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TREATMENT OF INDUSTRIAL WASTEWATER USING FENTON PROCESS

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Abstract : In this study, treatability of the real sugar industry wastewater that includes high concentration organic pollutants was investigated with the Fenton process which is frequently used in recent years. The performance of Fenton process is compared for removal efficiency of TDS, DO, COD and BOD. The effects of important factors such as pH, concentration of hydrogen peroxide and Aluminium Sulphate on treatment of wastewater was investigated in Fenton process. The scheduled Fe^{2+} dosage was achieved by adding the necessary amount and Fenton Agent 30V/V & Aluminium Sulphate (1N) added in the ratio of 8%, 10%, and 12%. The maximum removal efficiencies of TDS, COD and BOD were found as 39%, 50% and 55%. in the Fenton process. The results of this study show that the Fenton reaction has the potential to be used as a sugar industrial waste water treatment method in order to remediate organic compounds into simple components and increase its biodegradability.

IndexTerms - Fenton, Industrial Wastewater, Chemical Treatment, Hydrogen peroxide.

I. INTRODUCTION

The presence of many natural pollutants in surface water, ground water and wastewater might also end result from contaminated soil, agricultural runoff, industrial wastewater, and unsafe compounds garage leakage. These natural pollution, along with volatile phenols, benzene, and benzene derivatives, are taken into consideration surprisingly toxic and low biodegradable. In some cases, conventional treatment methods of biological processes are not suitable to remove them. In order to improve water quality, advanced treatment is needed to remove the refractory organics. One of the most effective advanced treatment process is Fenton treatment process [1]. The hydroxyl radical (OH) can be generated from the reaction between aqueous ferrous ions and hydrogen peroxide (H_2O_2), and it can extinguish refractory and toxic organic pollutants in wastewater. In 1894 [2], the Fenton reaction was discovered, and he stated that H_2O_2 could be activated by ferrous (Fe^{2+}) salts to oxidize tartaric acid. Nevertheless, its application as an oxidizing process for destroying toxic organics was obtained until the late 1960s [3]. The process was generally used to treat wastewater by radical oxidation and flocculation. H_2O_2 is catalyzed by ferrous ions to decompose into HO and to trigger the production of other radicals, which can fully oxidize organic matters. The hydroxyl radical (OH) has a strong oxidation capacity. Hydroxyl radicals can efficiently oxidize refractory organic pollutants in industrial wastewater and completely mineralized them into Carbon dioxide, inorganic salts and water. In the meantime, the iron complex produced in the treatment of industrial wastewater by Fenton will act the suitable flocculants [4]. The conventional Fenton continuous flow process configuration, including acid regulation, catalyst mixing, oxidation reaction, neutralization. It has many advantages, for instance its high performance and simplicity operated at room temperature and atmospheric pressure for the oxidation of organics and its non-toxicity. Hydrogen peroxide can break down into environmentally safe species like water and oxygen. However, Fenton process has some inherent disadvantages, which limit its application and promotion [5].

II.METHODOLOGY

INDUSTRIAL WASTEWATER COLLECTION

Collection of wastewater with by acquiring the necessary permits as per the norms applied in industry (Sugar Mill).

TESTING OF WASTEWATER

The Tests that conducted over wastewater for analyzing its characteristics are, Color & Temperature, pH, Dissolved Oxygen, Total Dissolved Solids, Chemical Oxygen demand, Biological Oxygen demand

Table 1. CHARACTERISTICS OF WASTE WWATER FROM SUGAR INDUSTRY

Parameter	Values	BIS Standards
Color	Dark Brown	-
Temperature (°C)	41	-
pH	5.1	6.5 – 9.0
Total Dissolved Solids (mg/lit)	2780	<2100
Dissolved Oxygen (mg/lit)	1.3	4-6
Chemical Oxygen Demand (mg/lit)	374	<250
Biological Oxygen Demand (mg/lit)	87	<50

It is important to note that the DO (dissolved oxygen) concentration may increase in treated effluent once the residual hydrogen peroxide present releases water and oxygen gas in its decomposition. It is also worth noticing that an increase in DO concentration may be caused by aeration in the jar test and a decrease in organic matter concentration.

