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PHOTOLYTIC REDUCTION OF METHYL ORANGE BY SnO2 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 Methyl Orange (MO) dye by using SnO_2 Metal Oxide Nano (MONP) Particles as a catalyst.

Keywords **– Methyl Orange, 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 [1-4] .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 [5-7].

2 Experimental works: Photolytic Degradation of MO by SnO_2 NPs:

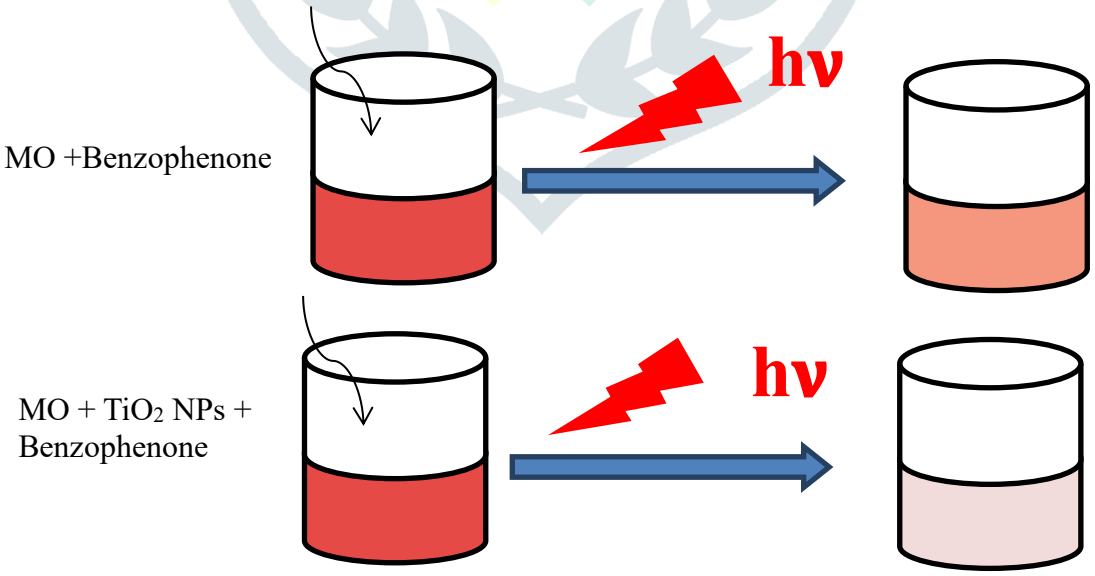
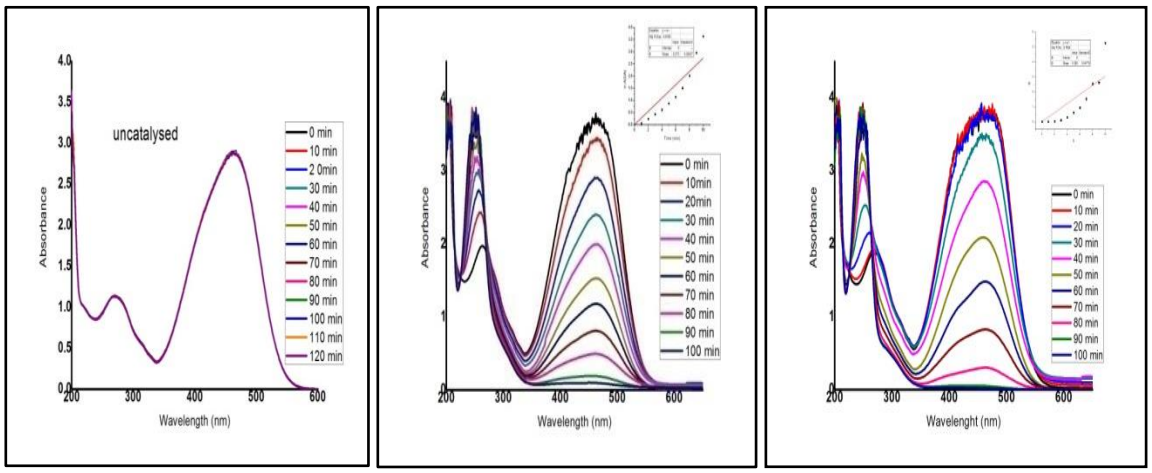


