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PHOTOLYTIC REDUCTION OF METHYLENE BLUE BY SnO_2 NANOPARTICLES

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Abstract : This study has been undertaken to investigate the photocatalytic activities such as degradation rate, time required to complete the degradation and kinetics of azo class of Methylene Blue (MB) dye by using SnO_2 Metal Oxide Nano (MONP) Particles as a catalyst.

***Keywords* – Methylene Blue, Benzophenone, SnO_2, Aloe vera, Acalypha indica**

1. INTRODUCTION

1.1 Photo reduction by sunlight in presence of benzophenone.

Alpha – hydroxyl ketones and their derivatives are extensively used in the photo curing of coating. The photochemistry is well investigated and some unsubstituted derivatives are biodegradable [1-5] .These compounds produces highly reactive free radicals on exposure to natural sunlight that is without the need for high power lamps often used in other photo degradation methods. In this investigation, benzophenone is employed as they are biodegradable and hence after aerobic biodegradation would not add to final carbon load in the water and therefore it was chosen as reducing generated on photolysis as the carbon centered free radicals generated on photolysis are reducing in nature [6-10].

2 Experimental works: Photolytic Degradation of MB by SnO_2 NPs

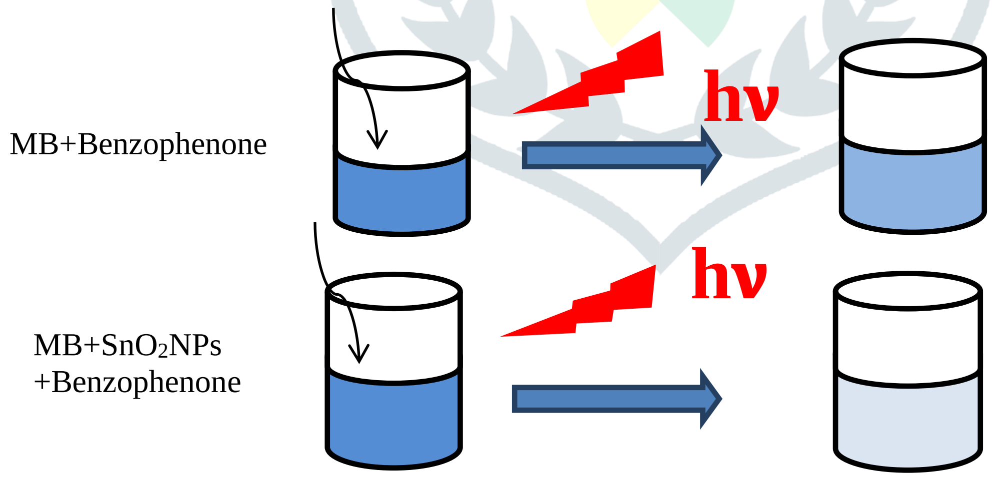
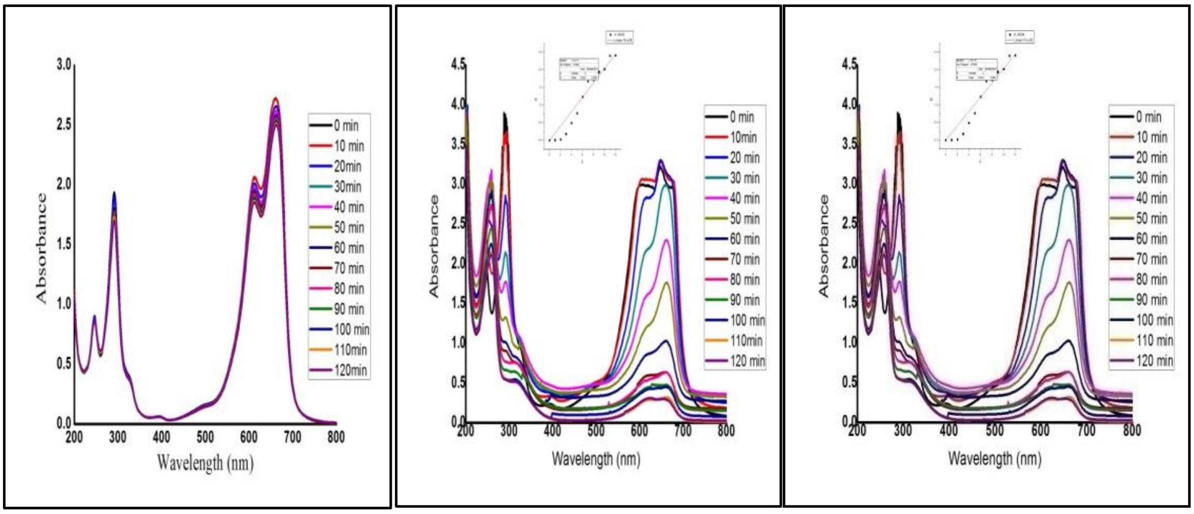


