Fenton's Oxidation of Distillery Spent Wash Using $FeCl_3$-H_2O_2

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Abstract- *Alcohol distilleries are extremely water demanding industries generating large volumes of high strength wastewater that poses a severe environmental disputes. This study intended at identifying options for improved water treatment technologies like AOP's thus employing Fenton's oxidation process for the treatment of spent wash. The effects of pH, Fe^{3+} loadings, H_2O_2 dosages (30 %), reaction temperature and reaction time, established optimum efficiency. For the treatment of raw distillery spent wash containing 56,400 mg/L BOD, 1,84,000mg/L COD and higher concentrations of TDS, Turbidity, and EC concentrations were found to be 93.48%.COD, 85% EC, 82% TDS, 92%Turbidity. At constant loadings of Fe^{3+} (18.18ml), 3.45 pH, 4 hour reaction time and constant mixing speed of 450 rpm. Optimum time for COD removal using H_2O_2-$FeCl_3$ was found to be 72.28% at 120th minute. Finally, the treatment process were in good agreement to attain the acceptable results in terms of environmental protection.*

Keywords- Fenton's oxidation, Hydrogen Peroxide, Biochemical Oxygen Demand, Chemical Oxygen Demand.

I. INTRODUCTION

Distillery industries are one of the most polluting industries noticed so far worldwide. At present in India there are about 579 sugar mills and 295 distilleries with a total installed capacity of 3198 million liters per annum and a yearly production of 1587 million liters alcohol. For the present study distillery spent wash from Indian Cane Power Limited at Duggavathi village of Harapanahalli TQ, Davanagere district. Karnataka, has been preferred.

Distillery wastewater contains a very high amount of COD, BOD, along with a dark brown color, known as melanoidins. Along with all these characteristics spent wash is daily generated in huge quantity during the ethanol production process. Hence, there is a great need to treat the spent wash generated from the distilleries using effective treatment technologies in order to achieve zero effluent discharge so as to safeguard our environment to the maximum possible extent.

Study Area: Wastewater sample was collected from the Indian Cane Power Limited, Duggavatti. The Company is located at Davanagere district, Karnataka. The spent washthus collected was checked for its initial characterization such as pH, EC, Colour, TDS, Turbidity, BOD, and COD.

Fig 1: Image Showing Hot Spent Wash Storage Tank

Fig 2: Sample collected in polyethylene can

II. METHODOLOGY

The experimental setup for this study was composed of a beaker of 2L holding capacity, magnetic stirrer, and a magnetic bead for stirring at checked resolution. The other glass weirs required for the experimental work are 1000 ml capacity measuring jar, 250 ml capacity beaker, Filter paper for the purpose of filtering the sample, Syringe for the

extraction of the supernatant liquid after the completion of the analysis.

III. RESULTS AND DISCUSSION

Table I: Characteristics of Spent Wash

Sl.No.	Parameters	Raw Spent Wash
01	pH	3.45
02	EC ($mScm^{-1}$)	96.71
03	Total Dissolved Solids (ppm)	138920
04	Turbidity (NTU)	6280
05	Color (Pt.Co)	68275
06	B O D (mg/L)	56400
07	C O D (mg/L)	184000
08	Chloride (mg/L)	8000-8500
09	Sulphate (mg/L)	7500 – 9000
10	Phenols (mg/L)	8000-10000

Analysis of Fenton's Process Using H_2O_2-$FeCl_3$to Studythe Effect on EC, TDS and Turbidity

Table II: Removal Efficiency of TDS, Turbidity and EC employing H_2O_2-$FeCl_3$

Constant parameters:

i. pH=3.5
ii. Time (T) =4hours
iii. $FeSO_4$ dosage=18.18ml

SL NO	H_2O_2Dosage (ML)	TDS (PPM)	Turbidity (NTU)	EC (µS/CM)	Removal Efficiency TDS (%)	Removal Efficiency Turbidity (%)	Removal Efficiency EC (%)
1	30	114984	2430	77039	17	61	20
2	60	74642	1520	46278	46	76	52
3	90	82796	920	53818	40	85	44
4	120	70571	710	42343	49	89	56
5	150	60986	680	37811	56	89	61
6	180	46872	605	31873	66	90	67
7	210	26075	565	15906	81	91	84
8	240	24505	530	14703	82	92	85

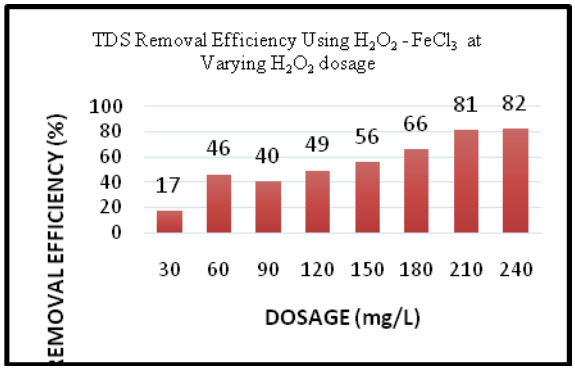

Fig 3: Effect of H_2O_2-$FeCl_3$Concentrations on TotalDissolved Solids.

