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TREATMENT OF DISTILLERY EFFLUENT BY USING ADVANCED OXIDATION PROCESS

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Abstract – *The project work was carried out to investigate the Treatment of Distillery Effluent by using Advanced Oxidation Process (AOPs). Recent trends proposed AOPs for oxidizing complex organic compounds or recalcitrant organic matters present in the Distillery Effluent to simple harmless compounds. Fenton oxidation process is one of the processes of AOPs, combination of Hydrogen peroxide and Ferrous ion reacts to form active Hydroxyl radical. Electro Fenton Process is an electrically aided Fenton reaction by the use of Electrodes. Application of the Response Surface Methodology (RSM) to check the Electro-Chemical Oxidation of Distillery Spent wash by using Aluminum electrodes. The Variables considered for the study are Fenton Dosage, Reaction time and Applied Current. COD, Colour, Turbidity and TDS are the response factors under consideration.*

Key Words: **Distillery Effluent, Advanced Oxidation Process, Electro Fenton Process, RSM, COD.**

1. INTRODUCTION

Distillery industries have been around for a long time, it is an industry that produces alcohol, rectified spirit, spirit and ethanol, as well as a large amount of wastewater. Because of large amount of wastewater produced by the alcohol industry in India, it is extremely hazardous to the environment. This distillery wastewater, also known as distillery effluent, is commonly referred as "Spent wash" or "Stillage". This DSW is highly recalcitrant, with high complexities, it has more BOD, COD, TDS, Turbidity, Colour, Odour [1]. This molasses based alcoholic distillery industry produces wastewater, which typically ranges from 10-15 liters per liter of alcohol produced in the distillery industry process and has characteristics such as dark brown colour, high BOD and COD values. When untreated Distillery Spent wash or alcoholic wastewater is discharged into water bodies or open sources, it can cause severe or unmanageable environment damage, such as disturbing underground or surface water and depleting soil properties. Although distillery wastewater has a negative impact on the environment. Therefore, proper treatment method is required to treat the wastewater from the distillery industry before discharge is more required. There are plenty of old technologies to treat industrial wastewater like Adsorption method, Physio-chemical method, Membrane technology, Aerobic treatment, Electro-coagulation method, Advanced oxidation process, etc. These methods are also used to treat Spent wash to get better results for removing the contaminated pollutants present in it [2]. Among all the methods AOPs are the suitable method to treat DSW. AOPs have different methods in which Fenton process is the most effective method to treat spent wash. Fenton process is the combination of H_2O_2 and Fe^{3+} ions which together make Fenton reagent, effective in treating polluted wastewater to remove recalcitrant components [2].

2. MATERIALS AND METHODOLOGY

2.1 Materials

To carry out the experiment various glassware, reagents (Fenton reagents), Chemicals and some instruments are used in the laboratory.

2.2 Methodology

The method adopted to treat Distillery Effluent is AOPs in which Electro Fenton process is suitable for the treatment of Distillery Effluent.

2.3 Electro Fenton Process

The EF process is a type of AOPs that is carried out electrically using electrodes. This process is simpler than other methods because it leads to the resurgence of Fenton reagent products and further aids in the oxidation reaction.

2.4 Experimentation

1. Raw sample (Distillery Effluent) was collected from the distillery industry and transferred to the laboratory with suitable conditions for further experimentation.

2. Sample was initially investigated for its basic parameters like pH, COD, BOD, TDS, EC, Turbidity and Chlorides.

3. This sample is then added to beaker (1000ml) and placed on magnetic stirrer by adding Fenton reagent (Hydrogen peroxide & Ferrous ions in 1:5 ratio). The sample is stirred well it is allowed to treat for certain time according to the RSM worksheet data.

4. After the treatment sample is allowed for settlement and then collected to know the % removal of COD.

5. This process is repeated until the maximum removal efficiency is occurred. All the readings are recorded for further analysis and the results are concluded.