The Fenton process treatment also achieved satisfactory removal rates, with turbidity removal and phenolic compounds above 65% and COD of about 58%. The removal of 58% of the COD indicates that the Fenton process technology is efficient in treating effluent from the cosmetic industry [6].

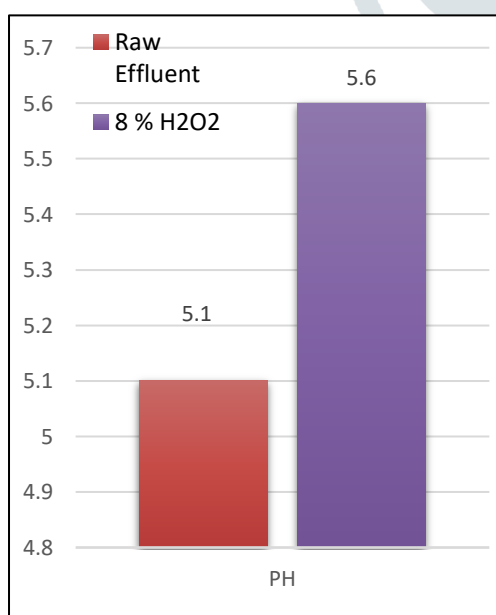
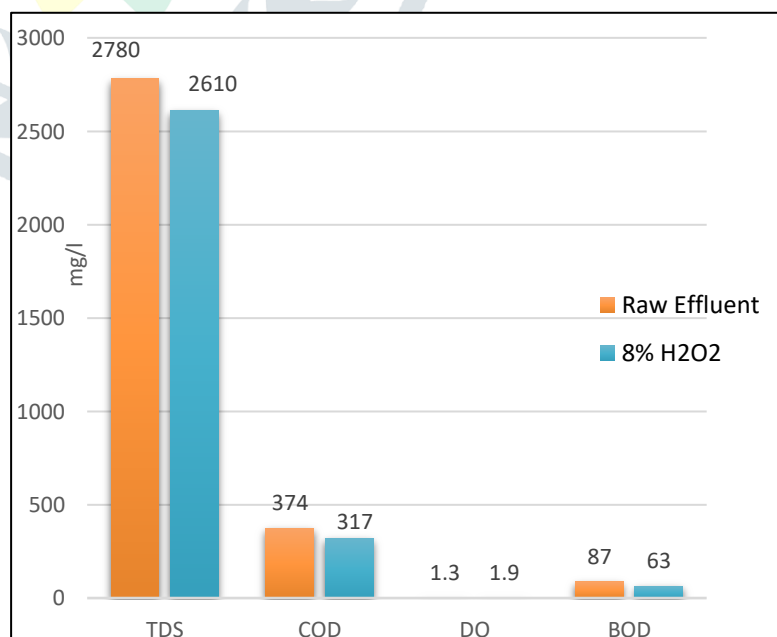
FENTON PROCESS

Fenton treatment procedure of waste water was carried out at ambient temperature in the following sequential steps.

- Waste water sample was filled in one liter beaker and stirred for mixing.
- The scheduled Fe^{2+} dosage was achieved by adding the necessary amount and Fenton Agent 30V/V & Aluminum Sulphate (1N) added in the ratio of 8%, 10%, and 12%.
- After fixed reaction time, before carrying out COD tests, pH was adjusted to 8 to remove residual Fe^{2+}
- Settlement was achieved for 30 minutes, and then examination of physical and chemical characteristics should be done.
- In between continuous stirring process will require.

Table 2. CHARACTERISTICS OF SAMPLE - 8% H₂O₂

Parameter	Values
Color	Dark Brown
Temperature (°C)	36
pH	5.6
Total Dissolved Solids (mg/lit)	2610
Dissolved Oxygen (mg/lit)	1.9
Chemical Oxygen Demand (mg/lit)	317
Biological Oxygen Demand (mg/lit)	63

