Fenton's Oxidation of Distillery Spent Wash

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Abstract: The distillery industry is one amongst the oldest and most extremely advanced industries in India characterized by high BOD, COD, Total solids and Color with a characteristic odor. The spent wash if discharged directly to the natural sources of water or else on to the land inflicts irreversible harm to the surroundings. In general, typical treatment strategies square measure unable to treat the recalcitrant materials present in it, since they're additional immune to biodegradation. Therefore, there's an excellent have to be compelled to incorporate technologies which will degrade materials immune to biodegradation, like advance oxidation processes. During the study, the reaction method of Fenton has been accustomed. The analysis employing chemicals like $FeSO_4$ at varying H_2O_2 dosages, fixed Fe^{2+} loadings, reaction temperature, reaction time, and mixing speed established an optimum efficiency in terms of COD reduction including EC, TDS and Turbidity. The best operating conditions for the treatment of distillery spent wash employing H_2O_2-$FeSO_4$ as test reagents removed 83.70% COD, 84.12% EC, 81.01%TDS, 93.06%Turbidity. At constant loadings of Fe^{2+} (18.18ml), 3.45 pH, 4 hour reaction time and constant mixing speed of 450 rpm, at these optimized condition, H_2O_2 dosage was varied in the range between 30ml to 240ml. Optimum time for COD removal using H_2O_2-$FeSO_4$ was found to be 76.63% at 60 minutes. The process proved the ability to effectively remove the COD content which when high in industrial wastewaters can lead to serious impacts on the environment.

Keywords: Biochemical Oxygen Demand, Chemical Oxygen Demand, Ferrous Sulphate, Hydrogen Peroxide.

I. INTRODUCTION

The accessibility of virtuous, immaculate water is one of the most basic prerequisite for all forms of life on the earth, inclusive of human beings to outlive or to sustain. But still its availability is an austere complication in the current days. In the course of time, this complication will be further broadened due to global urbanization, industrialization and population explosion, and may glimpse the creation of even worse bearings. The natural water resources that are unit approachable also are contaminated in many ways by the discharge of commercial, domestic and agricultural waste into them [1]. Therefore at this time this is importunate to exterminate pollutants and pathogens from wastes to enliven irrigation, industrial and domestic wastes, as well as all desperate wastes in recent years conventional biological and physical treatment technologies have been put into service inclusive of adsorption, ultra filtration, disinfection, coagulation and flocculation, etc. to exile pollutants. But they are not productive in obstracizing recalcitrant or refractory materials that are resistant to biodegradation.

These methods are not lucrative and effectual for wastewaters accommodating very high concentrations of toxic pollutants. The distillery industries are immensely polluting industries noticed so far all over the world. For the time being, there are around 579 sugar mills and 295 distilleries in India with a total installed capacity of 3198 million liters per year with an annual production of 1587 million liters of alcohol [2]. For the present study, the distillery passed the washing of Indian Cane Power Limited in the Duggavathi village of Harapanahalli TQ., Davanagere district. Karnataka, it has been aggrandized. The wastewater from the distillery contains a very high quantity of COD and BOD

together with a deep brown color, said to be melanoidin. The high resistance wastewater during the preparation of alcohol are high in COD and high in BOD. Processed Low-potent wastewater comprises of low concentrations of COD, BOD, Color, and other constituents [3]. Inclusive of all these characteristics, spent wash is brought out daily in large quantities during the ethanol production processes. Upon enlargement of the plant, the quantity of spent wash generated from the existing plant will further enhance a lot. Therefore, there is a great requirement to treat the spent wash generated by the distilleries adopting effective treatment technologies to reach zero discharge of effluent in order to safeguard our environment as much as possible [4]. In these days there is a great extremity to verify those techniques that are economically attainable, profitable, and respectful with the environment and can produce convincing and significant results [5]. Therefore, in the present work, the raw spent wash is treated with easily available chemicals to percolate the analysis together with the hydrogen peroxide.

