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Study of Effect of Temperature, Light intensity and Irradiation time during Decolouration Process of Methyl Green Dye

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Abstract : Methyl green is the oldest known synthetic groups. Most basic dyes of this series are beautiful crystalline Compounds with a reflex the colour of which is often complementary to the colour in solution. Methyl green a triarylmethane dye providing toxic effluents can be highly degraded using TiO_2 catalyst. Photo catalytic degradation of methyl green dye have been studied with the help of variety of parameters which are effect of temperature, light intensity and irradiation time. The influence of temperature has been studied in the range from 30^{O}C to 55^{O}C. The rate constant increased with the increase in the light intensity.
Keywords – Methyl green, Toxic, Catalyst, Temperature, Light Intensity.

Introduction - It is well Known that dyes and their degradation by Products originated through oxidation, hydrolysis reactions are highly carcinogenic (1) These substances are highly toxic, Stable to natural decomposition. Decomposition of dye effluents has therefore required increasing attention (2) Earlier studies have shown that a wide range of organic substrates can be completely photo mineralized in the presence of TiO_2 (3) Aqueous degradation of the commonly used textile dye methyl green has already been studied using heterogeneous catalysts such as TiO_2 with artificial visible light source. The aim of this paper is to study the effect of temperature, light intensity and irradiation time during Decolouration process of Methyl green dye.

Experimental: Methyl green was obtained from Loba Chemie. Photo catalyst TiO_2 was obtained from the S.D. Fine Company. All Solutions were prepared in doubly distilled water. Photo catalytic experiments were carried out with 50 ml of dye solution (3.8x10-5 mol dm-3) using 300mg of TiO_2 photo catalytic under exposure to visible irradiation in specially designed double-walled slurry type batch reactor vessel made up of Pyrex glass (7.5 cm height, 6 cm diameter) surrounded by thermostatic water circulation arrangement to keep the temperature in the range of 30$\pm$0.3.c. Irradiation was carried out using 500 w halogen lamp surrounded by aluminum reflector to avoid irradiation loss. During photo catalytic experiments after stirring for 10 min slurry composed of dye solution and catalyst was placed in dark for ½ h in order to establish equilibrium between adsorption and desorption phenomenon of dye molecule on photo catalyst surface. Then slurry containing aqueous dye solution and TiO_2 was stirred magnetically to ensure complete suspension of catalyst particle while exposing to visible light. At specific time intervals aliquot (3ml) was withdrawn and centrifuges for 2 min at 3500 rpm to remove TiO_2 particle from aliquot to assess extent of decolourisation photo metrically. Changes in absorption spectra were recorded at 480 nm on double beam UV-Vis, spectrophotometer (Systronic Model No. 166) Intensity of visible radiation was measured by a digital luxmeter (Lutron LX 101). pH of solution was measured using a digital pH meter.

Results and Discussion:

Effect of temperature: One of the advantages of photoreaction is that it is not affected or slightly affected by temperature change (4, 5). The influence of temperature has been studied in the range from 30^{0}C to 55^{0}C. The results are shown in Table 1 and Fig. 1. Increase in temperature led to decrease the rate of degradation. This gradual decrease in the reaction rate values could be attributed to the following reasons: the adsorption rate decreased with increasing temperature because the adsorption is a heat releasing process, increase in reaction temperature tend to increase electron-hole recombination and with increase in temperature the solubility of oxygen in water decreased (6).

Table 1: Effect of temperature: [MG] = 2.5×10^{-5} mol dm^{-3}, pH = 10.0
TiO_2 = 100 mg/ 10 mL, Light intensity = 20×10^{3} lux, Temperature = 30 ± 0.3 ºC.

Temperature (^{0}C)	k × 10^{-4} s^{-1}	$t_{1/2}$ × 10^3 s
30	2.45	2.82
35	2.35	2.94
40	2.12	3.26
45	2.00	3.46
50	1.80	3.85
55	1.75	3.96

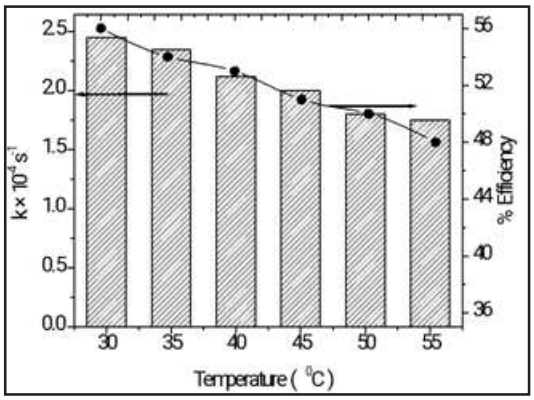

Fig. 1: Effect of temperature

Effect of light intensity and irradiation time:

Photocatalytic reaction rate depends largely on the radiation absorption of the photocatalyst. Research studies revealed increase in the degradation rate, with increase in light intensity during photocatalytic degradation. The influence of light intensity on the rate of degradation has been examined at constant dye concentration (2.5 × 10^{-5} mol dm^{-3}) and catalyst loading (100 mg/ 100 mL). Rate constant increased from 1.80 × 10^{-4} s^{-1} to 5.83 × 10^{-4} s^{-1} on increase light intensity from 10 × 10^3 lux to 35 × 10^3 lux.

Table 2: Effect of light intensity: [MG] = 2.5 × 10^{-5} mol dm^{-3}, pH = 10.0

TiO_2 = 100 mg/ 100 mL, Light intensity = 20 × 10^3 lux, Temperature = 30 ± 0.3 ^{o}C.

Light intensity×10^3 lux	k × $10^{-4}$$s^{-1}$	$t_{1/2}$× 10^3 s
10 × 10^3	1.80	3.85
15 × 10^3	2.03	3.41
20 × 10^3	3.37	2.05
25 × 10^3	4.41	1.57
30 × 10^3	4.49	1.54
35 × 10^3	5.83	1.18

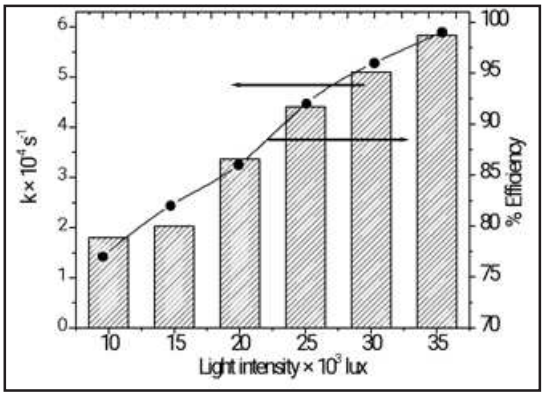

Fig. 2: Effect of light intensity

Conclusion : The influence of temperature has been studied in the range from 30^{O}C to 55^{O}C. The rate constant was decreased with increase in temperature photo catalytic reaction rate depends largely on the radiation absorption of the photo catalyst. Rate constant increased with increase in light intensity.

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