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A Comparative Study on Photo Catalytic Degradation of Textile Industry Effluent by Using TiO₂/ZnO Photocatalyst.

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ABSTRACT

The textile industry consumes large quantities of water and produces large volumes of waste water from different step of designing, scouring, bleaching, dyeing, finishing, folding and packing. Waste water from dyeing unit is rich in color containing residues of reactive dyer and chemical such as complex components many aerosols, high chrome, high COD & BOD concentration as well as much more hard degradation materials. The photo catalytic degradation of this effluent is reported in the present paper TiO₂/ZnO were used as photo catalyst for the study. The rate de-colorization was estimated from residual concentration spectrophotometrically. Effect of some operating parameters such as the initial pH, H₂O₂/COD ratio and the amounts of catalyst on the degradation of the effluent were investigated.

INTRODUCTION

The textile industry is a high consumer of water mainly as process water (90-99%) and cooling water (6-10%) and finally loaded with different pollutants dyer, surfactants, acids or basic salts, heavy metals and suspended solids. Dyes and pigments are widely used in the textile industry. Textile industries generate 100-170 lit dye effluent per kg of cloth processed which could be characterized by strong odor, high COD and wide range of pH. These pollutants, if not properly treated are responsible for introducing hazards into the receiving water bodies including aquatic liver, human beings and ecosystem stability. Result in becoming a cancer promoter, acute toxicity, skin diseases, allergenic and mutagenic. As a result of these problems, advanced oxidation processor (AOPs) have been considered as an effective technology in treating textile industrial waste water. AOPs are a group of processor that are based on the generation of hydroxyl radicals, which are highly reactive oxidants. AOP are able to oxidize a wide range of compounds that are otherwise difficult to degrade. Photo catalytic systems are the combination of a semiconductor (like TiO₂, ZnO, AlO₃, WO₃)^[1-14]

EXPERIMENTAL

The photo catalytic reaction was carried out in a batch reactor with dimension of 7.5 x 6 cm (height x diameter) provide with a water circulation arrangement in order to maintain the temperature in the range of 25 – 300 C. The irradiation was carried out using 500 W halogen lamp. In all cases during the photolysis experiments the effluent, Potassium dichromate, sulphuric acid and mercuric sulphate solution and the catalyst was placed in the reactor and stirred magnetically with simultaneously exposure to visible light. Sample was withdrawn at periodic intervals from the reactor to assess the extent of de-colorization. The intensity of light was measured by lux meter (Lutron LX-101). A photocolimeter was used for measuring absorbance at different time intervals at 620 nm.

Effect of Concentration of effluent

Photo catalytic degradation of effluent for different concentration of effluent like 8 ml, 12 ml, 16 ml, 20 ml and 24 ml solution containing 30 mg TiO₂ /nano catalyst. The change in concentration of the

effluent in the solution, plotted as function of concentration of effluent. It is seen that degradation of COD value was increased with time. Table-1 shows the k value of COD degradation when concentration of catalyst is constant and effluent concentration is changed.

An aliquot of 30 ml was taken out from the reaction mixture at regular time intervals and the absorbance was measured at $\lambda_{max} = 620 \text{ nm}$. It was observed that the absorbance of the solution decreases with increasing time intervals, which indicates that the concentration of COD decreases with increasing time of exposure. A plot of transmittance verses time was linear and follows pseudo first order kinetics. The rate constant was measured using following expression:

$$K = 2.303 \times \text{slope}$$

The results of typical run photo catalytic degradation of COD are shown in the Table 1 and graphically represented in Fig 1.

Amount of ZnO/TiO₂ = 50 mg
 Light intensity = 17500 lux
 (Effluent Concentration = 10 ml)

$\lambda_{max} = 620 \text{ nm}$.

Table 1: Effect of sample concentration

Sample Concentration ml	K value/sec (ZnO)	K Value/sec TiO ₂
8	96.92	94.95
12	109.64	104.78
16	146.53	143.53
20	169.98	163.98
25	179.68	177.18