Fig. 1: Photolytic Degradation of MO by SnO_2 NPs

Methyl orange was prepared by crushing the methyl orange dye in a mortar in crude ethanol. Similarly benzophenone was prepared in crude ethanol. A reaction mixture containing 4ml of 10^{-4} M methyl orange and 0.150 ml of 0.05 M benzophenone in a total volume of 50ml was exposed to sunlight by adding distilled water [12-15]. The absorbance of methyl orange 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 [8-10]

3.Analysis of Photolytic Degradation of MO by SnO_2 NPs



a) Photolytic Degradation of MO Without NPs Using Aloevera **b) Photolytic Degradation of MO by SnO_2 NPs** **c) Photolytic Degradation of MO by SnO_2 NPs using Acalypha indica**

Fig. 2: Analysis of Photolytic Degradation of MO by SnO_2 NPs

Photolytic Degradation of MO in presence of sunlight was used to judge against the catalytic performance of both prepared kinds of SnO_2NPs which had shown that Photolytic Degradation reaction changed into kinetically as well as thermodynamically favorable and its main spectral bands did no longer overlap with the SPR band of SnO_2 NPs [15-18]. The UV–visible spectrums have been shown strong absorptions at 460 nm and 258 nm in an aqueous solution of MO [11]. The absorption at wavelength 460 nm was because of the azo group and absorption at wavelength 258nm was due to the formed amino group [14 -16].

Photolytic Degradation of MO in presence of sunlight without catalyst was tremendously slow which is shown in figure 2 (a). From the figure, it is cleared that the intensity of λmax at 460 nm remained nearly stays same for numerous hours while a blank test was carried out without SnO_2 NPs catalyst [17]. Therefore this reaction couldn't be identified only with sunlight and it became no longer kinetically favorable in the absence of the catalyst. But the Photolytic degradation of MO started out straight away upon the addition of SnO_2NPs as a catalyst [11-12]. This became clear from the vanishing of the orange shade of the reaction medium as well as the decrease in intensity of the peak at 460 nm. The Photolytic degradation of MO via $NaBH_4$ resulting in the formation of amino compounds from the azo group of MO. The degradation reaction was completed within 120 min which become evident from almost zero absorption at 460 nm as shown in figure 2 (b-c). Thus the Photolytic degradation of MO by means of $NaBH_4$ in the absence of the SnO_2 NPs was thermodynamically favorable but not kinetically. SnO_2NPs catalyst supplied an alternative route of low activation energy for the Photolytic degradation of MO which reduced the kinetic barrier thereby making it thermodynamically as well as kinetically favorable [13].

5.4.4 Kinetics studies for photolytic degradation of MO catalyzed by NPs

The kinetics study of photolytic deprivation of MO catalyzed by SnO_2 NPs in presence of sunlight became achieved by means of the Langmuir-Hinshelwood mechanism [15].

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 phrases of (A_0 and A_t correspondingly) observe at a constant wavelength at time t, a plot of ln(A_0/At) regarding time offers a straight line whose slope is the velocity constant k [18-19]. Hence, k is the pseudo first order velocity constant for photolytic deprivation of MO by both prepared SnO_2 NPs. The reaction rate constant is found to be as below given table

Photolytic degradation of MO in presence of	Reaction rate constant
Without NPs	0.000001 min^{-1}
SnO_2 NPs. (Using Aloevera)	0.023 min^{-1}
SnO_2 NPs. (Using Acalypha indica)	0.019 min^{-1}

Table 5.5: Analysis of Photolytic deprivation of MO by SnO_2 NPs

4.5 Conclusions

The following broad conclusions may be drawn:

- Kinetics of degradation of MO has been investigated and found to be pseudo first order. The Rate Constant for degradation of MO it is 0.019 min^{-1} for acalypha indica and 0.023 min^{-1} for aloevera.

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