ISBN : 978-93-87793-82-8

TREATMENT OF TEXTILE INDUSTRY WASTEWATER BY ADVANCE OXIDATION BY FENTON'S PROCESS

***Saima Badar, **Mahd Zia, ***Abdul Mujeeb**

**Associate professor,Civil Engineering Department,IIMT College of Engineering, Greater Noida*

***Assistant professor(contract),Civil Engineering Department, Gautam Buddha University, Greater Noida*

****Associate professor,Civil Engineering Department,IIMT College of Engineering, Greater Noida*

Abstract

The textile industry is one of the large consumers of water and consequently, one of the main producers of wastewater in India. Textile wastewater effluent has been a serious environmental threat for years. This wastewater, with high Chemical Oxygen Demand (COD) and a strong dark colour, is classified as a high strength wastewater. The discharge of this type of wastewater without any type of treatment brings about considerable adverse impacts on the receiving water bodies and thus demands an efficient treatment process. Advanced oxidation processes are possibly one of the most effective methods for the treatment of textile wastewater. Fenton's process is one of the advanced oxidation processes. Fenton's process has been extensively used for the removal of COD, TOC, dyes, phenolic compounds and other organic chemicals from industrial and municipal wastewater. The aim of the study was mainly to investigate the efficiency of the Fenton's processes for the removal of COD and Turbidity from a real textile wastewater. The Fenton's process employs ferrous ions and hydrogen peroxide under acidic pH conditions. At optimized conditions, 82.63% reduction in turbidity and 91.97% reduction in COD is obtained for effluent at a reaction time of 20 minutes under low doses of H_2O_2 and Fe^{2+}. The optimum dose of hydrogen peroxide and ferrous sulphate was 6.0 ml/500 ml and 2.0gm/500ml, respectively. The optimum pH was found to be 3.0 and 6.0 respectively for oxidation and coagulation. Fenton process was found technically effective for the treatment of textile industry wastewater.

INTRODUCTION

Textile wastewater incorporates a vast assortment of colors and chemicals increases that make the environmental challenge for the textile industry as fluid waste as well as in its chemical composition. The different operations required in the cotton material industry are distorting, winding, estimating weaving, biting the dust, cushioning, steamer, printing, wrapping up. This procedure creates an extensive volume of effluents and forms a major source of wastewater containing natural and inorganic substances. Major contaminations in textile wastewaters are high suspended solids, chemical oxygen demand, heat, color, corrosiveness, and other soluble substances

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Modern wastewater contains dangerous and non-biodegradable compounds that influence the viability of ordinary treatment procedures. Contaminations in the wastewater originating from crude materials handling, prepare by-items, handle chemicals and final production. Natural, inorganic, color producing dyes, lethal mixes like cyanide and substantial metals, if released with no treatment are harmful to aquatic life. Thus, Advanced Oxidation Process (AOP) with Fenton reagent (Fe^{2+}/H_2O_2)helps to degrade organic mixes exhibited in contaminated water In AOP, hydroxyl radical ($OH^{\cdot}$) are produced in arrangement and are in charge of oxidation of natural mixes. Hydrogen Peroxide is a multipurpose oxidant for some frameworks. It can be connected with or without the catalyst.

METHODOLOGY

The textile processing industries produce wastewater which is one of the main sources of pollution of the rivers, canals and require proper management. The Fenton‘s reagent is used to remove COD, strong Colour and Turbidity of textile effluent characterized by its extremely high value of COD and a low value of BOD. For the experimental purposes, wastewater samples were collected from Sara textile industries, sec-4, Noida.

At first, the characteristics of raw wastewater samples were assessed. In Fenton‘s process wastewater is treated by means of oxidation and coagulation. Optimum pH for the Fenton‘s process was found out. The optimum dose of H_2O_2 with varying doses of $FeSO_4$ and optimum dose of $FeSO_4$ with varying doses of H_2O_2 were tested.

Analysis of textile industry wastewater

At first the characteristics of the samples were determined through extensive laboratory analysis. Important parameters that were tested in the laboratory are; pH, Turbidity, COD, TSS and TDS. For COD, TSS and TDS, the analysis was done as per standard methods APHA (1995). Digital pH meter was used for the determination of pH of the samples. The turbidity was measured using electronic turbidity meter (2100P).

