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EFFECT OF H_2O_2 ON UV PHOTOLYTIC REMEDIATION OF AQUEOUS SOLUTIONS OF METHYLENE BLUE

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ABSTRACT: *The photolytic decoloration of aqueous solution of Methylene Blue dye with UV rays in presence of H_2O_2 has been investigated in this paper. The rate of decoloration; followed as a function of decrease in absorbance, was monitored spectrophotometrically at the λ_{max} of 664 nm. The influence of factors such as exposure time, dye concentration and dose of H_2O_2 was studied. Results revealed that decoloration of Methylene Blue dye could not be achieved effectively when either of UV rays and H_2O_2 was used.The effective decoloration could be achieved only in the presence of both i.e. UV rays and H_2O_2.The dose of H_2O_2 has significant effect on the rate of degradation. The effective decoloration was achieved at comparatively low dose of H_2O_2. As the dose of H_2O_2 increased beyond a certain limit, it was found to have negative effect on efficiency of decoloration. It was observed that, dye concentration has no remarkable effect on rate of decoloration. The rate of decoloration was quite high initially, but as the time of exposure was increased, the rate of decoloration was found to be slow and steady.*

Keywords: *Advanced oxidation process, decoloration , H_2O_2, photolytic*.

1. INTRODUCTION

Various types of synthetic dyes are widely used in large quantities as colorant in diverse applications like in the textiles, paper, plastics, leather, food and cosmetic industry. These industries generate enormous quantities of dye effluents containing residual dyes,some of which are toxic,carcinogenic and very difficult to degrade and hence can not be treated effectively using the conventional treatment methods[1-3].The conventional procedures include variety of chemical,physical and biological methods,like coagulation,adsorption,membrane process,ozonation-Oxidation[4-6]. Moreover they cause secondary pollution as they merely transfer the compounds from aqueous medium to another phase[7-8].The effluent from these industries is often discharged to municipal sewage treatment plants or directly to waterways which pose a severe threat to the environment and hence use of conventional dye wastewater treatment methods are becoming increasingly challenging for existing plants due to recent awareness about clean environment and strigent laws[9-11].

The introduction of Advanced Oxidation Processes has proved to be very effective in treating the dye waste waters.Combination of UV rays and H_2O_2 has been successfully utilized in advanced oxidation process to treat different pollutants in waters [12-16]. It has been reported in past that UV rays in presence of H_2O_2 results in almost complete decolorization and mineralization of azo and anthroquinone dyes.

The mechanism involved in above process that leads to complete destruction and hence decolorization of dye is based on generation of very reactive $^{\cdot}OH$ radical (having oxidation potential of 2.8 V).This OH radical is capable of oxidizing a broad range of organic compounds including dyes[17-18].

Methylene blue is a cationic dye which finds application in the dyeing of paper, linen and silk textiles, in the painting of bamboo, hair dye.It can also be used in manufacturing of ink, Lake Colour. Methylene Blue, although not considered to be a very toxic dye but can have very harmful effects on the living things. After inhale symptoms such as difficulties in breathing, vomiting, diarrhea and nausea may occur in human beings[19].

The molecular formula of MB is $C_{16}H_{18}N_3SCl$.Its IUPAC name is 3, 7-bis (Dimethylamino)-phenothiazin-5-ium chloride. The structural formula is as shown below in Fig**1**.

In the present study, aqueous solutions of Methylene Blue dye were treated with UV rays-H_2O_2 Advanced Oxidation Process.The influence of parameters like exposure time,H_2O_2 dose,change in pH was explored.

2.EXPERIMENTAL

2.1 Materials

All chemicals used were of AR grade. The mythylene blue dye was used without any further purification. All the solutions were prepared fresh using double distilled water.

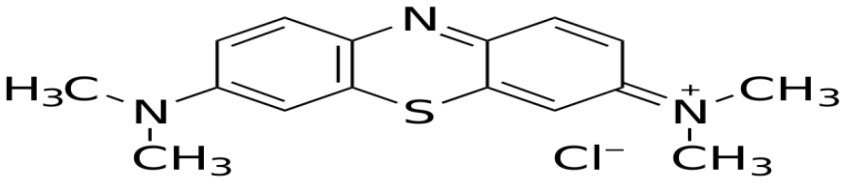

Fig.1. Structure of Methylene blue dye.

2.2 Methodology

The photolytic decoloration of aqueous solutions of Methylene Blue dye was carried out in absence and in presence of H_2O_2 using mercury lamp (12 W) as a source of UV rays .During the present study, first the UV rays alone were used to bring about the decoloration .Then it was studied by keeping concentration of dye solutions constant ,but varying the quantity of H_2O_2. The rate of decoloration followed as a function of decrease in absorbance, was monitored spectrophotometrically using Spectronic-D 20 spectrophotometer at the λ_{max} of 664 nm. The influence of factors such as exposure time, dye concentration and dose of H_2O_2 on the rate and extent of decoloration was also explored.

3. **RESULTS & DISCUSSION**

3.1 Calibration Plot

The calibration curve for methylene blue dye (as shown in Fig.**2**.) is prepared by plotting absorbance values against concentration of dye solutions. The change in absorbance with dye concentrations is found to be linear.

