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ADVANCED TREATMENT OF TREATED PHARMACEUTICALEFFLUENT WITH TIO_2/H_2O_2

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Abstract

Advanced treatment of treated pharmaceutical wastewater has been studied with Advanced Oxidation Process (AOP).Advanced oxidation processes (AOPs) are widely used for the removal of recalcitrant organic constituents from industrial and municipal wastewater. In a laboratory study removal of COD was studied for the treated effluent collected from the outlet of effluent treatment plant of the pharmaceutical industry by TiO_2/H_2O_2. Batch experiments were conducted to determine the optimum dose of TiO_2/H_2O_2 for different time interval. 74% of COD removal was observed with TiO_2/H_2O_2 dose of 1 g/L: 2 ml/L after 90 min of reaction time.

Keywords— *COD removal, Advanced Oxidation Process, Pharmaceutical wastewater, TiO_2, H_2O_2*

I. INTRODUCTION

Environmental degradation is an escalating problem owing to the continual expansion of industrial production and high-levels of consumption. A renewed dedication to a proven strategy to resolve this problem is needed (**Hashmi Imran 2005**). Pharmaceutical industry is one of the major industries causing water pollution. In India, Pharmaceutical industry generates about Gallons of wastewater processed depending upon the process employed and product manufactured.

Pharmaceutical manufacturing industry produces a wide range of products to be used as human and animal medications (**Pandian M. et. al. 2011**). Wastewater produced from the pharmaceutical industries is hazardous and toxic, and also often has intensive color and disgusting odor (**Dixit D. et. al. 2013**). Pharmaceutical process wastewaters are very diverse in pollutants and their pH is usually not neutral. Among all the pharmaceutical that cause contamination of the environment, an antibiotic occupies an important place due to their high consumption rates in both veterinary and human medicine. Antibiotics wastewater has high COD and very low BOD and hence is difficult to treat biologically (**Toloti A. 2011**).

Manufacturing of pharmaceutical industry can be characterized by five main processes (**Pandian M. et. al. 2011**): (1) Fermentation, (2) Extraction, (3) Chemical synthesis, (4) Formulation and (5) Packaging.

Although wastewater streams from all five processes have the potential to contain high organic load, fermentation and synthesis operations usually generate larger volumes of wastewater, and the wastewaters generated usually contain higher organic load (**Oktem et al., 2007**). The wastewater may therefore be high in BOD, COD, and TSS, with a wide range of pH from 1 to 11. Pharmaceutical wastewater if disposed with insufficient treatment may leads to great damage to the environment and groundwater resources. General treatment cannot be used for every pharmaceutical wastewater due to its variable composition. Therefore, specific treatment is required for specific type of wastewater (**Saleem M. 2011**).

Generally, Effluent Treatment Plants or ETPs are used by leading companies in the pharmaceutical and chemical industry to purify water and remove any toxic and non-effluent-treatment-plant toxic materials or chemicals from it. The treatment of pharmaceutical wastewater to the desired effluent standards has always been difficult due to the wide variety of the products that are produced in a drug manufacturing plant (**Carballa et al. 2004**).

Advanced oxidation processes (AOPs) are alternatives to the conventional treatments of wastewater. In 1987, Glaze et al. defined AOPs as “near ambient temperature and pressure water treatment processes which involve the generation of hydroxyl radicals in sufficient quantity to effect water purification” (**Glaze et al. 1987**). Hydroxyl radicals are highly reactive species that are able to attack and destroy even the most persistent organic molecules that are not oxidized by the oxidants as oxygen, ozone or chlorine.

Several methods are available for generating $^{\bullet}OH$ radicals. These include both non-photochemical and photochemical methods: –

- Ozonation at elevated pH (> 8.5)
- Ozone + hydrogen peroxide (O_3/H_2O_2)
- Ozone + catalyst (O_3/CAT)
- Hydrogen peroxide + catalyst (H_2O_2+CAT)
- Fenton system (H_2O_2/Fe^{2+})
- O_3/UV
- H_2O_2/UV
- O_3/H_2O_2/UV
- Photo-Fenton/Fenton-like systems
- Photocatalytic oxidation (UV/TiO_2)

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II. MATERIALS AND METHODS

The treated effluent was collected from outlet of effluent treatment plant of pharmaceutical industry. Immediately after the treatment wastewater was preserved at $4^{o}c$ temperature. The wastewater characteristics play a significant role on its treatment. Table 1 show various characteristic of the wastewater collected from the pharmaceutical industry. In this study Chemical Oxygen Demand (COD), TDS, TSS are measured as per the procedure described in the standard methods for the examination of the water & wastewater (APHA, AWWA, WEF 1998). pH of the sample was monitored by pH meter from the company EI products, Parwanoo (H.P), India. Instrument was calibrated by freshly prepared buffer solution (pH 4 to 9) time to time throughout the study.

