IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Photo Catalysts Are The Best Remedy For Treatment Of Waste Water

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ABSTRACT- The photo catalytic removal by using semiconductors especially TiO2 and SiO2 composite (TSC) were used out in presence of light to observe good semiconducting property. Preparation, characterization and applications of semiconducting materials were studied. The purification of the Wastewater in presence of photo catalysts were carried out. The photocatalysts remove of dyes, heavy metals and hardazous organic compound. The time required for photo catalytic degradation is different for different effluent samples, varied from 60 to 180 min. Parameters like band gap; Dose of Catalysts concentrations of effluent, pH, etc were studied. Studies. Results of the study showed that dyes removal in the dark was very low for the three types of Nano materials under the study conditions used. However, appreciable removal of dyes and metals was observed when using TSC for UV lights, the degradation of the dye by using semiconducting materials were characterized by XRD, and SEM analysis before and after application of photo catalysts.

KEYWORDS: Photo catalysis, TiO2, SiO2 semiconductors, XRD, SEM.

I. INTRODUCTION

Increasing demand for clean water due to rising population and pollution from industrial, Agricultural and domestic activities are among the factors affecting the quality of available water resources [1]. Chemical pollutants in the form of organics, inorganics and heavy metals are usually present in water bodies at generally low levels; however it is their high toxicity and potential to cause harm to humans that is of greater concern [2]. Nanotechnology holds great potential in advancing water and wastewater treatment to improve treatment efficiency as well as to augment water supply through safe use of unconventional water sources. Last few decades numerous research effect in the field of Photcatalysis by using semiconductor materials through particular system has been studied [3,4]. Dyes, heavy metals and hardagious organic compound produces huge amount of polluted effluents that are normally discharged on the surface water bodies and ground water aquifers [5]. This wastewater causes damages to the ecological system of the receiving surface water capacity and certain a lot of disturbance to the ground water resources. Most of the dyes used in the textiles industries are stable to light and non biodegradable [6]. In order to reduce the risk of environmental pollution from such as wastewater, it is necessary to treat before discharging it into the environment [7]. Study shows that toxic effects of these synthetic dyes as well as metals are observed in the presence of the ultraviolet component of sunlight (285-400 nm) [8].

Photcatalysis has large capability for the water treatment. It can be utilized for the decomposition of organic and inorganic compounds and removal of dyes [9]. A wide variety of semiconductors have been examined for their photocatalytic capacity shown to the most active amongst the other [10]. TiO_2 and SiO_2 composite (TSC) were selected as the photocatalyst for this project because it is insoluble in water, photos table, nontoxic, less expensive and It has higher photocatlytic efficiency [11]. Water treatment by using nanoparticles has high technology demand; its usage cost should be managed according to existing competition in market [12]. There are various recent advances on different nanomaterials (Nano structured catalytic membranes, Nano sorbents, Nano catalysts, bioactive nanoparticles, biomimetic membrane and Carbon Nanotubes for removing toxic metals, disease causing microbes, organic and inorganic solutes from water[13].The difficulty with the traditional waste water treatment techniques as adsorption, coagulation, chlorination, ionization, precipitation, ion exchange and reverse osmosis[14]. Most of these methods require high capital and recurring expenditure and consequently they are not suitable for small scale industries [15-16]. Beside the above a study of the effect of pH, contact time, dosage of photocatalyst, and characterization of semiconductors were studied.

Mechanism of Photocatalysis: mechanism:

Photocatalysis over a semiconductor oxide such as TiO2 is initiated by the absorption of a photon with energy equal to, or greater than the band gap of the semiconductor (3.2 eV for anatase), producing electron-hole (e-/h+) pairs, as written in the equation 1and 2.

$$TiO2 \quad h\nu \quad e^{-}(cb) \; (TiO2) \longrightarrow h^{+}(vb) \; (TiO2) \ldots\ldots\ldots\ldots (1)$$

The TiO2 and SiO2 composite particle can act as either an electron donor or acceptor for molecules in the surrounding medium. The valence band hole is strongly oxidizing, and the conduction band electron is strongly reducing. At the external surface, the excited electron and the hole can take part in redox reactions with adsorbed species such as water, hydroxide ion (OH-), organic compounds, or oxygen.

