

# PHOTOCHEMICAL OXIDATION FOR DECOLORIZATION OF REACTIVE RED DYE SOLUTION USING UV/H<sub>2</sub>O<sub>2</sub>

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## Abstract

Shading retains the daylight dependable in the photosynthesis of sea-going plants, keeping it from infiltrating into the water. This causes genuine risk to the biological community. Color is likewise obvious even at low focus; henceforth, the treatment of wastewater containing color must meet legitimate guidelines as well as stylish measures too. Hence the study concentrated on advanced oxidation processes using H<sub>2</sub>O<sub>2</sub> and UV for the decolorization of reactive dye, Remazol Red RB 133. The study observed that, H<sub>2</sub>O<sub>2</sub> and UV when used individually are inefficient in color removal. But when used in combination gives satisfactory results.

**Keywords:** Decolorization, Hydrogen Peroxide, UV, Reactive Dye

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## I. INTRODUCTION

Dyes constitute a little part of the aggregate volume of waste released in material handling. Shading expulsion from emanating is a noteworthy issue for material industry in view of a few reasons; the nearness of even a little division of colors in water is exceedingly noticeable because of high tintorial estimation of colors and influences the tasteful value of streams and other water assets (Joshi et.al, 2004). Colors are arranged by application and synthetic structure. They are made out of a gathering of particles in charge of the color shading, called chromophores, and also an electron pulling back or giving substituents that cause or heighten the shade of the chromophores called auxochromes (Christie, 2001). (Christie, 2001). The most important chromophores are azo (-N=N-), carbonyl (-C=O), methane (-CH=), nitro (-NO<sub>2</sub>) and quinoid groups. The most important auxochromes are amine (-NH<sub>3</sub>), carboxyl (-COOH), sulfonate (-SO<sub>3</sub>H) and hydroxyl (-OH). It is worth to mention that the sulfonate groups confer very high aqueous solubility to the dyes. The auxochromes can belong to the classes of reactive, acid, direct, basic mordant, disperse, pigment, vat, anionic and ingrain, sulphur, solvent and dispers dye (Andre et al. 2007).

## II. LITERATURE REVIEW

### A. Reactive Dyes

Reactive colors have been recognized as the trickiest compound in the material color effluents. They are portrayed by their promptly water dissolvability and their high steadiness and tirelessness basically because of their intricate structure and engineered birthplace. Since they are purposefully intended to oppose debasement, they subsequently offer an extensive resistance against concoction and photolytic corruption.

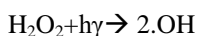
Additionally, the same number of material colors, responsive colors are generally non-biodegradable under normal vigorous conditions found in traditional biologic treatment frameworks. Among them the responsive azo colors family is of unique intrigue in spite of the fact that they are more often than not of non-dangerous nature, they may create under anaerobic conditions breakdown items as fragrant amines thought to be possibly cancer-causing, mutagenic and harmful. Shade of material effluents is created by colors utilized in coloring forms (Julia, 2007)

### B. Treatment Technologies

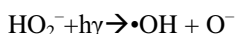
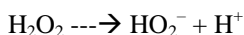
Effluent from the industries containing reactive dyes causes serious environment pollution because, the presence of dyes in water is highly visible and affects their transparency and aesthetic even if the concentration of the dyes is low. Reactive dyes cause respiratory and nasal symptoms, asthma rhinitis and dermatitis, allergic contact dermatitis. Adverse effects have also been detected from aquatic environment. Dyes have a very low rate of removal ratio for BOD to COD (less than 0.1) (Shyamala et.al, 2014). Most dyes have complex aromatic structure resistant to light, biological activity, ozone and not readily removed by typical waste treatment processes (Joshi et.al, 2004). The removal of dyes is therefore a challenge to both the textile industry and the wastewater treatment facilities that must treat it before its disposal into water bodies. Conventional oxidation treatment has found difficulty to oxidize dyestuffs and complex structure of organic compounds at low concentrations. To ease the problem, Advanced oxidation processes (AOP's) have been developed to generate hydroxyl free radicals among which UV/H<sub>2</sub>O<sub>2</sub> gaining larger interest.

The UV/H<sub>2</sub>O<sub>2</sub> process combines two processes: direct photolysis of organic compounds by absorption of UV light, and oxidation of compounds by means of •OH radicals, formed by absorption of UV light by H<sub>2</sub>O<sub>2</sub> (KWR, 2011).