Table 1: Initial Characteristics of Effluent Wastewater

Characteristics	Values
pH	7.6 – 7.89
Chemical Oxygen Demand (COD)	250 – 370 mg/L
TDS	1900 – 2100 mg/L
TSS	400 – 500 mg/L
Colour (Pt. Co Scale)	419

A. Experimental Setup

The schematic diagram of the laboratory scale reactor used for this study is shown in figure 1. The wastewater sample taken in the batch reactor was placed on a magnetic stirrer after removal of suspended solids. Hydrogen Peroxide (H_2O_2) and Titanium dioxide (TiO_2) were added in different dosage (TiO_2: 0.5, 0.3, 1, 2 g/L & H2O2: 0.2, 1, 2 ml/L &). Samples were taken from the batch reactor at different time intervals i.e. every 15 minute. These samples which are collected at every fifteen minutes till 3 hours are kept in quiescent condition for 2 hours for settlement. The samples were analyzed for COD. Parameters of wastewater like temperature & pH of wastewater were kept unchanged.

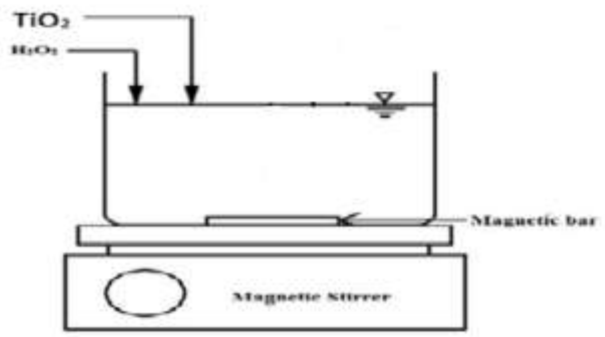

FIGURE 1: SCHEMATIC DIAGRAM OF THE LABORATORY SCALE REACTOR

III. RESULTS AND DISCUSSION

In this study, COD removal was studied after the treatment given with various dosage of TiO_2/H_2O_2 (H_2O_2: 0.2, 1, 2 ml/L & TiO_2: 0.5, 0.3, 1, 2 g/L). Graphical representation of % removal of COD at different reaction time is shown in figure 2. It is observed that the maximum 74% reduction in COD and 48% colour removal was observed with TiO_2 dose as TiO_2 dose as 1 g/L and H_2O_2 dose as 2 ml/L after 90 min of reaction time.

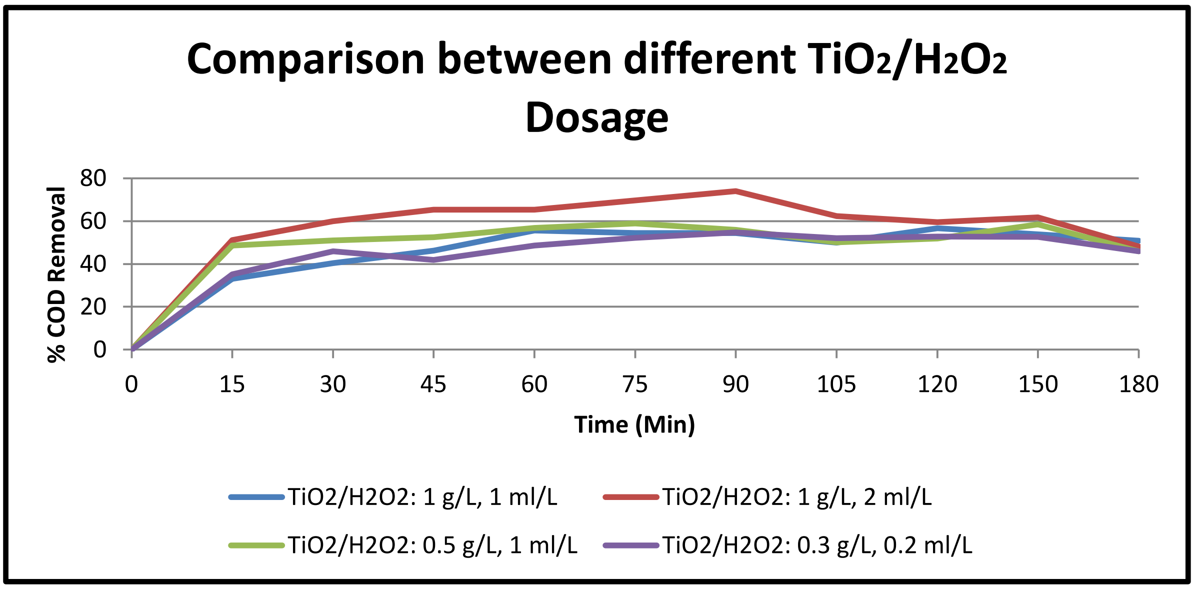

FIGURE 2: COD REMOVAL FOR VARIOUS DOSAGES OF TiO_2/H_2O_2 TREATMENT

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I like to say thanks to the pharmaceutical industry from which I have collected the wastewater for study purpose. And I would also like to convey my sincere thanks to my guide Mrs. R. L. Patel, who has given me guidance for this work and also helped me out at any point wherever I was stuck.

V. CONCLUSION

Proper treatment of pharmaceutical wastewater is important from public health and environmental protection point of view. Advanced oxidation processes (AOPs) are widely used for the removal of recalcitrant organic constituents from industrial wastewater.

From the graph it is observed that the maximum 74 % reduction in COD achieved after 90 min of reaction time. Hence the treated effluent is suitable for disposal on the sewerage system as per the norms given to the industry. Sludge generation is minimum in this treatment. So this treatment is very much environmental friendly. The treated effluent could be discharged to the sewer system under the condition that the appropriate wastewater monitoring and sampling facilities are available.

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