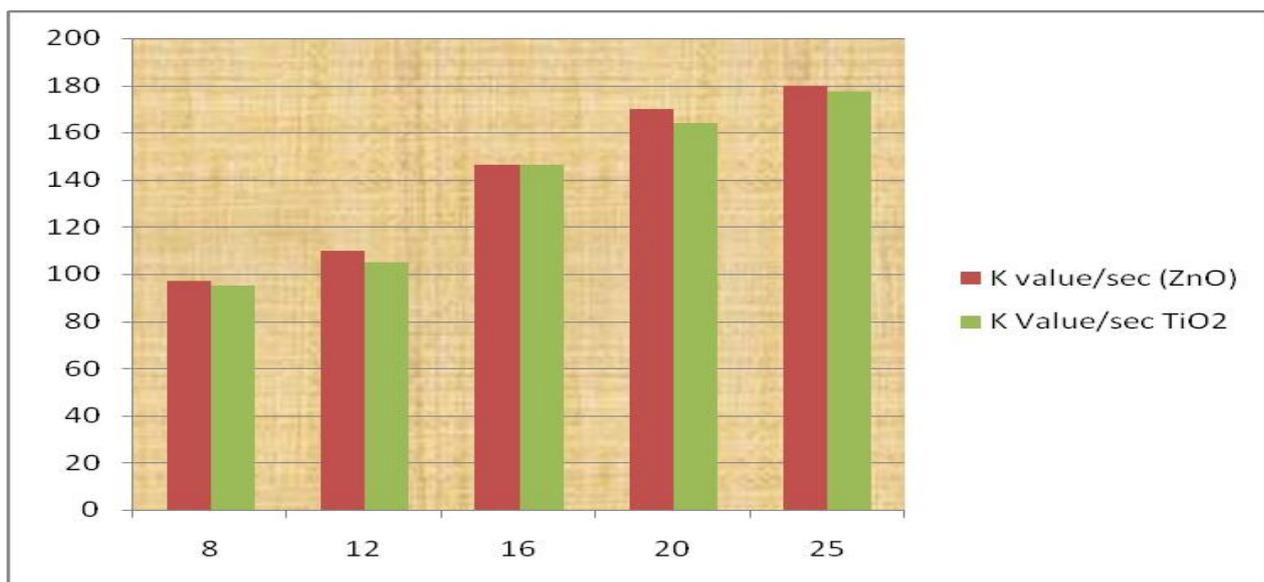


Figure 1: Bar diagram showing effect of sample concentration in % of degradation

Effect of Concentration of catalyst

The effect of concentration of both catalyst (ZnO and TiO₂) on the rate of photo catalytic degradation was observed by taking different concentrations of catalyst and effluent concentration was constant. The results are reported in the table 2. It is obvious to expect increase in reaction rate. It is evident that as the concentration of catalyst was increased, the rate of photo catalytic degradation of COD was increased.

From the experimental result we have observed that the decrease of k value with increase in initial concentration of the sample and vice versa can be attributed to the decrease in the path length of photon entering the solution due to impermeability of the solution. At low concentration the reverse effect observed, hereby increasing the number of photon of the solution. At low concentration the reverse effect

observed, explained in terms of the increase in requirement of catalysts surface for the increased concentration of the sample. But here the amount of catalyst had been kept constant. Hence the relative numbers of O₂ and OH radicals formed on the surface of TiO₂ are also constant. As a result the relative number of O₂ and OH attacking the organic molecule with increasing initial concentration of the catalyst. The plot of % of degradation Vs both catalyst. Amount of Ti O₂ = 30 mg, 60 mg, 90 mg, 120 mg, 150 mg. Amount of ZnO=30 mg, 60 mg, 90 mg, 120 mg, 150 mg.

Light intensity = 17500 lux λ max = 620 nm)

Table 2: Effect of catalyst concentration

Catalyst In mg.	K value/sec (TiO ₂)	K Value/sec(ZnO)
30	94.932	96.98
60	86.88	88.90
90	70.34	74.32
120	66.32	69.48
150	59.12	64.90

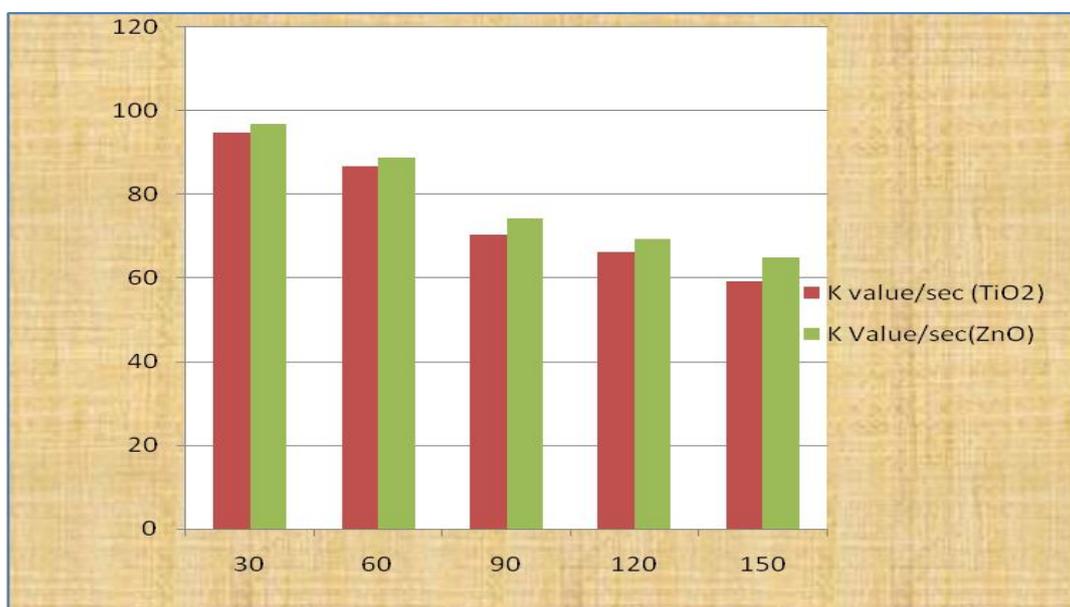


Figure 2: Bar diagram showing rate of degradation of Ti O₂ and ZnO

CONCLUSION

This paper describes the comparative study of the degradation of organic molecule through Ti O₂ & ZnO ,nano catalyst/UV and this is pseudo first order kinetics, the kinetics of heterogeneous catalytic(Ti O₂) reaction applied to waste water treatment. It is a novel experiment for determination of the kinetics of photo catalytic degradation of organic molecule (COD) in aqueous solution. It further validates the importance of AOPs in degraded through nano catalyst.

The Results of the study indicate that ZnO is very effective & suitable alternative to TiO₂. The best reaction dosage of ZnO catalyst is about 50 mg/150ml. The maximum degradation efficiency of textiles industrial dyeing section waste effluent was achieved with the combination of UV+ H₂O₂+ZnO. The maximum decolourisation occurred in \leq 90 min. The photodegradation of MB is 99%. It follows the first order kinetics.

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