The direct photolysis of hydrogen peroxide leads to the formation of OH radicals [Rein, 2001]:



Also HO<sub>2</sub><sup>•</sup>, which is in an acid–base equilibrium with H<sub>2</sub>O<sub>2</sub>, absorbs the UV radiation of the wavelength 254 nm:



H<sub>2</sub>O<sub>2</sub>/UV process has been successfully used for the destruction of chlorophenols and other chlorinated compounds

The present work concentrated on the decolorization of reactive dye, Remazol Red RB 133 by using H<sub>2</sub>O<sub>2</sub> and UV.

### III. MATERIALS AND METHODS

Remazol red is a monochlorotriazine reactive group. Its structure is shown in fig 1. Synthetic solutions of reactive dye have been chosen for the present investigation. The basis for the selection of red dye is the toxicity impact of azo dye to the environment. In the present investigation stock solution of the selected dye was prepared by dissolving accurately weighed 1g of dye in one litre of double distilled water. The resultant solution contains 1000mg/L concentration of reactive dye. 100 mg/L concentration of solution was chosen for the study with the working volume of 500 mL. (Mollah et al, 2010, Jovic et al, 2013)

UV reactor is as shown in fig 2. The UV reactor is equipped with 27W UV tube having a wavelength of 254 nm with an intensity of 30,000 μW-s/cm<sup>2</sup>.

Different dosages of hydrogen peroxide were added to glass beaker having dye solution. The beaker was placed on a magnetic stirrer for continuous stirring.

During the experiment, samples were collected at regular intervals and analyzed for decolorization using Mini Scan Elico Spectrophotometer. The pH measurements were made on Elico Ion Analyser (LI 126). Determination of the color of the sample carried out by measuring the absorbance at a wavelength of 510nm (λ<sub>max</sub>). The percentage of color removal was calculated as follows;

$$\text{Color removal (\%)} = \left\{ \frac{[\text{abs (max)} - \text{abs}(t)]}{\text{abs (max)}} \right\} 100$$

Where, abs<sub>max</sub> = Absorbance of the raw sample at 510nm.

abs<sub>t</sub> = Absorbance of the samples collected at regular time intervals, t at a fixed wavelength of 510 nm.

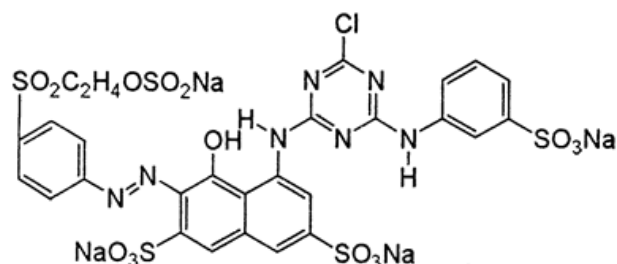


Fig 1: Molecular Structure of Remazol Red Rb 133

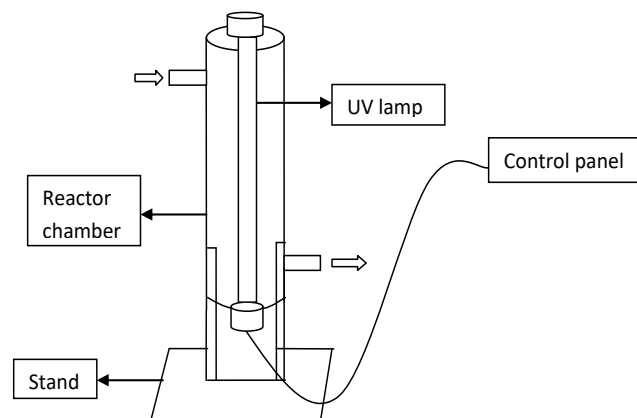


Fig 2: Advanced Oxidation by UV - reactor setup.

### IV. RESULTS AND DISCUSSIONS

The objective of any AOPs is to create and utilize hydroxyl free radical as solid oxidant to annihilate exacerbate that can't be oxidized by traditional oxidant (al-kdasi et.al, 2004).