Fig. 1: Photolytic Degradation of MB by SnO_2 NPs

Methylene Blue was prepared by crushing the Methylene Blue dye in a mortar in crude ethanol. Similarly benzophenone was prepared in crude ethanol[11-14]. A reaction mixture containing 4ml of 10^{-4} M Methylene Blue and 0.150ml of 0.05 M benzophenone in a total volume of 50 ml was exposed to sunlight by adding distilled water [16,19]. The absorbance of Methylene blue was monitored at 520 nm as a function of time. Similar reaction mixture of 50 ml in addition of 1ml of SnO_2 NPs with different protecting materials was exposed to sunlight and the absorbance was monitored at 520 nm.

4.4.5 Analysis of Photolytic Degradation of Methylene Blue by SnO_2 NPs



a) Photolytic Degradation of MB Without NPs

b) Photolytic Degradation of MB by SnO_2 NPs using Aloevera

c) Photolytic Degradation of MB by SnO_2 NPs using Acalypha indica

Figure 2: Analysis of Photolytic Degradation of MB by SnO_2 NPs

The Photolytic degradation of MB in attendance of SnO_2 NPs showed a maximum absorption band (λmax) at 667 nm with a shoulder at 610 nm [19] whereas, the strong absorptions also located at 292 nm and 246 nm in UV–Vis spectrum. The λmax at 664 nm was due to of the absorption of cyclic imine group, 292 nm was due to the absorption of poly cyclic earrings present in MB and 246 nm was due to absorption of the formed amino group [2-5]. This catalytic reaction can be simply escorted UV-Vis spectrophotometrically because the λ_{max} of MB is well separated from the surface Plasmon absorption of SnO_2 NPs.

In the absence of SnO_2 NPs as a catalyst, the photolytic degradation of MB via sunlight become extremely sluggish this is shown in Figure 2 (a). It was discovered that the intensity of λ_{max} at 667 nm stays almost unaffected for several hours when a blank experiment was performed without SnO_2 NPs as a catalyst [15-17]. Hence, this reaction was not kinetically favorable in the absence of SnO_2 NPs and couldn't be recognized only in presence of sunlight. But the degradation of MB started out instantly upon the addition of SnO_2 NPs as a catalyst. This was noticeable from the fading of the blue color of the reaction medium in addition to the lower in depth of the peak at 667 nm [17]. The reaction was completed in 120 min which was evident from almost zero absorption at 667 nm shows in figure 2 (b-c). Thus, the photolytic degradation of MB in the absence of the SnO_2 NPs was thermodynamically favorable but not kinetically. SnO_2 NPs catalyst supplied an alternative path of low activation energy for the photolytic degradation of MB which reduced the kinetic barrier thereby making it thermodynamically in addition to kinetically favorable [18].

5.4.6 Kinetics studies for photolytic degradation of MB by SnO_2NPs

The kinetics study for the photolytic deprivation of MB catalyzed by SnO2 NPs in attendance of sunlight was carried out by using the Langmuir-Hinshelwood mechanism [17 -18].

Rate constant k is the pseudo first order velocity constant, decided from the Langmuir-Hinshelwood expression given by using following equation

$$\ln \frac{C_0}{C_t} = Kt$$

Where C_0 and C_t are the initial and very last concentrations having equal in terms of A_0 and A_t correspondingly and tested at a fixed wavelength at time t, a plot of ln (A0/At) with time offers a straight line whose slope is the k. Hence, k is the pseudo first order rate constant for SnO_2 NPs.

The reaction rate constant is found to be as below given table

Photolytic degradation of MB in presence of	**Reaction rate constant**
Without NPs	0.000001 min^{-1}
SnO_2 NPs. (Using Aloevera)	0.018 min^{-1}
SnO_2 NPs. (Using Acalypha indica)	0.012 min^{-1}

Table 1: Analysis of Photolytic Degradation of MB by SnO_2 NPs

5.5 Conclusions

The following broad conclusions may be drawn:

- Kinetics of degradation of MB has been investigated and found to be pseudo first order. The Rate Constant for degradation of MB it is 0.018 min^{-1} for aloevera and0.012 min^{-1} for acalypha indica.

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