Effect of band gap of semiconductor

As a semiconductor is irradiated with light having energy (E= hγ) equal to or more than band gap energy, a heterogeneous photocatalyst reaction occurs on surface of semiconducting materials.The semi conducting forms a pair of valence band (Vb) hole and conduction band (Cb) electron as in case of zinc oxide and titanium dioxide. Titanium dioxide having band gap (3.23eV) semiconductor, is transport to visible light. The usual exited semiconductor has separated the hole and electron pairs that induced the photo catalytic reaction and hence the band gap energy has important role to play.

Preparation of Nano sized photocatalysts:

Nano sized semiconductors as TiO2, as well as SiO2 are one of the most basic functional materials for photcatalytic degradation. For the preparation of anatase TiO2 by using Titanium isopropoxide and ethanol stirred continuously for 30 min. Hydrolysis of titanium isopropoxide by adding distilled water slowly with continuous stirring. Solvent from the mixture was removed. The compound was heated at 393 K overnight. The dried sample was calcined at 753 K under air for 8 hrs. and the calcined samples are known as anatase TiO2 [17].

Preparation of SiO_2 Nanoparticles:

The materials required for the synthesis of SiO_2 nanoparticles prepared by using trimethoxyvinylsilane (TMVS 98% pure), Butanol (99% pure), and ammonium hydroxide solution 5 M (31.5% NH3 pure).. All these chemicals were of analytical graded, 5.5 mL TMVS was dissolved in 200 mL of de-ionized water. The mixture was stirred for 15 minutes before 200 μL of prepared NH_3 (1 mL NH_3 solution was dissolved in 1 mL de-ionized water) was added to ensure the pH is maintain in the range 9 - 11. Then, butanol was added into the mixture and continuously stirred for five minutes. The mixture was then transferred into a preheated reactor at the set temperature and continuously stirred at 320 rpm for one hour. After an hour, trimethoxyvinylsilane (TMVS) as SiO_2 precursor was added. The mixture was left overnight with continuously stirred at const. temperature, filter the precipitated clean SiO_2 several times and calcination for 3hrs at 400°C [18].

Spectrophotometric Study:

The photo degradation of waste water was followed by measuring absorbance periodically, by using Systronics-2203 spectrophotometer. The study of the absorbance characteristics of the effluents. The corresponding absorbance values for the wastewater The reaction mixture was irradiated with light source UV lamp (PHILIPS-400Watt) at a distance 30cm from the reaction vessel fig.2. Double distilled water was used through out the experiment. After each 15 minutes intervals sample was determined from aqueous solution and by centrifugation photocatalyst is separated.

In the experiment an accurately weighted amount of TiO_2 and SiO_2 composit (TSC) was added in flask in 100 ml dye solution. The pH of the dye solution was adjusted in between 3 to10 with addition of requisite volume of NaOH and HCl(Merck India). The absorbance of the supernatant solution was estimated to determine the dye concentration, and values of the % of dye removal were found to be maximum at different pH for different Dyes [19].