Fenton’s treatment of textile industry wastewater

Several attempts were made to minimize the chemical doses and the sludge production from each process. Additionally, the operation mode was adjusted to enhance the COD and turbidity removal rates. Overall COD and turbidity removal efficiencies under various operating conditions were

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investigated. Specifically absolute doses of Fenton's reagents, oxidation reaction time, and initial pH, pH during Fenton coagulation are described in this work.

In the experiment, a beaker equipped with a glass bar was used as a reactor; work was carried out by taking sample water into the beaker. Initial pH of sample water was adjusted to the desired value with concentrated sulphuric acid (H_2SO_4) such as for Fenton's oxidation to get the pH value below 5.0. The next step involves the addition of a definite amount of solid ferrous sulphate ($FeSO_4.7H_2O$). To start up the Fenton's reaction, 30% (w/w) hydrogen peroxide (H_2O_2) solution was added. The samples were mixed using glass rod for oxidation process to take place and left for different reaction time. After the reaction, rapid mixing at 45 rpm for 1 min, slow mixing at 25 rpm for 14 min was done. For Fenton Coagulation pH greater than 6.0 was maintained. The pH was controlled with an accuracy of ± 0.02 by adding either sodium hydroxide or sulphuric acid prior to the mixing process, if necessary. Then samples were allowed to sediment for periods of 30 min to settle down the produced sludge. After the precipitation, the upper liquid was separated from the precipitate to find out the efficiency of the Fenton's oxidation-coagulation process. These steps were repeatedly done for several parametric changes to assess the effects on COD, color and Turbidity removal efficiency. A flow diagram is shown in figure 3.3 to express the different process that has been carried out during the Fenton's process.

RESULTS AND DISCUSSIONS

The characteristics of raw wastewater as analyzed in laboratory are given below

Table 1 Characteristics of raw textile effluent sample

S.NO.	Parameters	Raw sample	Indian standards for releasing into inland surface water
1	pH	7.86	5.5-9
2	COD(mg/L)	792	<250
3	TDS(mg/L)	1168	<2100
4	TSS(mg/L)	324	<100
5	Turbidity(NTU)	78.9	1-5

Effect of various doses of H_2O_2 on COD and Turbidity removal

In the first batch experiment the dose of Ferrous sulphate ($FeSO_4.7H_2O$) was fixed at 2g/ 500ml and the Hydrogen peroxide was varied from 2ml to 8 ml/ 500ml sample, the results are presented in graphical form (Fig 1).

ISBN : 978-93-87793-82-8

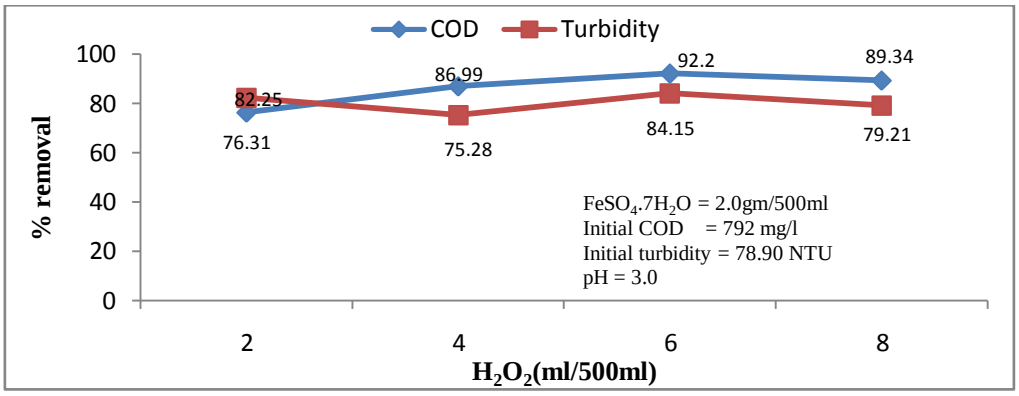

Fig1 Effect of various doses of H_2O_2 on COD and Turbidity removal at pH 3.0

It is clear from the above table and the graph that the maximum COD and Turbidity removal was obtained at Hydrogen peroxide dose of 6ml/500ml sample.

Effect of various doses of $FeSO_4.7H_2O$ on COD and Turbidity removal

The removal of Turbidity and COD for textile effluent under different ferrous doses at constant H_2O_2 doses of 6.0 ml/500ml is shown in Fig 2. At Fe (II) doses of 2gm/500ml, the turbidity and COD removal was maximum 83.26% and 92.52% respectively. In Fenton's process, ferrous doses significantly affect the COD and Turbidity removal.