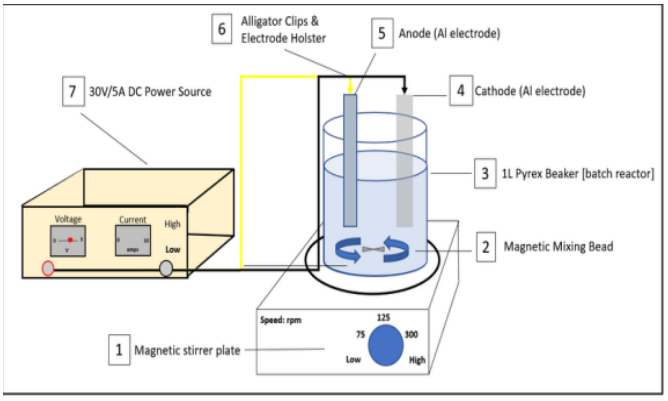

Fig -1: Experimental setup of Electro Fenton Process

3. Results and Discussion

Results obtained from this study are discussed below in this chapter.

3.1 Analysis of basic parameters of Distillery Effluent

Table -1: Initial characteristics of Distillery Effluent

Parameters Analyzed	Raw Spent wash values
pH	4.2
TDS (ppm)	138920
BOD (mg/L)	56400
COD (mg/L)	184000
EC (ds/m)	92500
Colour (Pt-Co)	43080
Turbidity (NTU)	6280
Chlorides (mg/L)	10650

3.2 Experimentation of Electro Fenton Process

Sample of Distillery Effluent is treated by considering various conditions they are varying pH, varying Fenton dosage, varying reaction time and by varying applied current to remove polluted contaminants (COD, Colour, TDS & Turbidity).

Parameters monitored after the treatment are COD, Colour, TDS and Turbidity. Treated sample is examined to note the % removal of the monitored parameters for varying pH, Fenton dosage, reaction time and applied current. The results are tabulated in the table 2 below and the % removal efficiency is represented graphically.

Table -2: % Removal Efficiency of COD for various factors

Various Factors Considered	% Removal efficiency of COD				
pH	2.0	2.5	3.0	3.5	4.0
	56.52	71.74	91.03	83.69	81.52
Fenton dosage	0.005	0.0075	0.01	0.0125	0.015
	71.74	83.69	90.48	87.50	81.52
Reaction time	10	20	30	40	50
	56.52	81.52	92.11	91.03	90.76
Applied current	1.0	1.5	2.0	2.5	3.0
	81.52	92.11	93.20	92.93	92.39

The above-mentioned table represents the results obtained for the % removal efficiency of COD by varying pH i.e., from 2 to 4 pH, varying Fenton dosage i.e., 0.005 mol/L to 0.015 mol/L, varying reaction time i.e., from 10 mins to 50 mins and varying applied current i.e., from 1A to 3A.

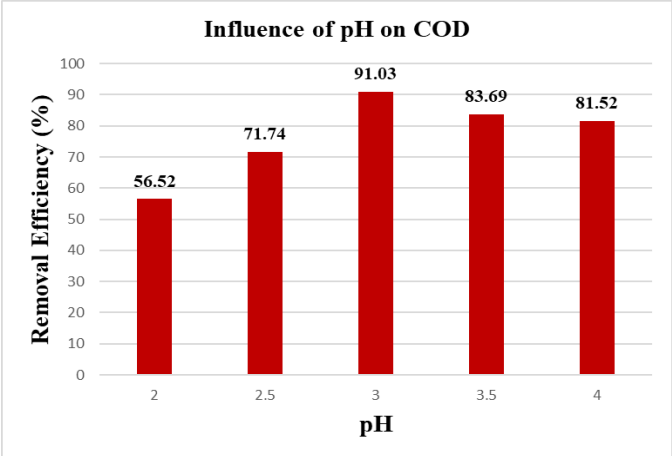

Chart -1: % Removal efficiency of COD for varying pH

Above graph shows the results obtained for the % removal efficiency of COD for varying pH from 2.0 to 4.0 pH. The maximum removal efficiency is observed at pH 3.0. Hence, maximum efficiency can be obtained at acidic condition.

