Degradation of Anionic Dye using Fe /Tio2 Composite by Photocatalysis

B.Saritha, M.P. Chockalingam, Aswathy.M

Abstract: ***Dyeing industry discharges large amount of colored wastewater into water bodies without proper treatment. There are various methods to treat wastewater, but recently Photocatalytic treatment has been proven effective. So an effective Iron /Titanium Dioxide (Fe/TiO2) photocatalytic composite has been synthesized by sol-gel method. The synthesized Fe /TiO2 composite was characterized by scanning electron microscope (SEM), X-ray diffraction (XRD), Energy Dispersive Spectroscopy (EDAX). The photocatalytic degradation study of Fe/TiO2 composite under UV light was studied using the aqueous solution of anionic dye Congo Red. The effect of various parameters such as catalyst loading, pH and initial concentration of the dye on degradation has been investigated. The maximum degradation of Congo Red dye concentration in aqueous medium was obtained at pH=5 and 200 mg/l of Fe/TiO2 composite for 10 mg/l concentration of Congo Red dye. Finally, the results prove that photodegradation of Congo Red dye in aqueous solution using composite was very effective under UV irradiation***

Keywords : ***Photocatalytic degradation, Congo Red dye, Sol-gel, Fe/TiO2 composite, UV irradiation***

I. INTRODUCTION

Coloring enterprises releases immense measure of shaded wastewater which are very lethal that contaminates nature. Throughout the most recent couple of decades enormous scale use of synthetic compounds in different human exercises has become extremely quick, especially in a nation like India which needs to go for fast industrialization so as to continue over developing huge issue of populace. The real wellspring of water contamination is residential waste from urban and rustic regions, and mechanical squanders which are released into characteristic water bodies.

Ground water is the biggest wellspring of crisp water in creating nations and it is likewise exposed to such peril (2).Therefore corruption of the colors in modern wastewaters has created significant consideration because of their enormous volume of generation, moderate biodegradation, low decoloration and high toxicity(3-6).Various physico-substance treatment strategies are broadly utilized for treatment of these waste waters. Among all treatment strategies, photocatalytic degrdation is a promising method, for expulsion of different poisonous synthetic compounds found in wastewater. Heterogeneous photocatalytic oxidation is a powerful strategy to expel low groupings of natural contaminants (7).

Shading endeavors discharges huge proportion of concealed wastewater which are deadly that taints nature. All through the latest couple of decades gigantic scale utilization of manufactured mixes in various human activities has turned out to be amazingly brisk, particularly in a country like India which needs to go for quick industrialization in order to proceed over creating tremendous issue of people. The present case of current development changes the typical movement of materials and brings novel engineered substances into nature (1). The genuine wellspring of water pollution is private waste from urban and natural locales, and mechanical wastes which are discharged into trademark water bodies.

Ground water is the greatest wellspring of fresh water in making countries and it is moreover presented to such risk (2).Therefore defilement of the hues in current wastewaters has made critical thought in view of their colossal volume of age, moderate biodegradation, low decoloration and high toxicity(3-6).Various physico-substance treatment methodologies are comprehensively used for treatment of these waste waters. Among all treatment procedures, photocatalytic degrdation is a promising strategy, for removal of various noxious manufactured mixes found in wastewater. Heterogeneous photocatalytic oxidation is a ground-breaking methodology to remove low groupings of characteristic contaminants (7).

II. EXPERIMENTAL STUDY

A. Materials

All synthetic concoctions were of systematic evaluation reagents moving along without any more cleaning and obtained from Merck Company. Titanium Isopropoxide, Ferric Nitrate [Fe(NO¬3)¬.3¬9H¬2¬O]were utilized as got and obtained from Merck, India and were utilized moving forward without any more purging. Congo Red color was acquired from material industry. The atomic structure of Congo Red color is given in Fig. 1. Refined water was utilized for readiness of color arrangements . The pH of the arrangements were balanced with HCl/NaOH. [20],[22], [24]

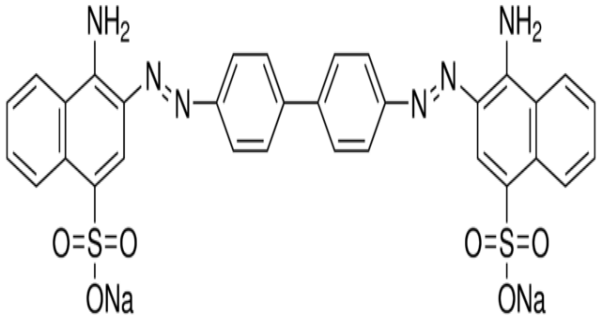

Figure 1: Structure of Congo Red Dye

B. Photocatalytic Reactor

The photocatalytic experiments were carried out in batch immersion type reactor. The reactor consists of a long [13], [15] ,[17]tube made of quartz which was placed inside the glass reactor fitted with standard joint. The reactor consists of 8W low pressure mercury vapor lamp which was placed inside the quartz tube.