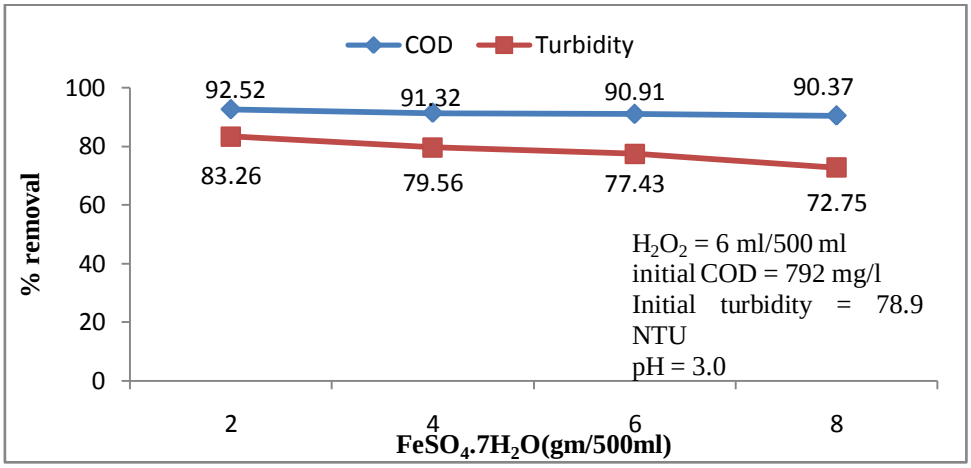

Fig 2Effect of various dosage of $FeSO_4.7H_2O$ on COD and turbidity removal at pH 3.0

ISBN : 978-93-87793-82-8

Effect of various higher doses of H_2O_2 on COD and turbidity removal

In this study a constant dose of Fe (II) = 12 gm/500ml shows that in a higher dose of peroxide (12 ml/500ml) removal of Turbidity and COD is maximum. The extent of oxidation (the degree of direct reduction of COD) depends on the amount of H_2O_2 typically used.

The experiments were performed in the range of 12-18 ml H_2O_2/500ml sample. As the doses of H_2O_2 changed COD removal efficiency varies from 69.49 % to 52.65%. Turbidity removal decreased from and 89.11% to 65.77%. The results are presented below in Fig 3.

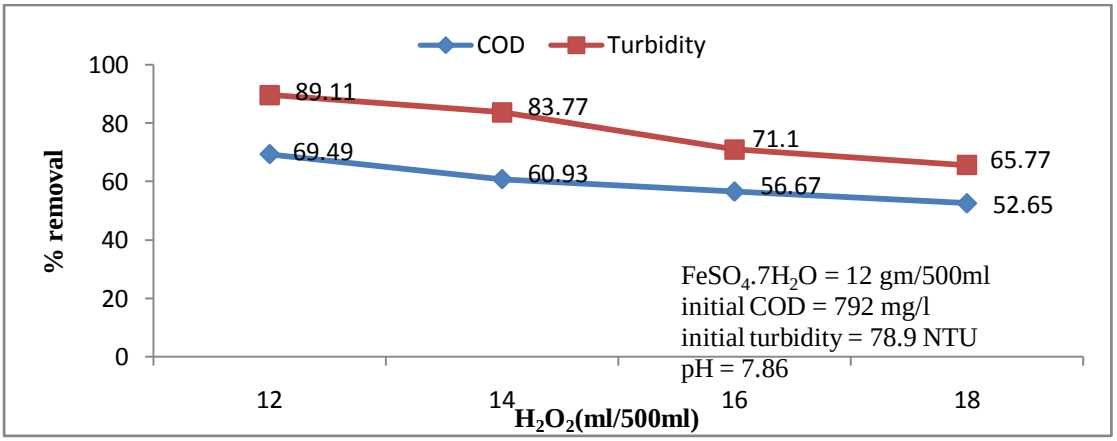

Fig 3 Effect of various higher doses of H_2O_2 on COD and turbidity at pH 3.0

Effect of various higher doses of $FeSO_4.7H_2O$ on COD and Turbidity removal

The removal of Turbidity and COD for effluent under different ferrous doses at constant H_2O_2 doses of 12 ml/500ml is shown in Fig. 4.4. At Fe(II) dose of 12gm/500ml, the turbidity and COD removal was maximum 87.7% and 64.81% respectively. The results are presented below in Fig 4.

