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Photocatalytic Degradation of Textile Effluent and COD reduction TiO_2, ZnO and TiO_2-ZnO (TZO) Composites:

Jyoti Bathri[1], Dr. O.N.Choubey[2]

[1] Department of Chemistry, N.M.V. College, Hoshangabad, Madhya Pradesh, India.
[2] Principal of Govt. Narmada P.G. College, Hoshangabad, Madhya Pradesh, India
E – mail: jyoti.bathri2@gmail.com

Abstract

Photocatalysis based on metal semiconductor is the most promising idea to utilization of abundant energy from sun or UV light for COD removal. In the present study comparison of photocatalytic performance of TiO_2, ZnO and composites based on TiO_2-ZnO in the degradation of textile waste wate. The photocatalytic test was carried out under UV light in order to reduce Chemical Oxygen Demand in textile waste water. TiO2 and ZnO both have high photocatalytic activity, large chemical stability, non-toxicity, great band gap energy and environment friendly. But when mixed both nanocatalys TZO composite displays a largely improved photocatalytic activity such as reduce COD rapidly in textile waste water.

Keywords: Photocatalytic degradation, COD, TZO, TiO_2, ZnO.

1. Introduction

Rivers have great significance in our lives and we cannot ignore their importance. They are primary part of lives as we would not be able to drink or eat without water. The whole industry depends on river water. Some industries and cities are situated at the bank of river for their benefit. They show the growth of country but these industries also affect the water quality directly or indirectly.

The global textile industry could certainly have not been left behind. Out sourcing and trade has become an integrals part of the Textile Industry. These industries focused on the production of useful products but it has been ignored the waste byproducts it generated huge quantity of heavy materials like: Cd, Hg, Ni etc., colored dye effluent, toxic pigments, bleaching agents etc. From dry and wet process in the textile industry. Some conventional

method do not degrade the highly pollutants. One important technique "Nanotechnology" is a forth coming field where innovative methods produce new products at nanoscale.

Photocatalytic degradation has a new route for Nanotechnology. It is an important technique for removing impurities from industrial waste by the use of light radiation and nanoparticles. It employing Heterogeneous Semiconductor material may play a vital role in environmental abatement. Heterogeneous Catalysts like TiO_2 and ZnO used for degradation of waste water pollutants. Both photocatalysts has widely used as an environmentally, because of its various qualities, such as optical properties, low cost, high photocatalytic activity, chemical stability and non-tonicity. Compared to single element of ZnO and TiO_2, composite display a largely improved photocatalytic activity. In this paper we will study the photocatalytic TiO_2, ZnO (TZO) for textile polluted water degradation.

2. Sample Collection and Analysis of Sample

For the present study, we collected the waste water from textile industry Budni. Sample water was collected in sterilized dry plastic bottle. Firstly this bottle rinsed with tap water and finally rinsed with deionizer water. During sampling sample bottle rinsed with sample water and sample were stored at 4˚C temperature.

For sample analysis all chemicals and solution prepared by distilled water. All the parameters were analyzed. Temperature of the effluent determined at the spot by thermometer. Other physiochemical parameter was determined in the research laboratory Govt. Narmada College, Hoshangabad.

Analysis of physiochemical parameters

After sampling, standard methods applied for determination of various physiochemical parameter like pH temperature, total dissolved solid (TDS), alkalinity, hardness, D.O., BOD, COD etc. pH was determined by mercury pH meter. Similarly temperature was determined by glass thermometer, DO and BOD were determined by wrinkle method and COD was determined by open reflux method. Physio-chemical parameter of textile waste water sample shown in table 1:

S.No.	Parameter	Unit	Sample Value
1.	Temperature	˚C	25
2.	Colour	-	Bluish Black
3.	pH	ppm	9.3
4.	TDS	mg/l	3030
5.	Alkalinity	mg/l	214
6.	Total Hardness	mg/l	268
7.	D.O.	mg/l	4.1

8.	B.O.D.	mg/l	490
9.	C.O.D.	mg/l	1613
10.	Sulphate	mg/l	526
11.	Chloride	mg/l	560
12.	TSS	mg/l	167

Table 1 Analysis of sample water

3. Material and Method

3.1 Preparation of Nanocatalysts by Sol Gel Method

ZnO and TiO_2 nanocatalyst both nanocatalysts synthesized using Sol-gel method. The precursor of Zinc Oxide was Zinc acetate and ethanol, by continues stirring add 0.4M NaOH mixture. Titanium oxide was prepared by TTIP Titanium isopropoxide and ethanol ZnO/TiO_2 nanocomposits.

