

Industrial Wastewater Treatment using Fenton Process

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Abstract— advanced oxidation process is being used increasingly as an alternative treatment process for the remediation of textile waste water. Although the vast majority of waste water supply systems deliver “Safe” water after treatment, incidental and often undetected contamination does not occurs. Hence, the increasing demands of high quality water, initiated investigators to show considerable attention towards the low cost waste water treatment and its re-use. This paper discusses the attempts to the treatment of textile effluent by advanced oxidation process. Advanced oxidation process was performed by selecting 2:1 ratio of Fenton reagent. The influence of Turbidity, Total Dissolved Solids (TDS), Total Suspended Solids and Chemical Oxygen Demand (COD) was studied in the collected sample. An appreciable change in color and turbidity is observed. The maximum removal efficiencies for COD and TSS obtained are 95.23% and 97.24%. This technique can be applied for treatment of a large volume and industrial scale of textile wastewater.

Keywords— Advanced Oxidation Process, Fenton Process, Hydrogen Peroxide, Ferrous Sulphate

I. INTRODUCTION

The textile industry, since its beginning, has been hampered by the large volumes of water required for the preparation and dyeing of cloth. More recently, water consumption and waste generation have become considerable concerns for textile manufacturers and finishers. Textile industry wastewater is characterized primarily by measurements of BOD, COD, colour, heavy metals, total dissolved and suspended solids.

BOD or biochemical oxygen demand is the measure of the oxygen consuming capabilities of organic matter. Water with high BOD indicates the presence of decomposing organic matter and subsequent high bacterial counts that degrade its quality and potential uses. COD or chemical oxygen demand, measures the potential overall oxygen requirements of the wastewater sample, including oxidisable components not determined in the BOD analysis.

Colour is defined as either true or apparent colour. True colour is the colour of water from which all turbidity has been removed. Apparent colour includes any colour that is due to suspended solids in the water sample. Colour and turbidity both cause an aesthetic and real hazard to the environment. The aesthetic value considers the discolouration of recreational streams and waterways.

The real hazards caused by colour and solids in waste are dye toxicity and the ability of the colouring agents to interfere with the transmission of light through the water, thus hindering photosynthesis in aquatic plants. Heavy metals, typically chromium and copper, are very hazardous to human and aquatic life at relatively low concentrations. Heavy metals are introduced into the wastewater of textile manufacturing through the use of parameterized dyes and heavy metal after washes, which are used to increase the light fastness of the finished product. Total dissolved solids

or TDS, characterise the general purity of water and is often largely due to soluble ions such as sodium, chloride, and sulfate. Obviously, high TDS is detrimental to fresh water aquatic life.

Typically, textile wastewaters have high biological oxygen demand/chemical oxygen demand (BOD/COD), a substantial proportion of which is represented by substances present in a highly emulsified and/or soluble form. The organic polluting load can be many times greater than that in ordinary domestic sewage and can also be highly coloured. A number of pretreatment processes such as equalizing/balancing, gravity adsorption or neutralization are available, and actual treatment can be achieved by chemical oxidation, ultrafiltration, adsorption, and biological or physico-chemical techniques.

Selection of the appropriate method of treatment is influenced by a large number of factors related to each effluent characteristic, such as relative costs, levels of treatment required or site restrictions, etc. For example, biological and physico-chemical treatments are often used in tandem to obtain maximum removal of organics in textile wastewater. The dual use of methods combats certain organics that are not biodegradable, as well as other organic constituents that may not be amenable to chemical precipitation. Fenton process can be an alternative. It is a chemical coagulation process with the addition of hydrogen peroxide wastewater being treated. It is also a simple technique. Detention time and chemical dosage are the important parameters in Fenton process. Although it is a chemical process, according to many research studies proven that higher removal efficiencies can be obtain.

II. OBJECTIVES

The objectives of this study were

- 1) To characterize the textile wastewater
- 2) To determine the optimum conditions for chemical dosage
- 3) To test the efficiency of chemicals

III. MATERIALS AND METHODS

A. Textile Wastewater

The wastewater used in this work was taken from the local textile industry in Pappanam code and was kept at 4°C prior to the experiments. Samples were collected in bottles and kept at 4°C before use. The length of the storage before starting experiments varied from one day to six weeks. All experiments were conducted at room temperature.

B. Chemicals

The chemicals used for Fenton process are Hydrogen peroxide (H_2O_2), ferrous sulfate ($FeSO_4$), Sodium Hydroxide ($NaOH$) and Sulphuric acid (H_2SO_4) were used for pH adjustments.

C. Fenton Process

Fenton process requires the usage of hydrogen peroxide (H_2O_2) as the oxidation agents. The molecules of H_2O_2 consist of two hydrogen molecules and two oxygen molecules. Hydrogen peroxide produced hydroxyl radicals OH^\bullet . It oxidized Fe^{2+} ions into Fe^{3+} . The Fenton reaction causes the dissociation of the oxidant and the formation of highly reactive hydroxyl radicals that attack and destroy the organic pollutants. Oxidation defined as the loss of at least one electron when two or more substances interact. These substances may or may not include oxygen.