C. Synthesis of Fe / TiO2 composite

Mix few ml of Titanium Isopropoxide with 2-propanol and distilled water. Then add Fe(NO3)3 9H2O solution to it. Mix it well using magnetic stirrer for 4 hrs. Keep this mixture in oven at 100°C for 10 hrs. Then cool to room temperature. Then heat the mixture at 450°C for 5hrs in Muffle Furnace to obtain Fe/TiO2 photocatalytic composite.

D. Photocatalytic Degradation of the Dye under UV Irradiation

Investigations were done under UV light. To 200 ml of color arrangement, a specific measure of impetus was added and suspension was exposed to UV light illumination. The watery suspension was blended all through the examination. A little amount of the example was taken after certain time interim, Fe/TiO2 composite were isolated utilizing rotator and the debasement rates were determined from assimilation estimations of Congo Red color focus estimated utilizing UV-Visible spectrophotometer

III. RESULTS AND DISCUSSIONS

Characterization of Fe / TiO2 composite

A . Surface morphological studies

The SEM images of Fe/TiO2 composite depicts the surface features which has been shown in Fig. 2. (a) and (b). Here the particles are agglomerated and are truely spherical in shape. Boundaries of particles are clearly shown in the SEM study of Fe/TiO2 composite. The surface texture and porosity nature of the composite is observed, this defines Fe/TiO2 composite as nanoparticles of few nanometer size in the form of nano clusters.

B. XRD measurement

The XRD results for Fe/TiO_2 composite (Fig.3.) have peaks at 2Θ values of 25.52º, 38.05º, 48.16º, 54.31º, 62.85º,70.42º and 75.35º can be assigned to the diffractions of (101), (112), (200), (105), (204), and (215) which indicates the formation of anatase phase of TiO_2.

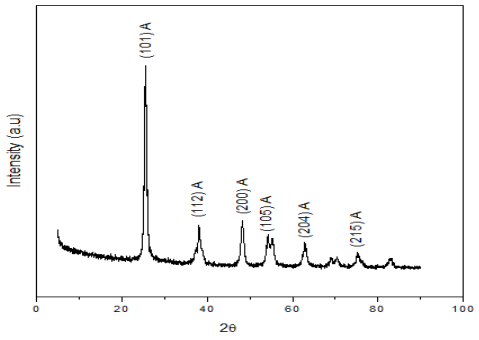

Figure 1: XRD pattern of Fe / TiO_2 composite

EDAX Spectrum

The EDAX spectrum for Fe/TiO2 composite shows different peaks which clearly depicts the presence of Ti, Fe and O. The EDAX (Energy Dispersive Spectroscopy) analysis of Fe /TiO_2 composite has been shown in Fig. 2. [14],[16], [18]