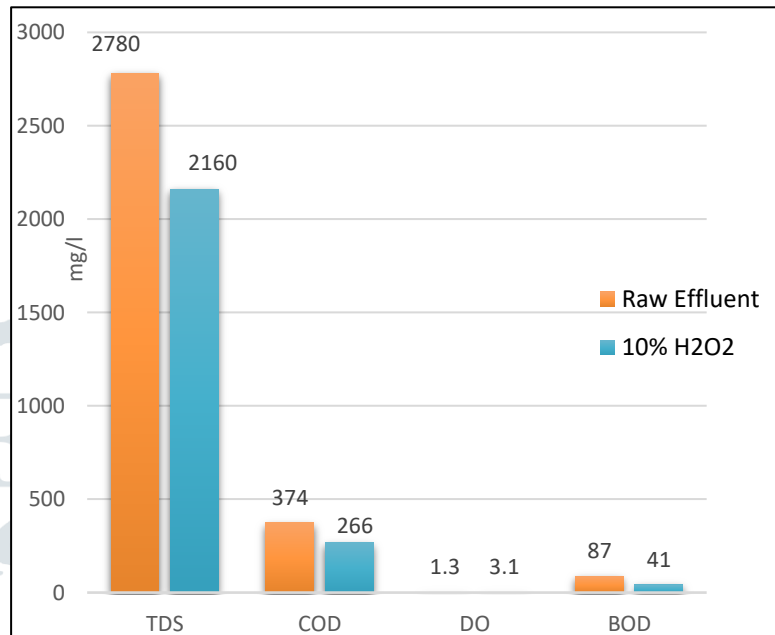
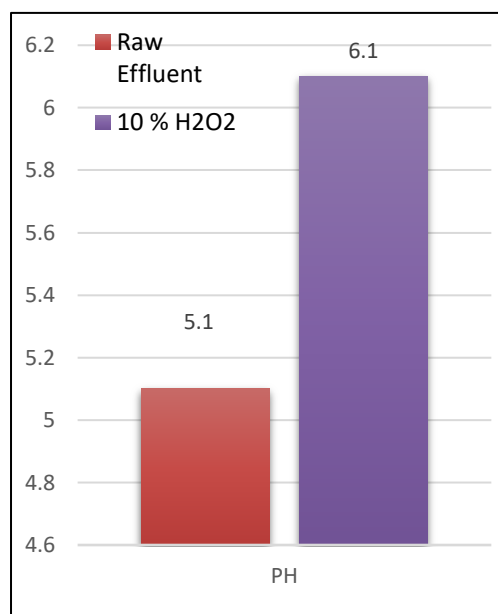
Figure 1: Variation in pH of wastewater with 8% H₂O₂Figure 2: Variation in characteristics of wastewater with 8% H₂O₂

The Figure 1 denotes the raise in pH value from 5.1 to 5.6 when 8% H₂O₂ added.

The Figure 2 represent the changes in value when 8% H₂O₂ added namely the value of TDS has reduce from 2780 mg/L to 2610 mg/L, COD has reduced from 374 mg/L to 317 mg/L, DO has raised from 13 mg/L to 1.9 mg/L, BOD has reduced from 87 mg/L to 63 mg/L.

Table 3. CHARACTERISTICS OF SAMPLE - 10% H2O2

Parameter	Values
Color	Brown
Temperature (°C)	32
pH	6.1
Total Dissolved Solids (mg/lit)	2160
Dissolved Oxygen (mg/lit)	3.1
Chemical Oxygen Demand (mg/lit)	266
Biological Oxygen Demand (mg/lit)	41