D. Fenton Process Procedure

Fenton process was conducted with the help of jar test. Various dosages were used for Fe^{2+} and H_2O_2 . The process proceeded with rapid mixing of wastewater sample at 130 rpm for 2 min, slow mixing at 30 rpm for 18 min, then settling for 30min. after settling, filtration were done. Then, filtrate was taken for analyses. After jar test COD, TSS and turbidity of wastewater samples were measured.



Fig. 1: Coagulation



Fig. 2: Sedimentation



Fig. 3: Filtration

E. Analytical Methods

Turbidity of the solutions was measured by mean of Turbidimeter. Chemical Oxygen Demand COD was measured following titration method according to the Standard Methods for Examination of Water and Wastewater (APHA, American Public Health Association 2000). Total suspended solids TSS was also measured by standard method (APHA, American Public Health Association 2000).

F. Removal Efficiency

The calculation of COD, TSS and turbidity removal efficiency after electrocoagulation treatment and Fenton process were performed using the following formula

$$\text{Efficiency (\%)} = \{[C_0 - C_f] \times 100\} / C_0$$

C_0 - concentration before treatment

C_f - concentration after treatment

IV. RESULTS AND DISCUSSION

A. Textile Wastewater Characteristics

The initial characteristic of Textile wastewater was carried out and the pH of the sample was alkaline in nature. Other physico- chemical characteristic obtained is given in the table.

pH	11.13
Turbidity	-14 NTU
TDS	12980 mg/l
TSS	2900 mg/l
COD	1680 mg/l
Colour	Brown

Table 1: Characterization of Textile Wastewater

B. Effect of $FeSO_4:H_2O_2=2:1$ ratio

The dosage of Fenton reagent has been studied by varying Fenton concentration on 2:1 ratio.

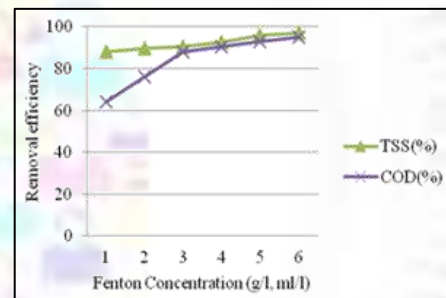


Fig. 4: Effect of $FeSO_4:H_2O_2=2:1$ ratio

As shown in Fig 4, different concentrations of Fenton's reagent have been studied for maximum COD removal of textile waste water by keeping pH at 3. The removal efficiencies for COD and TSS are varied from about 64.28% to 95.23% and 87.93 to 97.24%.

C. Effect of Fe^{2+} concentration

The dosage of Fe^{2+} has been studied by keeping constant H_2O_2 concentration about 0.6 ml/l. the concentration of Fe^{2+} has been varied from 0.2 to 1.2 g/l.

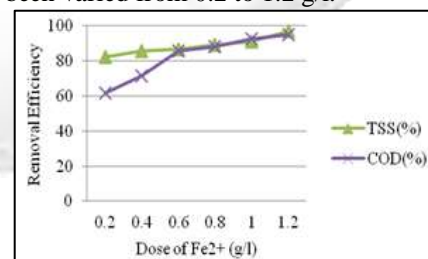


Fig. 5: Effect of Fe^{2+} concentration

As shown in Fig 5, effect of Fe^{2+} concentration have been studied for maximum COD removal of textile waste water by keeping pH at 3. The removal efficiencies for COD and TSS are varied from about 61.9% to 95.23% and 82.41 to 97.24%.

D. Effect of H_2O_2 Concentration

The dosage of H_2O_2 has been studied by keeping constant Fe^{2+} concentration about 1.2 g/l. The concentration of H_2O_2 has been varied from 0.1 to 0.6 ml/l.

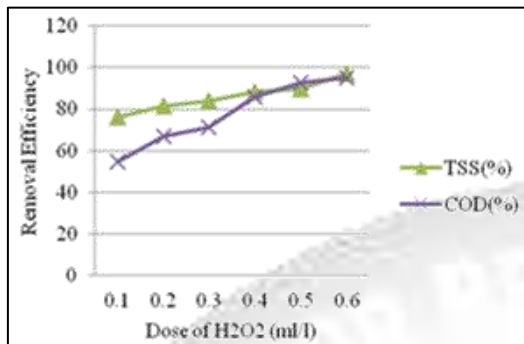


Fig. 6: Effect of H_2O_2 concentration

As shown in Fig 6, effect of H_2O_2 concentration has been studied for maximum COD removal of textile waste water by keeping pH at 3. The removal efficiencies for COD and TSS are varied from about 54.76% to 95.23% and 76.2 to 97.24%.

V. CONCLUSION

In fenton process, maximum removal efficiencies for COD and TSS obtained are 95.23% and 97.24%. The main advantages of Fenton process over other process are its simplicity, high efficiency of the oxidation reaction, the easily available chemicals, the low cost, the simplicity of the procedure and no need for special equipment. From above discussions Fenton process is an efficient method for Industrial wastewater treatment. Nevertheless, although COD was generally decreased by chemical oxidation, high efficiency of organic components degradation is not always followed by reduction of COD to an acceptable level. Therefore, in order to optimize Fenton's reaction special care should be taken not only to remove organic constituents but also to reduce toxicity, odour and color removal, and biodegradability improvement. COD reduction should be a critical measure of the success of this method. Sludge production, the need of chemicals and electrical energy consumption are drawbacks of this processes.

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