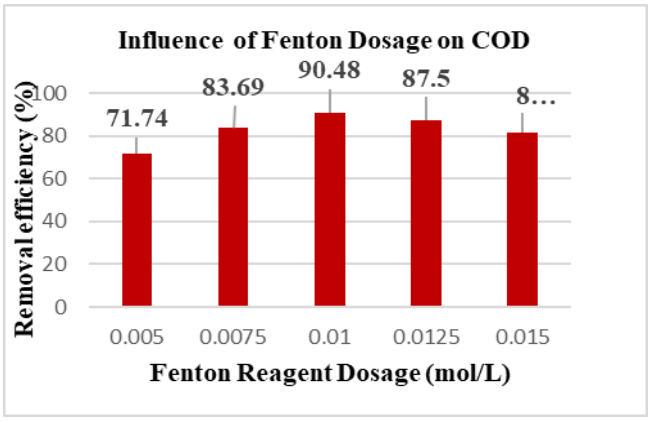

Chart -2: % Removal efficiency of COD for varying Fenton dosage

Above graph shows the results obtained for the % removal efficiency of COD for varying Fenton dosage from 0.005 mol/L to 0.015 mol/L. The maximum removal efficiency is observed at 0.01 mol/L Fenton dosage.

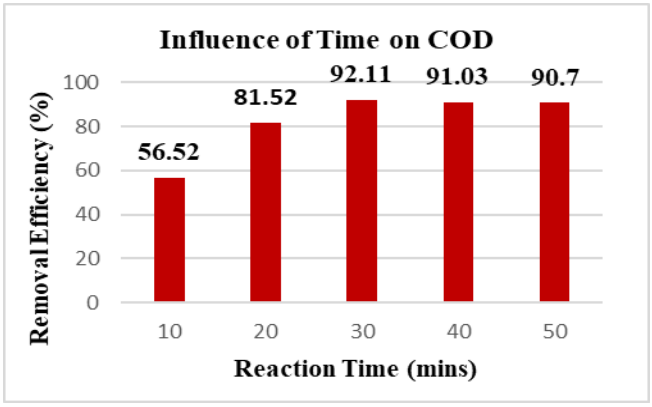

Chart -3: % Removal efficiency of COD for varying Reaction time

Above graph shows the results obtained for the % removal efficiency of COD for varying Reaction time from 10 mins to 50 mins. The maximum removal efficiency is observed at 30 mins.

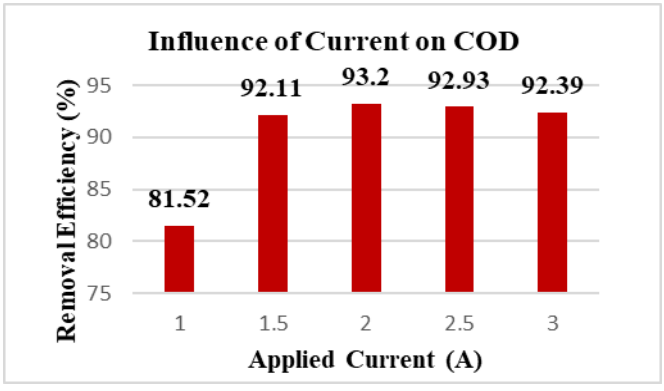

Chart -4: % Removal efficiency of COD for varying Applied current

Above graph shows the results obtained for the % removal efficiency of COD for varying Applied current from 1A to 3A. The maximum removal efficiency is observed at 2A.

3.3 Response Surface Methodology (RSM)

RSM is a tool that aids in determining the maximum removal efficiency of responses such as COD, Colour, Turbidity and Total Dissolved Solids. The significant parameters are Fenton dosage, Reaction time and applied current. RSM programming in Minitab 22 was used to plot the experimental design data, optimization data, graphs, surface plots and contour plots. RSM includes a number of optimization tools, including Central Composite Design (CCD), Box-Behnken Design (BBD) and Full Factorial Design (FFD). The Box-Behnken Design experimental tool is used in this project work to create the relationship between the Dependent variables or Responses functions and the independent variables.

The RSM software will plot the desired graph based on the maximum contaminants removed from the treatment process under good working conditions. RSM Software includes different graphical representation to show % removal efficiency of monitored parameters which are known as plots, they are;

1.Fitted line plot

2.Contour plot

3.Surface plot

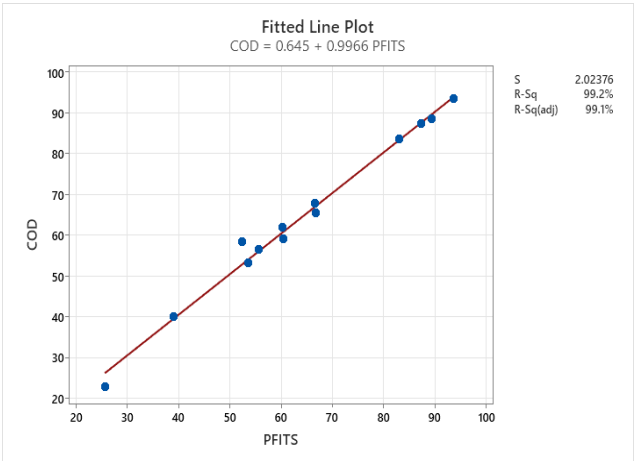

Chart – 5: Fitted Line Plot for % Removal Efficiency of Experimental COD v/s Predicted COD Values

Above plot represents the fitted line plot for % removal efficiency of COD for experimental and predicted values of COD.