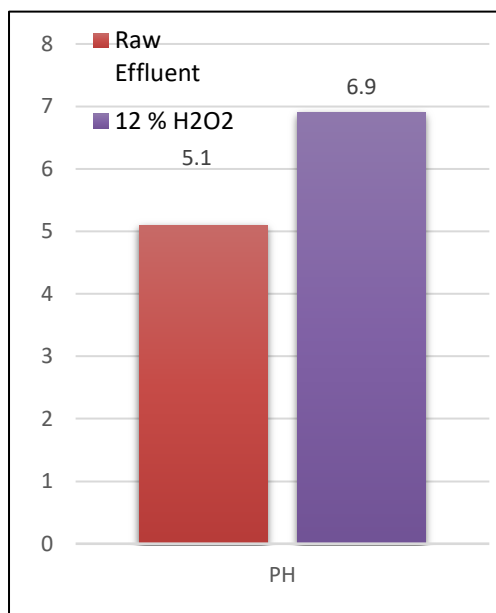
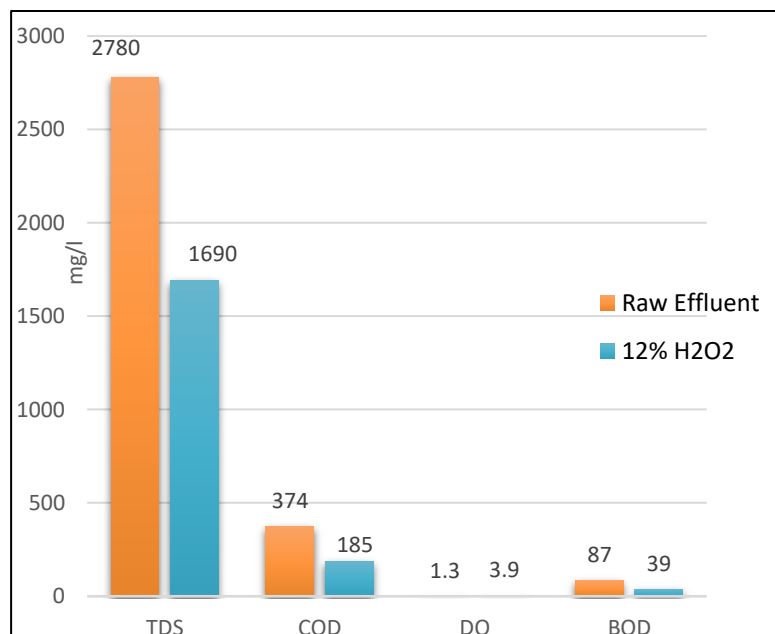
**Figure 3: Variation in pH of wastewater with 10% H2O2****Figure 4: Variation in characteristics of wastewater with 10% H2O2**

The Figure 3 denotes the raise in pH value from 5.1 to 6.1 when 10% H2O2 added.

The Figure 4 represent the changes in value when 10% H2O2 added namely the value of TDS has reduce from 2780 mg/L to 2160 mg/L, COD has reduced from 374 mg/L to 266 mg/L, DO has raised from 13 mg/L to 3.1 mg/L, BOD has reduced from 87 mg/L to 41 mg/L.

Table 3. CHARACTERISTICS OF SAMPLE - 12% H2O2

Parameter	Values
Color	Light Brown
Temperature (°C)	29
pH	6.9
Total Dissolved Solids (mg/lit)	1690
Dissolved Oxygen (mg/lit)	3.9
Chemical Oxygen Demand (mg/lit)	185
Biological Oxygen Demand (mg/lit)	39

Figure 5: Variation in pH of wastewater with 12% H₂O₂Figure 6: Variation in characteristics of wastewater with 12% H₂O₂

The Fig 5 denotes the raise in pH value from 5.1 to 6.9 when 12% H₂O₂ added.

The Figure 6 represent the changes in value when 8% H₂O₂ added namely the value of TDS has reduce from 2780 mg/L to 1690 mg/L, COD has reduced from 374 mg/L to 185 mg/L, DO has raised from 1.3 mg/L to 3.9 mg/L, BOD has reduced from 87 mg/L to 39 mg/L.

III.CONCLUSION

Test results has shown that 12% usage of Fenton reagent (H₂O₂) has shown better results when compared to 8% & 10%.

The raise of pH is 35%, the reduction of Total Dissolved Solids is 39%, the raise of Dissolved Oxygen is 200%, the reduction of Chemical Oxygen Demand is 50%, the reduction of Biological Oxygen Demand is 55%, and the reduction of Temperature is 29%.

By analyzing the test results and comparing it with BIS Standards it has clearly shown that the water can be discharged in environment with no regrets. Finally as an alternative and as a low cost effective study it helps in treating sugarcane effluent.

The only drawback of this project is, wastewater is treated in chemical method and chemical are not cheaper when compared to the biological way of treatment In addition of time there may be even high levels of reduction and raise in characteristics too. Depending on the addition of chemical in varying time and varying concentration can results in difference too.

This study can help in reducing the cost by avoiding the construction of big Effluent Treatment Plants ETPs. Fenton reaction was efficient for reduction of COD and enhancement of biodegradability of sugar industry waste water.

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