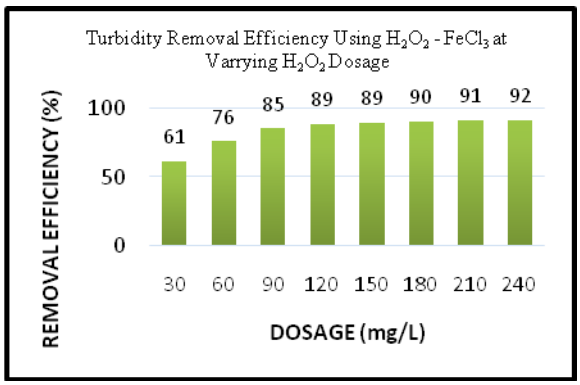

Fig 4: Effect of H_2O_2-$FeCl_3$Concentrations on Turbidity

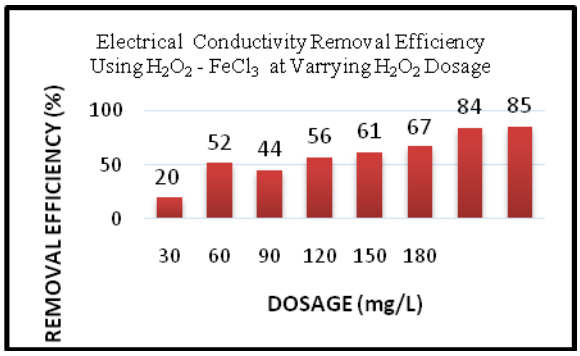

Fig 5: Effect of H_2O_2-$FeCl_3$Concentrations on Electrical Conductivity

After the completion of 4hr reaction time using H_2O_2–$FeCl_3$ as test reagents, the supernatant liquid thus collected was tested for the above mentioned analysis. Which indicated the significant reduction in Turbidity with the gradual increase in the dosage of H_2O_2 and fixed $FeCl_3$ concentration. Similarly, both EC and TDS also showed gradual reduction in their concentration with the increase in reagent concentrations.

Analysis of Removal Efficiency of COD Using H_2O_2-$FeCl_3$

Table III:Removal Efficiency of COD Using H_2O_2-$FeCl_3$

Constant parameters:

i. Time (T) = 4 hour
ii. pH=3.5
iii. $FeSO_4$ dosage=18.18 ml.

SL.NO	H_2O_2Dosage (ml)	COD Value (mg/L)	COD Removal Efficiency (Percentage)
01	30	102000	44.57
02	60	40000	78.26
03	90	29000	84.24
04	120	21000	88.59
05	150	14000	92.39
06	180	12000	93.48
07	210	16000	91.30
08	240	18000	90.22

The above table indicates that the parameters maintained for the study were fixed at an acidic pH of 3.5 and $FeCl_3$ dosage of 18.18ml and at Room temperature, and slightly varying H_2O_2dosages

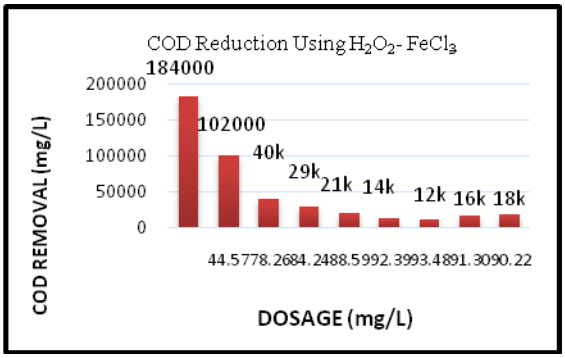

Fig 6: Effect of H_2O_2-$FeCl_3$ concentrations on COD

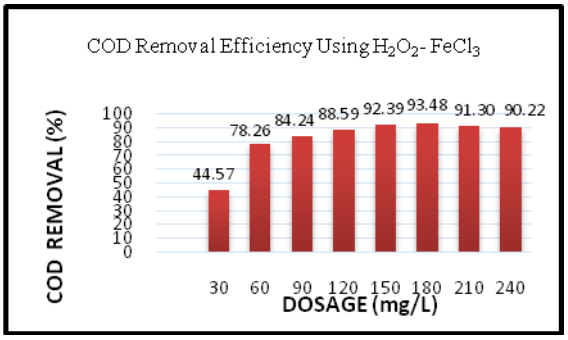

Fig 7: Graph Depicting the COD Removal Efficiency at varying H_2O_2 Dosages Employing H_2O_2-$FeCl_3$ as Test Reagents.