#### C. Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>)

H<sub>2</sub>O<sub>2</sub>, can be utilized as a part of different applications as a result of the distinctive routes in which it works specifically, and in light of the fact that it has neither vaporous discharge nor concoction buildups as found with other synthetic oxidants. The study concentrated on the effect of H<sub>2</sub>O<sub>2</sub> alone on the decolorization of the reactive dye. Fig 3 shows the results of percentage of color removal when different dosages of H<sub>2</sub>O<sub>2</sub> added to the 100 mg/L concentration of reactive dye solution.

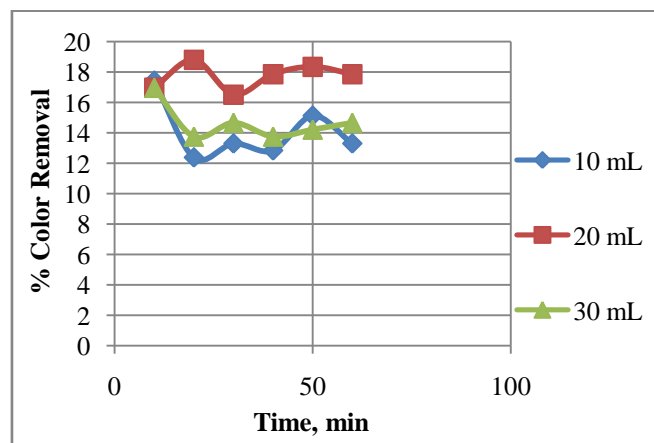
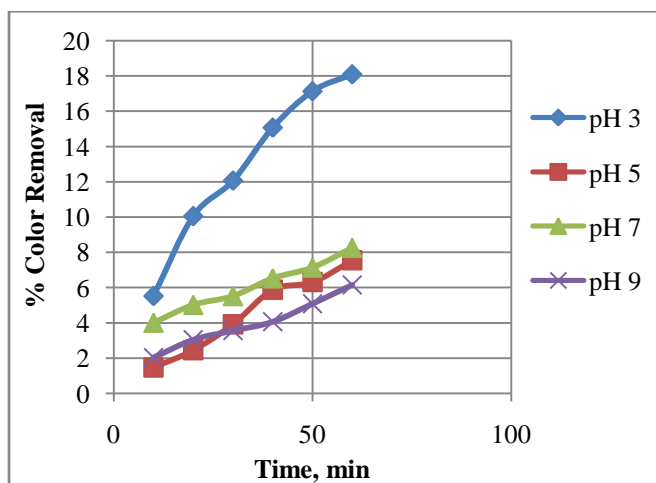


Fig 3: Percentage Color Removal when Different Dosages of H<sub>2</sub>O<sub>2</sub> Added.

From the fig 3 it is observed that, a maximum of 13.30%, 17.86% and 14.67% of color removal achieved with 10, 20 and 30 mL dosages of  $H_2O_2$  alone. The rate of decolorization is maximum with 20 mL of  $H_2O_2$  later it decreased. The impact of working conditions were watched when measuring through a spectrophotometer at the obvious most extreme ingestion, it was found that the rate of decolorization expanded with the underlying measurement of  $H_2O_2$  up to a greatest and past which decoloration was restrained (Kehinde, et.al, 2014)

#### D. UV

UV radiation is considered as a basic component in photochemical oxidation for which the discharged wavelength assumes a critical part. Such AOPs are generally used to corrupt intensifies that retain UV radiation inside the relating scope of the range. Fig 4, shows the results of percentage of color removal only with UV irradiation at different pH. From the fig 4, it is observed that at an acidic pH the color removal efficiency is higher i.e 18.09% compared with other pH values.



**Fig 4:** Variation of Color Removal at Different pH with UV

From, fig 3 and fig 4, it is observed that, decolorization of reactive dye is not effective when  $H_2O_2$  and UV are used alone. High convergence of the  $H_2O_2$  goes about as a radical forager, while; low centralization of  $H_2O_2$  creates insufficient of hydroxyl radicals ( $OH^\bullet$ ) that devoured by color and this leads moderate rate of oxidation. Accordingly an exchange off between them will bring about an ideal  $H_2O_2$  dose, which still should be checked tentatively (Al-kadesi et. al, 2004).