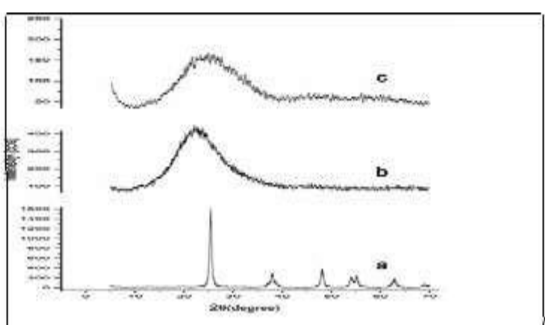
Source:

Industrial wastewater streams containing heavy metals are produced from different industries. Electroplating and metal surface treatment processes generate significant quantities of wastewaters containing heavy metals (such as cadmium, zinc, lead, chromium, nickel, copper, vanadium, platinum, silver, and titanium) from a variety of applications. These include electroplating, electroless depositions, conversion-coating, anodizing-cleaning, milling, and etching. Another significant source of heavy metals wastes result from printed circuit board (PCB) manufacturing. Tin, lead, and nickel solder plates are the most widely used resistant over plates, inorganic pigment manufacturing producing pigments that contain chromium compounds and cadmium sulfide; petroleum refining which generates conversion catalysts contaminated with nickel, vanadium, and chromium.

RESULT AND DISCUSSION

X ray Analysis:

The XRD pattern of TiO_2 and SiO_2 particles and TiO_2-SiO_2 composite(TSC) shows that TiO_2 shows broad peak, It indicates that the size of the particles is very small. The average crystalline size and morphology of the prepared and commercial TiO2 and SiO_2 powder were determined seperately from XRD pattern. The X ray diffraction pattern of TiO2 , SiO2 and TiO2-SiO2 composite (TSC) shows the peak at 25.25° for TiO_2 & SiO_2 at 21.68° the diffraction pattern shows a shift to 25.24 and 23.38 indicating the interrelation of surfactant ions in the SiO2. X ray diffraction of TiO2 SiO2 and TiO2- SiO2 composite (TSC) were recorded by Philips Holland. Xpert MPD model using Cu-Kα target.



`**Fig. 1. XRD pattern of the TiO_2 a-nanoparticles, b-SiO_2 nanoparticles and c- TiO_2/SiO_2 nanocomposite**

Effect of pH:

The pH of is one of the most important factor controlling the photocatalysis process of dye on to the the photocatalyst. The removal of Acid blue was maximum at pH 8.0 was reported 76.4 % removal, Maximum removal of Congo red dye was 89.4% at pH 8.0. it was increases from 3 to 6 and decreases from pH 8 to 11. Fig. 2

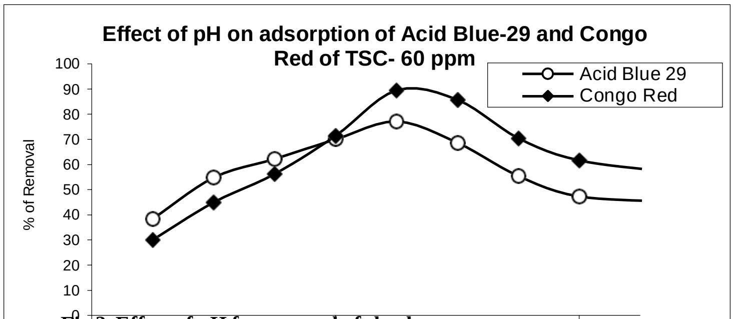


Fig 2. Effect of pH for removal of the dye

Effect of photocatalyst dose:

The photocatalyst dose was studied with 100 ml solution of different dyes with the concentration 20, 40 and 60 ppm with varying photocatalysis as TiO2 and ZnO dose with 0.2 g/l to 0.6 g/l at pH 8 (figure 3). The percentage removal of the dyes increase with increase in dosage of the photocatalyst. The amount of the photocatalyst increased with an increasing the dye concentration However, the % removal rate decreases with an increase in the dye concentration. It is also noted that the rate of the removal of the dye is as faster at the lower concentration and decreases with an increase in the concentration of photocatalyst. It is found that with decreasing concentration of the dye from 1 g/Lit to 6 gm/Lit. The percentage removal of Acid blue-29 increases from 32.5 to 84.6%. The removal of the dye was found to increases constantly with increasing the concentration of TiO2 –SiO_2 Composite for the dye 5 gm/Lit, It was 84.2 % and decreases up to 86.4 % at 6 gm / (Fig.3).