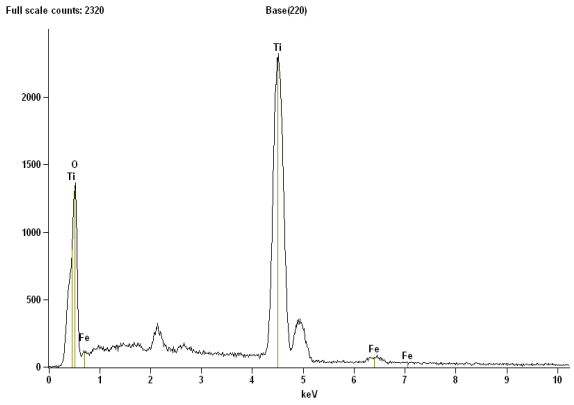

Figure 2: EDAX spectrum of Fe/TiO_2 composite

Photocatalytic Batch Study

A . Effect of catalyst loading

Bunch photocatalytic examinations were done utilizing different measurements of Fe/TiO2 composite (50 to 300mg/l) with consistent convergence of 10 mg/l of Congo Red color (Fig.5). It was seen that as Fe/TiO2 composite portion expanded, the rate debasement of color fixation expanded. Over 200 mg/l of Fe/TiO2 composite portion, there is no critical increment in the debasement of color. Along these lines, 200mg/l of Fe/TiO2 composite has been considered as an upgraded portion for debasement of Congo Red color. The expansion in corruption rate with increment in the impetus stacking is because of increment in all out dynamic surface zone for example accessibility of increasingly dynamic destinations on impetus surface. However, higher portion of impetus brings about increment in turbidity of the suspension which diminishes the infiltration of UV light and consequently photoactivated volume of suspension. Accordingly it very well may be reasoned that higher portion of impetus may not be helpful both in perspective on accumulation just as decreased illumination field because of light dissipating. [20],[22], [24]

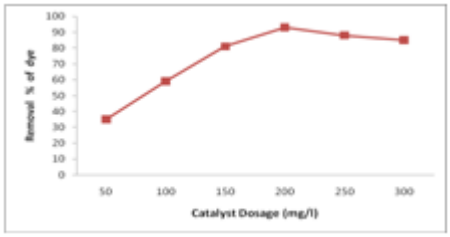

Figure. 3: Study of effect of catalyst dosage

B . Effect of pH

Material coloring wastewater is released at various pH; along these lines it is critical to consider the job of pH on corruption of color. So as to contemplate the impact of pH, tests were done at different pH esteems (2 to 8) at steady color fixation (10 mg/l) with Fe/TiO2 composite (100 mg/l). It was seen that the debasement effectiveness increments with increment in pH and most extreme corruption of 85 % for Fe/TiO2 composite was seen at pH 5 (Fig. 6). When changing upto pH 8 there is no critical increment in corruption. This demonstrates the shading expulsion proficiency of photocatalyst relies upon pH. [26],[28],[30]

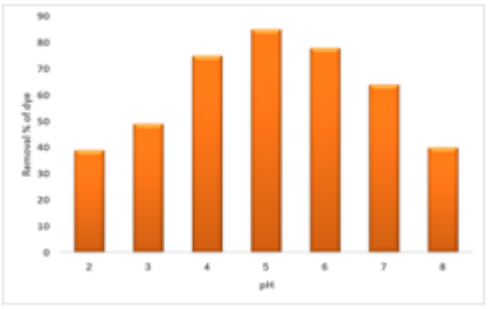

Figure 4: Study of effect of p

C. Effect of initial dye concentration

The effect of starting centralization of shading course of action has been investigated on the photocatalytic corruption at perfect pH (5) and driving force divide (Fe/TiO2 composite =200 mg/l). The shading center was contrasted from 50 to 150 mg/l. The clarification for this lead may be a result of the extension in the level of adsorption on the reactant surface which lessens the synergist activity. It has been seen from the Fig.7. The corruption decreases with augmentation in shading obsession with the impulse. At high shading center a great deal of UV light may be devoured by the shading molecule rather than the impulse and this may in like manner lessen the synergist viability. [7],[9] ,[11]

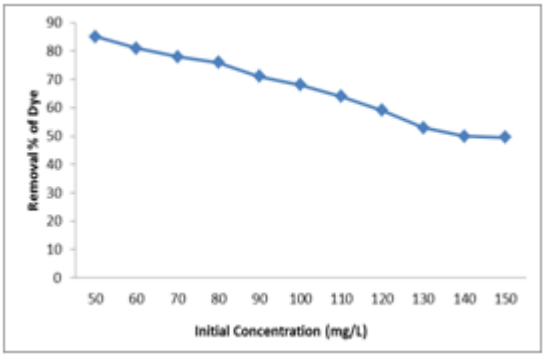

Figure. 5: Study of effect of initial dye concentration

IV. CONCLUSION

In this research work, the Fe/TiO2 composite has been synthesized successfully by sol-gel method and the characterizations clearly depicted the anatase phase of the synthesized Fe/TiO2 composite. The Fe/TiO2 composite dosage, pH of the solution and dye concentration plays a significant role in the photodegradation activity. Thus composite dosage = 200 mg/l and pH = 5 was found to be the optimal pH for 10 mg/l concentration of Congo Red dye under the photocatalytic batch study. Thus Congo Red dye has been effectively degraded to more extent with Fe/TiO2 composite along with UV light.

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