II Study Area and Methodology

A. Study Area

Wastewater sample is collected from the Indian Cane Power Limited, Duggavatti. The Company is located at Duggavathi village, Harapanahalli TQ, Davanagere District, Karnataka. The Distillery plant is located at Latitude N $14^{0}57^{'}915^{"}$ and Longitude E $75^{0}50^{'}625^{"}$, at an Altitude of 1766 feet above the Mean Sea Level (MSL). Today the company offers a wide array of products such as Rectified Spirit, Neutral Spirit, Impure Spirit, Ethanol, IMFL (Indian Manufactured Liquor) that are best in terms of quality. Spent wash was collected and checked for its initial characterizations such as pH, EC, Color, TDS, Turbidity, BOD, and COD.

Fig 1: Image Showing Indian Cane Power Limited, Davanagere

B. Methodology

Sample Collection was done in a clean and sterilized 2 litre capacity polyethylene can. In the month of January, 2019, Firstly, examining vessel was cleaned and flushed precisely with refined water and afterwards washed with sample during collection. At that point effluent was preserved in an ice box at a temperature of 4 ºC within 2 hours of collection of the sample. All the glassware's used for the experimental work were of borosil make and all the chemicals employed were of analytical grade and nice brand chemicals.

Fig 2: Image Showing Spent Wash Stored in Lagoons

For all trials 1L raw spent wash was taken as test sample in a 2L capacity glass beaker. During the experimentation the stirring speed was set at 450 rpm. This speed was observed to be the optimum speed where proper mixing of the whole solution in the beaker was done without any vertex formation resulting in the incomplete mixing of the test solutions.

The sample was tested for its initial pH by instrumental test and was noted to be acidic in nature. Thus, the whole study was carried out at 3.5 pH value. For each trial the hydrogen peroxide dosage was varied keeping all other parameters fixed in order to find the optimum H_2O_2 dosage for COD removal. After the completion of 4hr reaction time using H_2O_2-$FeSO_4$, the tested sample was allowed to stand for some time so as to separate the solids at the bottom. The supernatant liquid then collected was used for TDS, Turbidity, Electrical conductivity and COD analysis. After finding out the optimum dosage of H_2O_2 and $FeSO_4$, kinetic study were conducted for 4hr time duration so as to find the optimum time for the maximum COD removal efficiency. Then, after the completion of the analysis part COD removal efficiency was calculated using equation.

$$\text{Removal Efficiency} = \frac{(\text{COD i} - \text{COD f})}{\text{CODi}} \times 100$$

III RESULTS AND DISCUSSIONS

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	Colour (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

Very high COD, BOD content along with values of color, EC, Turbidity, TDS, etc., indicates that it is inefficacious to treat by conventional wastewater treatment techniques, instead the sample needs advanced treatment techniques like AOPs. A significant variation in these parameters was observed after the completion of experimentation part on employing Fenton's Process of AOPs.

A Analysis of Fenton's Process Using H_2O_2-$FeSO_4$

Effect of H_2O_2-$FeSO_4$ on EC, TDS on Turbidity:

Table II: Removal Efficiency of TDS, Turbidity and EC employing H_2O_2-$FeSO_4$.
Constant parameters: i) pH=3.5, ii) Time (T) =4 hour, iii) $FeSO_4$ dosage=18.18ml.

Sl No.	H_2O_2 Dosage (ml)	TDS (ppm)	Turbidity (NTU)	EC (µS/cm)	Removal Efficiency TDS (%)	Removal Efficiency Turbidity (%)	Removal Efficiency EC (%)
1	30	121833	2520	81628	12	60	16
2	60	93493	1480	57966	33	76	40
3	90	71683	910	46594	48	86	52
4	120	65015	760	39009	53	88	60

5	150	56818	630	35227	59	90	64
6	180	46872	590	31873	66	91	67
7	210	30243	545	18448	78	91	81
8	240	25895	430	15537	81	93	84

After the completion of 4hr reaction time using H_2O_2–$FeSO_4$ as test reagents, the supernatant liquid thus collected was tested for the above mentioned analysis. This indicated the significant removal of EC, TDS and Turbidity. The experimental analysis showed gradual reduction in these concentrations with an increase in reagent concentrations.

