. The pace of reaction decreases as pH rises and falls.

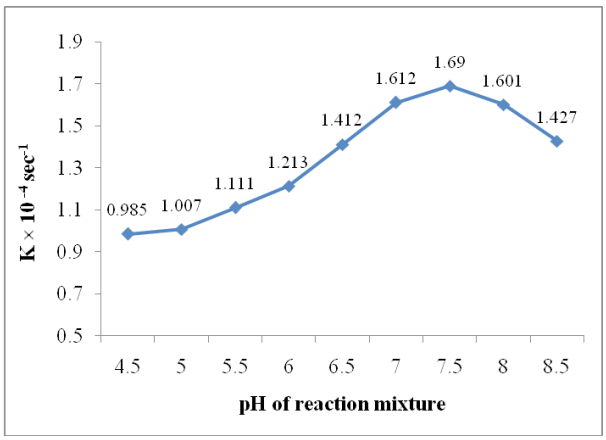


**Fig. 3.** A plot showing impact of the hydrogen ion concentration on photodegradation of dye.

### An Impact of Dye Concentration Changes

For $SrCrO_4$, the influence of dye concentration on photodegradation was detected in the range of 1.5× $10^{-5}$ M to 7.5 × $10^{-5}$ M, holding all other parameters constant. Figure 4 shows the findings. For Strontuim Chromate, the degradation of dye rises up to 3.5 ×$10^{-5}$ M with increasing dye concentration. The catalyst surface becomes saturated when the concentration of dye is increased. As a result, dyes with a high degree of saturation block the passage of light to the photocatalyst. Consequently, the rate of decomposition drops. Dye molecules cling to the catalyst's surface, causing it to degrade.

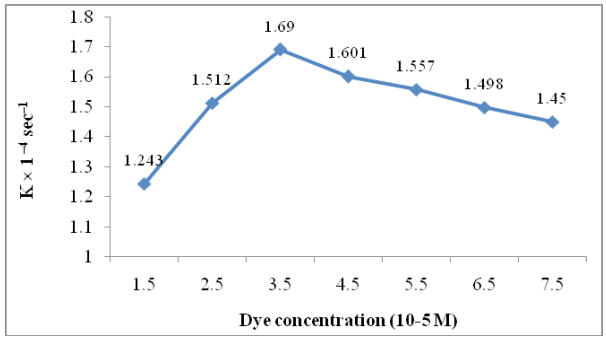


**Fig. 4.** A graph illustrating the impact of dye concentration change on dye decolourization rate.

### Effect of changes in the amount of Catalyst

It has been shown that the degradation rate of $SrCrO_4$ rises to 0.25 g/100 ml with an increase in the quantity of photocatalyst used, while all other parameters remain the same, as measured by a variation in the amount of Strontium Chromate used. Figure 5 shows the findings. The pace of reaction then stabilizes or declines as the quantity of catalyst increases. Increasing the quantity of catalyst on the catalyst's surface area will prompt an expansion in its number of dynamic locales. After a certain amount of catalyst (0.25 g/100 ml) dye particles are unavailable for adsorption so, rate of degradation decreases.

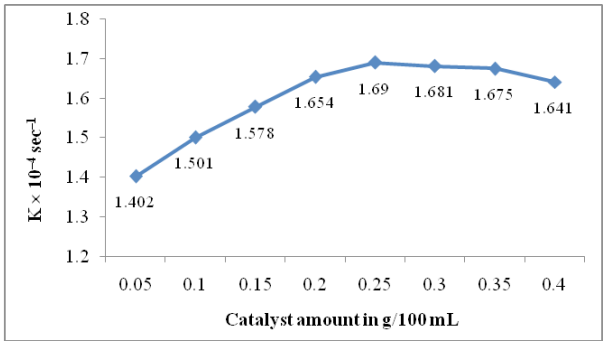


**Fig. 5.** A graph illustrating the impact of catalyst quantity variation on dye decolorization rate.

### Photooxidation Product of Sulphur Black 1

Under a visible light source, the reaction mixture comprising 3.5 × $10^{-5}$M Sulphur Black 1 and 0.25 g/100mL catalyst $SrCrO_4$ was irradiated. 7.5 was the pH of the reaction mixture. The absorption band at 570 nm (λmax) in UV-Vis region was also absent. Two-propanol, a powerful radical scavenger, verified the presence of $OH^{\bullet}$. Adding 2-propanol to the mix significantly decreased the pace of reaction. $OH^{\bullet}$ radical oxidized dye. The photodegradation yield further oxidized by $OH^{\bullet}$ radical and form carbon dioxide, water, nitrate ion and nitrite ions. As a result, the colour has been completely mineralized. The final result is a harmless molecule or ion that does not affect the environment. The existence of harmless end product was done by some chemical experiments.

**Mechanism :** A tentative mechanism has been proposed for degradation of Sulphur Black 1 on the ba-

sis of the experimental observation 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.

$$_1Dye^0 \longrightarrow {}_1Dye^1$$
$$_1Dye^1 \longrightarrow {}_3Dye^1$$

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. Dissolved oxygen grabbed the electron from conduction band to create $O_2^{\cdot-}$ radical and Hole react with $OH^-$ and form $OH^{\cdot}$ Radical.

$$SrCrO_4 \longrightarrow SrCrO_4^*$$
$$h^+ (VB) + e^- (CB)$$
$$O_2 + e^-(CB) \longrightarrow O_2^{\cdot-}$$
(Dissolved oxygen)
$$h^+ + OH^- \longrightarrow OH^\bullet$$
$$h^+ + H_2O \longrightarrow OH^\bullet + H^+$$
$$_3Dye^1 + \text{radical} \longrightarrow \text{colourless end product}$$

$OH^-$, $O^{2-}$ are strong oxidant and these species are oxidized dye molecules.

## Conclusion

Strontium Chromate used as a photo catalyst for degradation of Sulphur Black 1. Hydrogen ion concentration, concentration of Dye and amount of catalyst effects the photo degradation of Sulphur Black 1. It was concluded favourable condition for photo degradation at pH 7.5, 0.25g $SrCrO_4$/100 ml, 3.5 X $10^{-5}$M dye concentration. It may be explored for water treatment of industrial effluents in future.

## Acknowledgement

I am very thankful to the Principal of M. L. V. Govt. College Bhilwara and H.O.D., Department of Chemistry, M.L.V. Govt College Bhilwara for provided all laboratory facilities for research work.

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