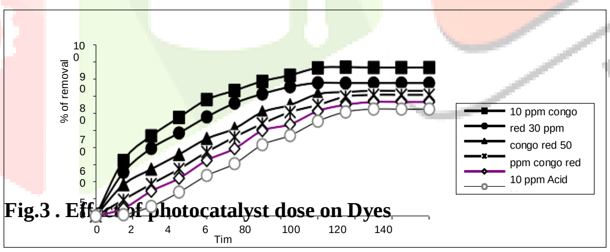


Fig.3 . Effect of photocatalyst dose on Dyes

Effect of contact time:

The effect of contact time on the amount of Alizarin red S adsorbed was investigated using 20, 40, 60 ppm initial concentration with 0.5g/l of TiO2 and ZnO, respectively. It was observed that the Photcatalysis percentage was found to be maximum at 120 minutes increases. As concentration of the dye is increases the percentage of photocatalysts should increases for complete removal of the dye from 92.9 to 78.5% Fig. 4.

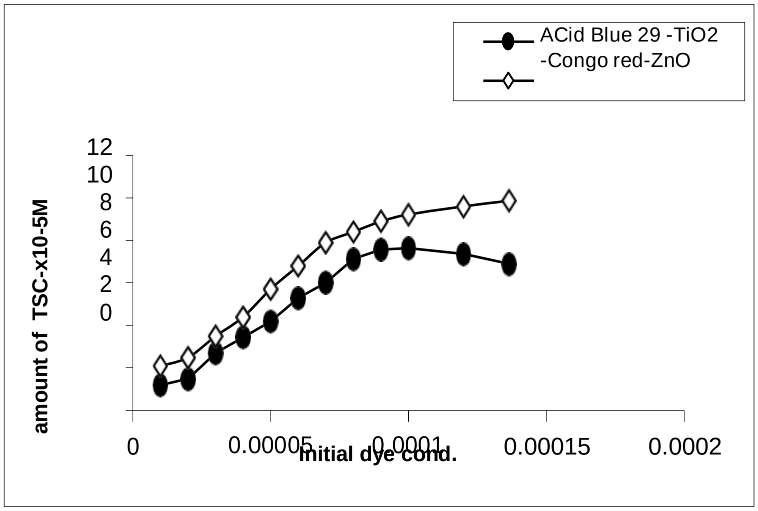


Fig.5. Effect of contact time with TiO_2 at pH 6

II. CONCLUSION

Nanotechnologies have made great improvements for handling water contamination problems and will clearly make further advancements in future. Nanotechnology based treatment has offered very effective, efficient, durable and eco friendly approaches. These methods are more cost-effective, less time and energy consuming with very less waste generations than conventional bulk materials based methods. However certain precautions are to be taken to avoid any threat to human health or environment due to the nanoparticles. The technology should be cost effective and friendly with ease in establishment and use The results of this study clearly establish that TiO2 semiconductor Photcatalysis can be efficientlyused for the degradation of the dyes and other organic compounds in dyeing and printing effluents. In order to determine the rate of photochemical degradation of dyes in different effluent samples, the absorbance values at different irradiation times were measured periodically at fixed (TiO2) = 5 gm/L. Initially the decrease in concentration the degradation of dyes were fast. Photocatalytic oxidation using TiO2 and UV light was successfully applied for the degradation of dye. The degradation rate was increased significantly by increasing the amount of catalyst, while on increasing concentration of photoctalyst. pH condition were foundn to be significantly affected the degradation of dye. TiO2 as a photocatalyst was an effectively for the remove the dyes. Nano sized anatase TiO2 can remove the dye from aqueous solution. Its possible to obtained a wastewater free from dye as well as trace metal by using TiO2 as well as SiO_2.

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