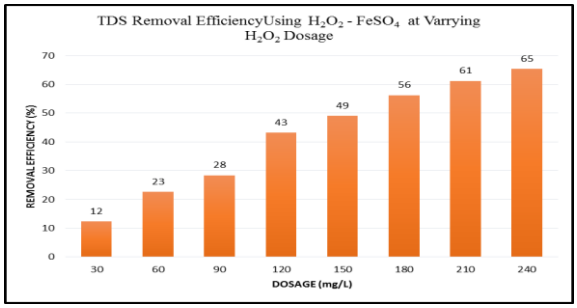

Fig 3: Effect of H_2O_2.$FeSO_4$ Concentrations on TDS

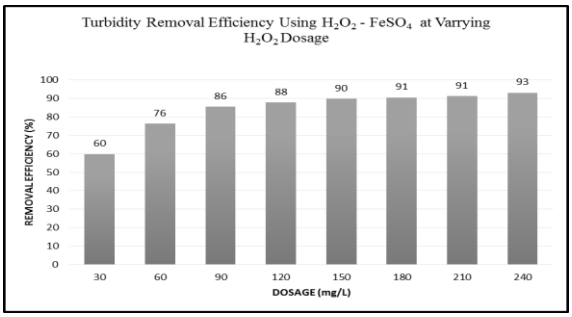

Fig 4: Effect of H_2O_2-$FeSO_4$ Concentrations onTurbidity

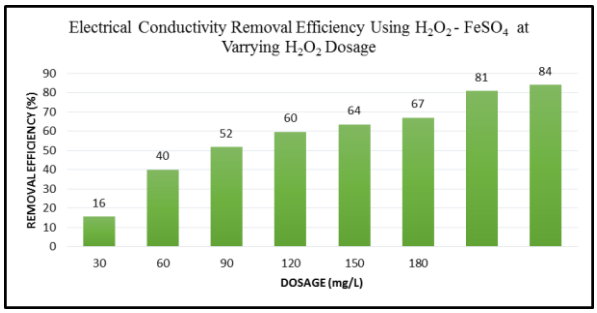

Fig 5: Effect of H_2O_2-$FeSO_4$ Concentrations on Electrical Conductivity

B. Effect of H_2O_2-$FeSO_4$ on Chemical Oxygen Demand

Table III: Removal Efficiency of COD Using H_2O_2-$FeSO_4$

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

SL No.	H_2O_2 Dosage (ml)	COD Value (mg/L)	COD Removal Efficiency (%)
01	30	142000	22.83
02	60	80000	56.52
03	90	52000	71.74
04	120	30000	83.70
05	150	34000	81.52
06	180	34000	81.52
07	210	33000	82.07
08	240	32000	82.61

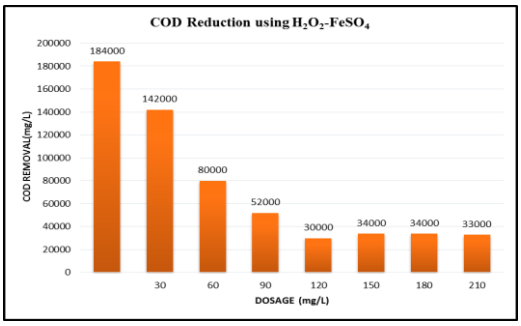

Fig 6: Effect of H_2O_2-$FeSO_4$ concentrations on COD.

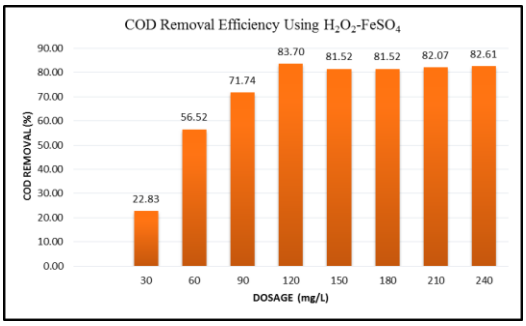

Fig 7: Graph Depicting the COD Removal Efficiency at varying H_2O_2 Dosages Employing H_2O_2-$FeSO_4$ as Test Reagents.

