Feasibility of Fenton Process for the Degradation of Carbofuran from Waste Water

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Abstract: A comprehensive study has been investigated for the degradation of Carbofuran from wastewater using Fenton's reagent which produces hydroxyl radicals. Various process parameters such as pH, dosages of H_2O_2 & $FeSO_4$ were analyzed in the Fenton process. The doses of H_2O_2 & $FeSO_4$ were varying with different combination of the sets. The mineralization efficiency of COD & BOD was examined with different combination sets of H_2O_2 & $FeSO_4$ and finds the optimum dosage of Fenton reagent ($FeSO_4$+H_2O_2). Experimental results showed that Fenton's reagents are playing a key role in treatment process. The optimum ratio of [$FeSO_4$]:[H_2O_2] was 1:5 while the optimum pH was 3.0. Fenton process does not gives good results in neutral or alkaline media.

Keywords: Fenton reagent; Pesticide; Waste water; COD; BOD.

1. INTRODUCTION

Water is a source of life and energy and groundwater is one of the major sources of drinking water. Wastewater is categorized and defined according to its sources of origin. Agro-industrial wastewaters have considerable impact on the environment in terms of pollutant strength. Agriculture is the backbone of our country using large quantities of pesticides, the chemicals that kill plants or pests and compete for humanity's food supply [1]. The use of pesticides in agriculture, forest, garden, park and in non-agricultural sectors such as wood preservation, disinfection or household use is increasing day by day which is polluting water resources [2]. The maximum concentration of Carbofuran reported by the World Health Organization (WHO) in 3 µg/L in potable water [3]. Fenton process was first reported by H. J. H. Fenton in 1894. Fenton process form hydroxyl radical ($OH^{\bullet}$) with the reaction between peroxide (hydrogen peroxide) and ferrous (fe^{2+}) / ferric (fe^{3+}) ion to form which oxidize organic and inorganic compound [4]. Fenton is one of the most proficient technology for removal of hazardous organic and toxic compound from waste water [5, 6].

2. CHEMICALS AND METHODS

2.1 Chemicals

Technical grade carbofuran ($C_{12}H_{15}NO_3$) of 98% purity provided by Sigma–Aldrich (Mumbai). Chemicals $FeSO_4$ and H_2O_2 was borrowed from Merck, Mumbai. Standard 0.1 N NaOH and 0.1 N H_2SO_4 solutions were used to maintain the required pH. Distilled water was consumed for all experiment.

2.2 Experimental approach

Stock solution of carbofuran of 60 mg/L was prepared by dissolving 60 mg of carbofuran in 10 ml acetone and make up to 1 ltr in volumetric flask. The batch experiments were conducted at 29°C to check the efficiency of Fenton's process. The removal efficiency of COD and BOD with Fenton reagent has been analyzed by changing the ratio of $FeSO_4$ and H_2O_2. Chemical oxygen demand (COD) was determined by standard method in a COD digester. BOD was determined in a BOD incubator.

Fenton treatment has been done with 400 ml stock solution in glass beaker of 500 ml capacity for each run. Analysis was conducted at different ratio of $FeSO_4$& H_2O_2 to find the optimum dose of $FeSO_4$ & H_2O_2. The pH of the sample was maintained at 4 with the help of pH meter. Essential amount of $FeSO_4$ was added to the solution for the generation of Fe^{+2}. Initiate the reaction by adding demanded volume of H_2O_2. Proceed the reaction using magnetic stirrer at 60 rpm for 1hr. The pH of the sample was neutralized for the judgment of COD and BOD removal.

3. RESULTS AND DISCUSSION

3.1 Effect of pH

Fenton process is highly depends on the solution pH essentially due to iron and hydrogen peroxide factors [7-10]. The Fenton reaction was conducted at different range 2-10. The optimum pH for the Fenton reaction was found to be 3. Due to presence of relatively inactive iron oxohyroxide and ferric hydroxide precipitate at higher pH reduces the activity of Fenton reagent. At pH below 3, decrease in removal efficiency was observed. The efficiency of the Fenton process is lower at both high and low pH. Thus proper control of pH is very necessary to increase process efficiency.

3.2 Effect of Fe^{+2} concentration

Fig. 1 shows the effect of $FeSO_4$ concentration on the removal efficiency of COD/BOD present in the pesticide waste water. The initial value of COD and BOD in pesticide wastewater is 7030 and 3140 mg/l, rspectively. It can be seen that the

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removal effeciency is strongly depends on the doses of $FeSO_4$. Volume of H_2O_2 was kept fix at 15 ml and the doses of FeSO4 was vary from 1.5 to 3.5 gm. It has been seen that maximum removal effecieny of COD and BOD is 63.08% and 62.25%, respectively. The percentage removal efficiency shown in table 1.