#### E. Combination of UV and $H_2O_2$

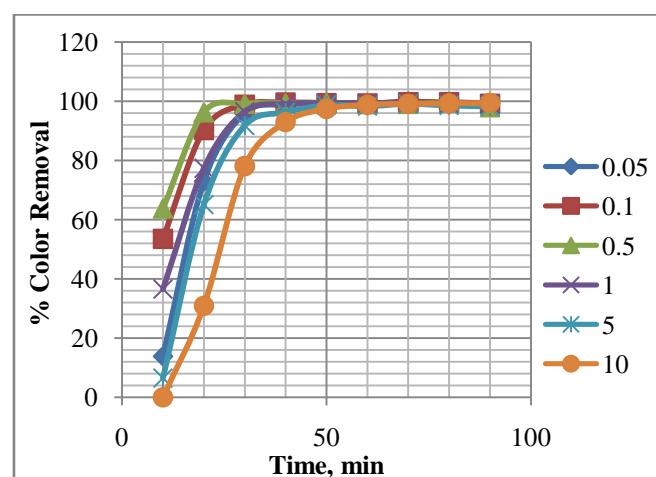
The UV/ $H_2O_2$ -based processes have shown better performance with removal efficiencies higher than 80% for all investigated parameters obtained when it was integrated with the biological treatment, thereby meeting the discharge limits while no-biodegradability enhancement was shown when the process was used as an end treatment (Kehinde, 2014).

Hence the study attempted with the combination of different dosages  $H_2O_2$  and UV for the decolorization of the reactive dye. Different dosages of  $H_2O_2$  added to the dye solution and placed in the UV reactor as shown in fig 2.

Fig 5 shows the decolorization of color with different dosages of  $H_2O_2$  (0.05, 0.1, 0.5, 1, 5, 10 mL) at different contact time of UV.

From fig 5 the variation of color removal of dye solution added with  $H_2O_2$  and exposed to UV radiations is found to be > 99%. It is in agreement with the other literature also (Sandip et.al, 2011)

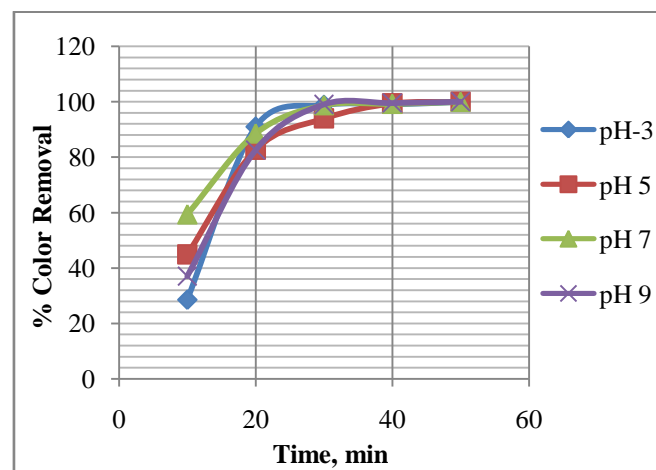
It is also observed that, with a dosage of 0.5 mL of  $H_2O_2$  with an exposure time of 50 min 99.48% of color removal achieved. Hence for further studies,  $H_2O_2$  dosage of 0.5 mL and 50 min duration was considered.



**Fig 5:** Percentage Removal of Color with Different Dosages of  $H_2O_2$  and UV at Different Contact Time.

#### F. Effect of initial pH onf UV+ $H_2O_2$

The research work also concentrated on combination UV and  $H_2O_2$  under different pH also. Table shows variation of color removal at different of pH 3, 5, 7 and 9.



**Fig 6:** Effect of pH on decolorization

It is observed from the fig 6, at the end of the reaction 100% decolorization was obtained at all different pH. At duration of 20 min, 90.99% of color removal was observed with a pH of 3. After 30 min of reaction time under different pH the decolorization was almost same. Later there was a gradual increase in the removal efficiency.

## V. CONCLUSIONS

From the results of  $H_2O_2$  and UV, it is concluded that, these oxidizing agents are inefficient to remove color when used alone. But in combination with each other, proved to be effective in the decolorization process. When UV alone is used, it is dependent on acidic pH. When used in combination with  $H_2O_2$ , it is effective in the color removal at pH 3. But after a reaction time of 30 min decolorization was almost similar with different pH. Hence study concluded that, Advanced Oxidation Process using UV/ $H_2O_2$  represent a powerful treatment for decolorization of reactive dyes in textile wastewaters.

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