Gradual reductions in the COD value were observed. Whereas, at 180 ml H_2O_2 dosage significant reduction in the

COD value from 184000mg/L to 12000mg/L was observed, whose removal efficiency turned out to be 93.48 %.

From the above table it can be observed that the removal efficiency is found to be almost similar for the last few dosages and on further increasing the dosage the COD value increases instead of decreasing indicates the adverse effect on further increasing the H_2O_2 dosage.

Thus, dosage of 180ml is considered to be the optimum for analysis involving H_2O_2-$FeSO_4$ test solutions.

Evaluation of Optimum Reaction-Time for Fenton's Process Employing H_2O_2-$FeCl_3$ as Test Reagents.

Table IV: COD Removal Efficiency at Varying Time Intervals.

Constant parameters:

i. pH=3.5
ii. H_2O_2 =120ml
iii. $FeCl_3$ dosage=18.18ml

SL. NO	Time (min)	COD Removal (mg/L)	COD Removal Efficiency (Percentage)
01	30	137000	25.54
02	60	84000	54.35
03	90	71000	61.41
04	120	51000	72.28
05	150	60000	67.39
06	180	62000	66.30
07	210	64000	65.22
08	240	64000	65.22

The above table 4 indicating the kinetic study results for the H_2O_2-$FeCl_3$ analysis for a fixed time duration of 4hr done at fixed pH, $FeCl_3$ and H_2O_2 concentrations of 3.5, 18.18ml and 180ml respectively.

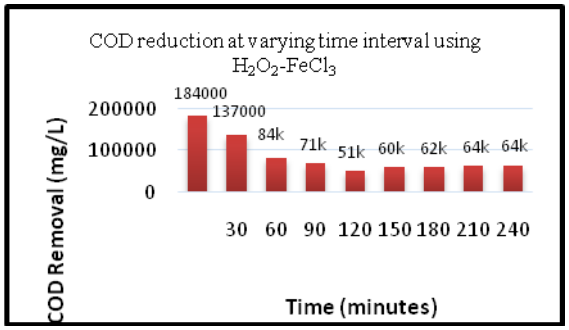

Fig 8: Graph Depicting the COD Removal at Varying Time Intervals Employing H_2O_2-$FeCl_3$

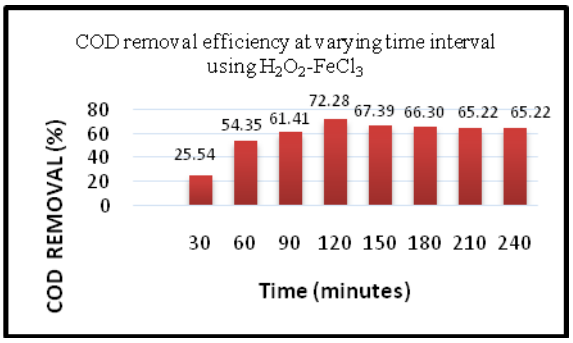

Fig 9: Graph Indicating the COD Removal Efficiency Employing H_2O_2-$FeCl_3$ as Test Reagents at varying Time Intervals.

IV. CONCLUSIONS

Coalition of H_2O_2-$FeCl_3$ was found to be more effective in COD removal, at 180 ml H_2O_2 dosage, a significant removal in the COD content from 184000mg/L to 12000mg/L was observed, whose removal efficiency turned out to be 93.48%.

The optimum reaction time was found to be occurring at 120 min with an efficiency of 72.28%. Whereas the reaction efficiency is quite less and almost similar for the rest of the trials.

Fenton's process in acidic condition was found to be successful in reducing the COD to considerable extent. Fenton's process as a treatment process for distillery spent wash is found to be effective and economical too.

V. ACKNOWLEDGEMENT

The Authors are thankful to Chairman and Staff of Department of Civil Engineering Department, University B. D. T College of Engineering Davanagere. Authors are also thankful to their family and friends.

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