C. Evaluation of Optimum Reaction-Time for Fenton's Process Using H_2O_2-$FeSO_4$

Table IV: COD Removal Efficiency at Varying Time Intervals
Constant parameters: i) pH=3.5, ii) H_20_2 =120ml, iii) $FeSO_4$ dosage=18.18ml.

SL No.	Time (min)	COD Value (mg/L)	COD Removal Efficiency (%)
01	30	132000	28.26
02	60	43000	76.63
03	90	45000	75.54
04	120	52000	71.74
05	150	54000	70..65
06	180	66000	67.39
07	210	64000	65.22
08	240	68000	63.04

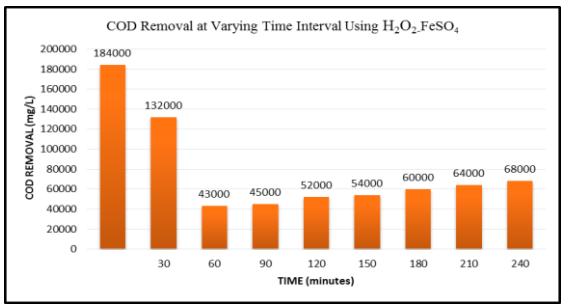

Fig 8: COD Removal at Varying Time Intervals Employing H_2O_2-$FeSO_4$.

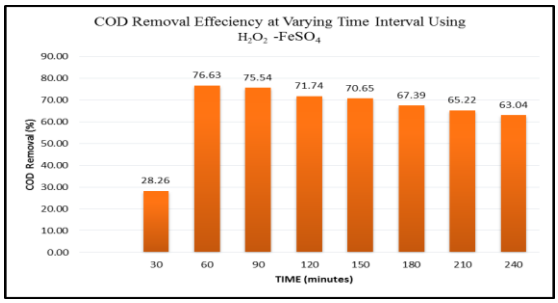

Fig 9: COD Removal Efficiency at Varying Time Intervals Employing H_2O_2-$FeSO_4$ as Test Reagents

The above graph and table Indicates the Kinetic Study results for the H_2O_2-$FeSO_4$ analysis for a fixed time duration of 4hr done at fixed pH, $FeSO_4$ and H_2O_2 concentrations of 3.5, 18.18ml and 120ml respectively. The maximum reaction efficiency was found to be occurring at 60 min that is 76.63%. Whereas the reaction efficiency is quite less and almost similar for the rest of the trials. Thus, from the above analysis it is observed that at 60^{th} min maximum reduction in the COD took place. The above table and graphical representation depicts that for raw spent wash with fixed acidic pH of 3.5, $FeSO_4$ dosage of 18.18ml, normal room temperature, and slight variations in the H_2O_2 dosages gradual reduction in COD value can be observed, whereas at 120 ml H_2O_2 dosage significant reduction in the COD content from 184000mg/L to 30000mg/L was observed, whose removal efficiency brought out to be 83.70%. From the higher table it is discovered that the removal potency is sort of similar for the previous few indefinite quantities and on additional variation within the dosages the COD worth will

increase rather than decreasing indicates the adverse impact on additional increasing H_2O_2 considered to be the optimum dosage for H_2O_2-$FeSO_4$ reaction.

IV CONCLUSIONS

In case of H_2O_2-$FeSO_4$ analysis the maximum removal efficiency is COD was observed, whereas at 120 ml H_2O_2 dosage significant reduction in the COD value from 184000mg/L to 30000mg/L was observed, whose removal efficiency turned out to be 83.70%. The maximum removal efficiency was found to be occurring at 60^{th} min that is 76.63%. Results obtained from the overall study concluded that $FeSO_4$ showed effective COD removal efficiency. Fenton's process in acidic condition was found to be successful in removing the COD to a considerable extent. Fenton's process as a treatment process for distillery spent wash was found to be efficient and economical.

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