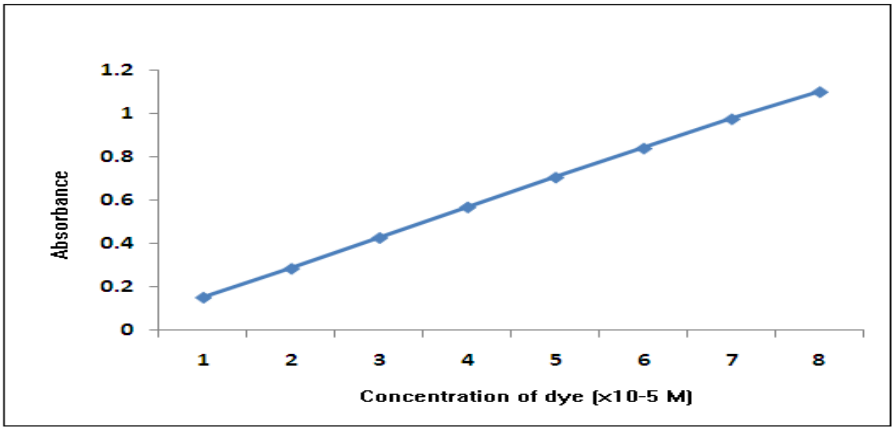

Fig.2.Calibration plot of Methylene blue dye

3.2 Discussion

Fig. **3** shows the percent decolorization of dye with exposure time of UV rays(in minutes) in presence and absence of H_2O_2. It can be seen from the graph that, in the absence of H_2O_2, the rate and extent of decolorization was slow and only 20% decolorization could be achieved. It is further seen that, initially the rate of decoloration was good, but as the time of exposure was increased, the rate of decoloration remained almost unaffected. The drastic change in rate and extent of decoloration was observed on addition of H_2O_2.This can be attributed to the generation of highly reactive $OH^{\cdot}$ radicals, which are generated on incidence of UV photon on H_2O_2 as per the equation(1).

It was further observed that, as the quantity of H_2O_2 was increased, the rate and extent of decolorization increases initially but when dose exceeded a certain value the rate and extent of decolorization was retarded. This may be due to the scavenging of $OH^{\cdot}$ radicals due to H_2O_2 at higher concentration as per equation(2).

$$H_2O_2 + h\upsilon \longrightarrow 2HO^{\cdot} \qquad \text{Eq.(1)}$$

$$HO^{\cdot} + H_2O_2 \longrightarrow HO_2 + H_2O \qquad \text{Eq..(2)}$$

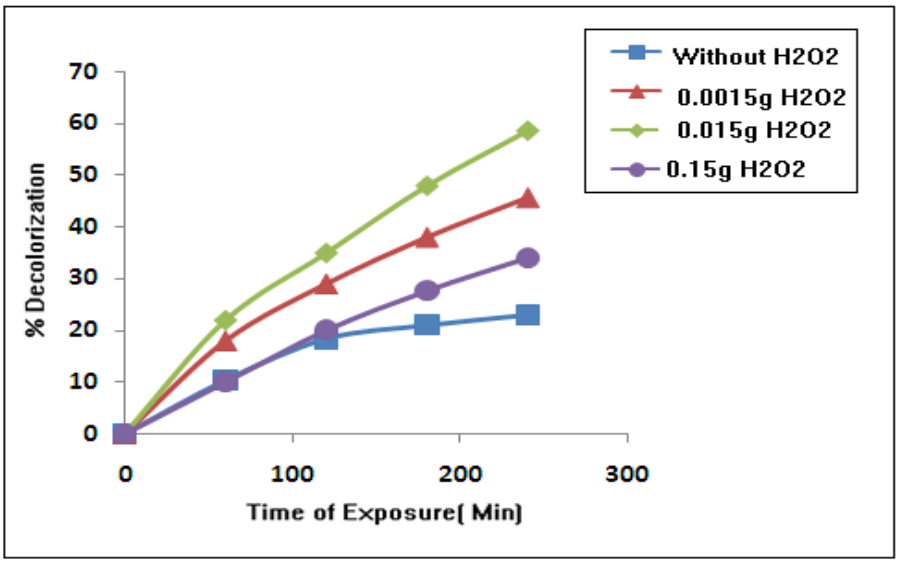

Fig.3.Effect of H_2O_2 on the extent of decolorization

It is also observed that, the pH and conductance of the irradiated solutions remains unchanged.

CONCLUSION

In the present study, the decoloration of Methylene Blue dye solutions was achieved effectively only when both UV rays and H_2O_2 were present. The degradation rate and extent increased with increase in concentration of H_2O_2 and reached the limiting value of H_2O_2. At the higher concentration of H_2O_2 the rate and extent of decoloration decreased. This can be explained on the basis of scavenging of OH^- radicals by H_2O_2 at higher concentrations. The pH and conductance of the irradiated solutions was remained unchanged.

Thus, UV photolysis of dye containing effluents can be achieved effectively by using UV rays-H_2O_2 advanced oxidation process. The another advantage of using this process is that it is a clean process as it do not involve formation of any precipitate as well as do not increase the dissolved solid in solutions.

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