The ZnO and TiO_2 nanocatalyst prepared in the previous step were mixed at 1:1 weight ratio on a magnetic stirrer by continuous stirring for 30 minute at 200˚C temperature.

3.2 Experiment Instrument

For photocatalytic degradation, we use photocatalytic reactor which is called double walled beaker reactor. It is joined with magnetic stirrer on hot plate; mercury lamp is situated perpendicular above beaker for irradiation.

3.3 Photocatalytic degradation procedure

For the photocatalytic degradation test, we take sample water in a photocatalytic reactor and add nanocatalysts TiO_2, ZnO and TZO one by one. The suspension is magnetically stirred at a particular time. This process is irradiation under mercury light. Semiconductors were used in their optimal conditions.

3.4 Degradation Test

In photocatalytic reactor 40 ml sample is taken, 0.5 mg quantity of each photocatlaysts is added and magnetic stirred was done continuously for two hours at 40˚C temperature. At this time the reactor continues to receive mercury lamp light, we analyzed the COD (Chemical Oxygen Demand) of sample by volumetric titration method. We titrate the solution with FAS 0.1N solution and calculate the value of COD. Before photodegradation the value of COD was 1613 mg/l.

4. Result and Discussion

After photodegradation the effect of parameter like pH, TDS and COD on exposure time for the degradation of textile waste water was studied.

Effect on pH – In the textile processing unit pH is very much important factor. pH is depends on the dye concentration. Above textile sample has pH 9.3 but after photocatalytic degradation the pH was decreased.

Effect on TDS – Total dissolve solid level is increases in textile waste water by using common salt and other salt. The value of TDS in sample water was 3030 ppm but after photocatalytic degradation TDS value were increased.

Effect on COD – COD is the total chemicals in the sample water that can be oxidized after photocatalytic degradation the value of COD showed that COD of sample reduce by ZnO = 654 mg/l, TiO_2 = 878 mg/l and TZO = 134.8 mg/l.

Nanoparticles	**Time Duration (Hrs.)**	**Sample Quantity (ml)**	**Temp. (˚C)**	**Nanocatlyst Quantity (mg)**	**COD (mg/l)**	**TDS (ppm)**	**pH**
ZnO	2	40	40	0.5	654	2180	9.0
TiO_2	2	40	40	0.5	878	7370	8.9
TZO (TiO_2-ZnO)	2	40	40	0.5	134.8	6320	8.7

Table 2. Comparison COD of various nanoparticles

After photodegradation the effect of parameter pH, COD, TDS shown in the table:2

The aim of this paper is to reduce COD from textile waste water by photocatalytic degradation. Above table show the pH of textile sample decrease due to ZnO and TiO2 but sharply decrease due to TZO. COD value minimized after Photodegradation, both nanocatalysts reduces COD but composite TZO minimize COD rapidly.

5. Conclusion

Photocatalytic water treatment by nanocatalyst is a hot topic for pollutant degradation. TiO2 and ZnO has a unique properties for above work because it has cheap operating cost, simple morphology design, non toxic and have a band gap energy. Compared to the single ZnO and TiO_2 coupled ZnO-TiO_2 composite display a widely improved photocatalytic activity. In this research paper ZnO and TiO_2 nanopartical prepared by sol-gel method where mixed at 1:1 ratio to prepare ZnO-TiO_2 composite. The photocatalytic activities show ZnO-TiO_2 minimized the value of COD faster compared to ZnO-TiO_2. The performance of TZO nanocatalyst developed good photocatalytic activity. TZO can be utilized as a photocatalyst in textile waste water treatment and environmental pollution.

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