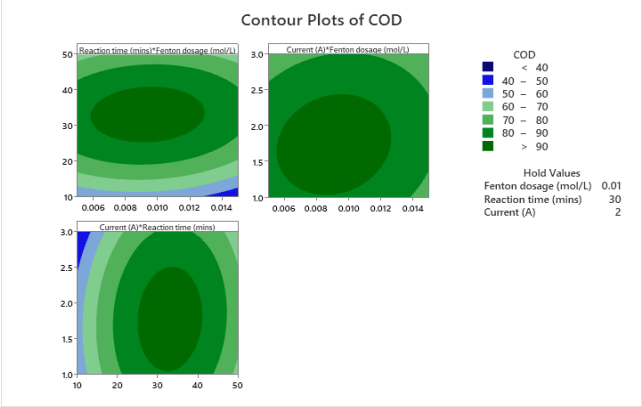

Chart – 6: Contour Plots for COD % Removal Efficiency w.r.t Independent Variables

Above plot represents the contour plot for % removal efficiency of COD with respect to independent variables such as Fenton dosage, reaction time and applied current.

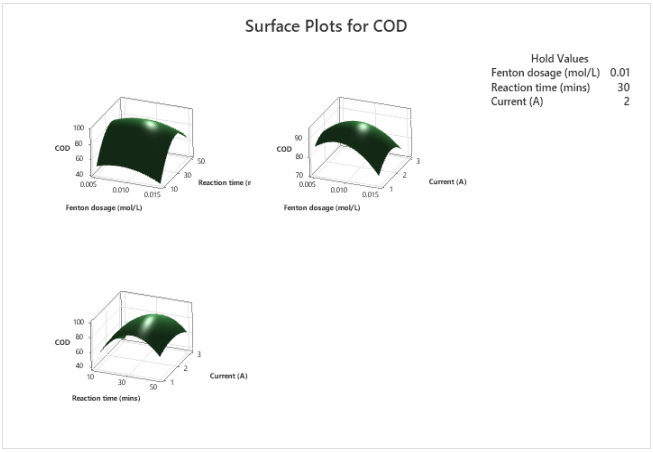

Chart – 7: Surface Plots for COD % Removal Efficiency w.r.t Independent Variables

Above plot represents the surface plot for % removal efficiency of COD with respect to independent variables such as Fenton dosage, reaction time and applied current.

4. CONCLUSIONS

According to the study "Treatment of Distillery Effluent (Spent wash) by using Advanced Oxidation Process", the Electro Fenton Oxidation process is used by the application of Response Surface Methodology (RSM), which includes Experimental evaluations and Prediction models discussed in previous. The following conclusions are drawn from the experimental analysis data and predicted values; the results are concluded as follows;

The preliminary parameters or characteristic analysis show that the Distillery effluent or Raw Spent wash contains more recalcitrant organic matters, which are reduced by Advanced Oxidation Process (AOPs). In the Electro Fenton Oxidation process, the optimal conditions for maximum removal efficiency of COD, Colour, Turbidity and TDS were pH = 3.0, Fenton reagent dosage = 0.01 mol/L (i.e., Fenton dosage of $FeSO_4$ = 560 mg/L and H_2O_2 = 1.0 ml), Reaction time = 30 mins and applied current = 2A. Independent variables such as Fenton dosage, Reaction time and Applied current are varied to check the maximum removal efficiency with respect to the independent variables. These independent variables such as Fenton dosage, reaction time and applied current will affect the removal efficiency of the responses such as COD, Colour, Turbidity and TDS. The experimentation was done by the application of Response Surface Methodology (RSM) to check the maximum removal efficiency or the adequacy of the experimentation and the obtained experimental values.

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