ISBN : 978-93-87793-82-8

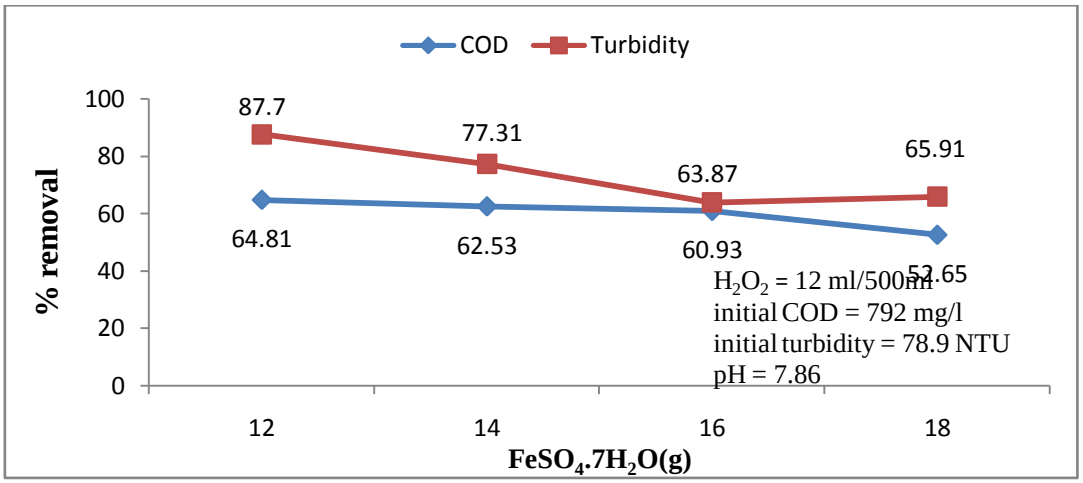

Fig 4 Effect of various higher doses of FeSO4.7H2O on COD and Turbidity removal

Comparison between of results at lower and higher doses of fenton's reagent

- In the lower doses of Fenton reagents maximum percentage removal efficiency of COD and turbidity achieved was 92.52 % and 84.15 % respectively. While in higher doses maximum removal efficiency was 69.49 % and 89.11 %.
- It was observed that in lower doses of fenton's reagent, the removal efficiency of COD and turbidity was more than compare to higher doses of fenton.

CONCLUSION

The pH 3.0 was set for Fenton's reagent to oxidize organic matter for dye effluent. Because from literature it was known that the fenton process if effective at this pH. Fenton treatment of Textile effluent gives satisfactory results with respect to the removal of COD and turbidity. By using Fenton's reagent maximum COD and Turbidity removal were 92.84 %, 91.50 % for textile effluent. Considering the removal efficiencies, optimum dose of hydrogen peroxide (H_2O_2) is found to be 6.0 ml/500 ml. The concentration of OH^- increases with increasing hydrogen peroxide doses, leading to increased oxidation rates of color and organic compounds (COD). The optimum dose of ferrous sulphate was 2.0 gm/500 ml. The removal efficiency of Lower doses was found better than the higher doses. In this study, Fenton process was found effective in removing COD and turbidity for the treatment of textile industry wastewater.

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RECOMMENDATIONS FOR FURTHER STUDY

1. In this study only $FeSO_4.7H_2O$ were used as a catalyst, other coagulants like Mohr salt, $Fecl_3$ can also be used to test the effectiveness of Fenton coagulation on the treatment of textile effluent.

2. Fenton method for treatment of textile effluent can be compared with other AOP such as Photocatalytic oxidation with TiO_2, Ozonation, Ozone combined with UV and H_2O_2, UV irradiation with H_2O_2.

3. In this study, only Fenton process as AOP was performed. Some other Physicochemical and Biological treatments can also be done to find out the effective removal of colour, COD, and Turbidity.

4. In further studies, tests can be done using any other less expensive oxidizing agents like chlorine, ozone, potassium permanganate in place of hydrogen peroxide to explore their efficiency.

5. Tests can be performed considering the different stoichiometric ratio of Ferrous and hydrogen peroxide.

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