Table 1: Removal efficiency of COD/BOD with doses of $FeSO_4$

$FeSO_4$ (gm)	Parameters	Final conc. (mg/l)	Removal efficiency (%)
1.5	COD	4194.09	40.34
	BOD	1813.98	42.23
1.75	COD	3079.84	56.19
	BOD	1416.77	54.88
2.25	COD	2595.48	63.08
	BOD	1185.35	62.25
3	COD	2856.99	59.36
	BOD	1323.51	57.85
3.5	COD	3552.96	49.46
	BOD	1643.48	47.66

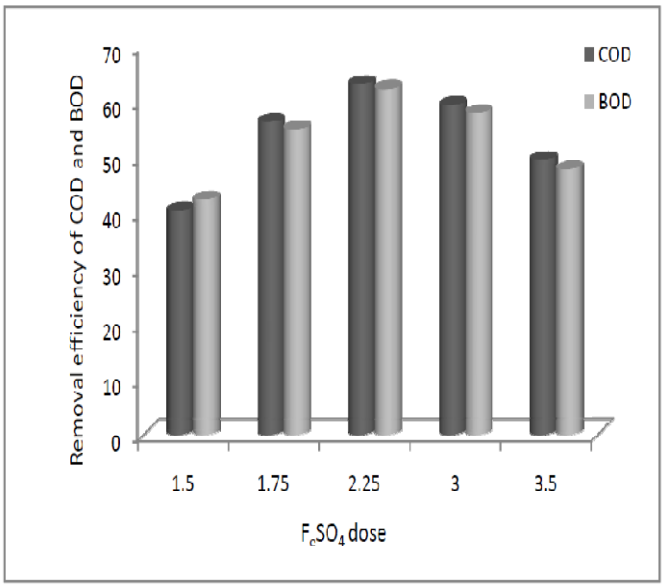

Fig. 1. Variation of COD/BOD removal with $FeSO_4$ doses.

3.3 Effect of H_2O_2 concentration

Fig. 2 shows the effect of H_2O_2 concentration on the removal efficiency of COD/BOD present in the pesticide waste water. It can be seen that the removal effeciency is strongly depends on the doses of H_2O_2. Optimum dose of H_2O_2 was analyzed, after analyzing the optimum dose of $FeSO_4$. The Volume of H_2O_2 was very from 12 to 21ml and the doses of $FeSO_4$ was kept fix at 2.25 gm. It has been seen that maximum removal effecieny of COD and BOD is 63.08% and 62.25%, respectively. The percentage removal efficiency shown in table 1.

Table 2: Removal efficiency of COD/BOD with H_2O_2 doses

H_2O_2 (ml.)	Parameters	Final conc. (mg/l)	Removal efficiency (%)
12	COD	5420.83	22.89
	BOD	2366.93	24.62
12.5	COD	2217.97	68.45
	BOD	1043.11	66.78
14	COD	2491.43	64.56
	BOD	1182.84	62.33
18	COD	2901.98	58.72
	BOD	1440.63	54.12
21	COD	3259.11	53.64
	BOD	1531.69	51.22

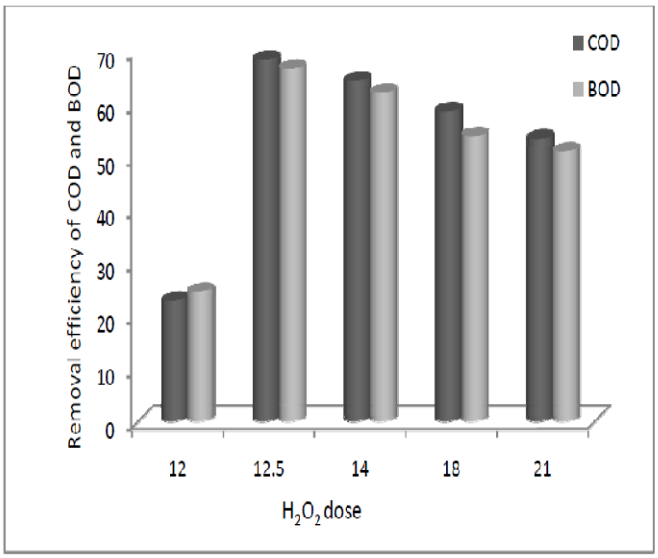

Fig. 2. Variation of COD/BOD removal with H_2O_2 doses.

4. CONCLUSION

From the experimental studies it was analyzed that pesticide waste watercan be treated by Fenton process. Results showed that better removal effeciency was acheived at Fe^{+2}:H_2O_2 – 1:5 ratio. The optimum pH was obtained 3. At neutral or alkaline pH the removal effeciency of COD/BOD is low.

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