COMPARATIVE STUDY FOR COD REMOVAL IN SECURED LANDFILL LEACHATE USING COAGULATION AND ELECTROCHEMICAL OXIDATION

[1]Jayshree M. Gami, [2]Prof. Mitali A. Shah
[1]Student of civil Engineering, [2]Faculty of civil Engineering
[1]Department of Civil Engineerings
Sarvajanik College of Engineering and Technology, Surat, India

Abstract: Leachate from the secured landfills is a highly toxic wastewater in terms of organic matters and heavy metals present in it. Biological, Physico-chemical and Advance technologies were mostly used for the landfill leachate. In this performance study Advance treatment Electrochemical Oxidation and Conventional treatment Coagulation were used for the treatment of leachate. Comparison between Conventional and Advance treatment is shown in this study. The experiments of Electrochemical oxidation conducted with Iron and Aluminum (Anode and Cathode) at varying parameters such as Current (0.5,2,5 Amp.), Voltage (5,10,15,30 V), Contact time (10-120 min.). optimum COD reduction using Electrochemical Oxidation was obtained 57% at applied current 2 Amp. and 120 min. Contact time. The experiments of Coagulation were conducted in JAR apparatus. $FeCl_3$ was used as coagulant and optimizing the different varying parameters such as pH (4,5,6 and original pH 7.5) and Coagulant dose (100-650 mg/L). Stirring time was kept 30 min. at 80 rpm speed. Optimum COD reduction was obtained 55.6% at pH 5 for 600 mg/L $FeCl_3$ dose.

Keywords: Landfill leachate, Coagulation, Electrochemical Oxidation.

I. INTRODUCTION

With increasing urbanization and industrial activities generation of solid waste is also increased rapidly. The problem of industrial solid waste management became worsened day by day. Approximately 95% of solid waste disposed into the landfills in world [13]. Since long time landfilling is the most preferred technique for solid waste disposal. The main problem associated with the landfills is highly toxic liquid generation from landfills [1]. Rain water percolates through the landfills, moisture content of solid waste generates the liquid which is highly toxic in nature is termed as leachate [1]. The highly concentrated leachate consists of organic compounds such as , Total Organic Carbon, Chemical Oxygen Demand (COD) etc., and inorganic compounds such as Magnesium, Calcium, Iron, Sodium etc., Heavy metals such as, Iron, Nickel, Zinc, Copper etc., Pathogens as well as Suspended particles [24]. Landfill leachate conventionally treated by Biological, Physico-chemical and Advance technologies. Biological treatments such as aerobic and anaerobic treatments, Physico-chemical such as Coagulation-flocculation, Adsorption, Chemical precipitation, Air stripping etc. Advance technologies such as Advance oxidation, Electrooxidation, Fenton oxidation etc. [12]

Electrochemical treatment is relatively more economic and higher efficiency method. Now a days for the removal of organics from the landfill leachate EC has been applied. In the EC process wastewater is treated into reactor having two electrodes (anode and cathode) and by applying current organics were removed by direct or indirect oxidation [2]. Coagulation is most favoured and an oldest treatment used for the landfill leachate. Coagulation is very effective for the non-biodegradable organics and heavy metals removal from the landfill leachate. Coagulation has been suggested mainly as a pre-treatment method for leachate. In the coagulation process destabilization of colloidal particles were occurred by addition of coagulants [21]. This technique effectively removes the suspended and colloidal solids from the leachate. Generally Ferric/Alum salts were used as coagulants for the landfill leachate treatment. In the present study $FeCl_3$ was used as coagulant in the experiments. The influencing parameters in the experiments were pH, dosage of coagulants, reaction time, mixing speed and temperature.

II. LEACHATE CHARACTERIZATION

Leachate samples were collected from TSDF landfill site (Gujrat) during the period of November 2018. The samples were stored at 4°C. temperature Chemical analysis of the samples were performed according to standard methods. The characteristics of leachate sample are presented in Table 1.

Table 1: Characteristics of secured landfill leachate

Parameters	Initial value	Discharge limit
COD (mg/L)	~ 14000-20000	250
pH	7.5-9	5.5-9.5
Chloride	1,45,160	1000
TDS (mg/L)	1,50,000	2100

III. MATERIALS AND METHODS

Electrochemical Oxidation

The purpose of the experiments is to assess feasibility study of the Electrochemical Oxidation process at varying parameters like Contact time, applied voltage, current etc. and also to carry out the cost-effectiveness of the treatment. Glass was used to establish a lab-scale reactor fabricated using this material (30×19×12.5 cm) with a total designed volume of 6 L and working volume of 3 L. Iron and Aluminum electrodes having 10 cm of length and 5 cm width and 0.5 cm thickness were used as anodes and cathodes. The distance between anode and cathode was 1.5 cm. Digital direct current supply was used as source of electric supply for the experiment. The current is adjustable between 0-10 Amperes and 0-30 Voltage with digital display. Leachate Wastewater was applied to the reactor with various operating parameters like contact time (10-120 min.), Current density (0.5,2,5 A/cm^2), Applied Voltage (5,10,15,30 V) respectively at pH 7.5 and then after % removal of COD, Chloride removal were calculated.

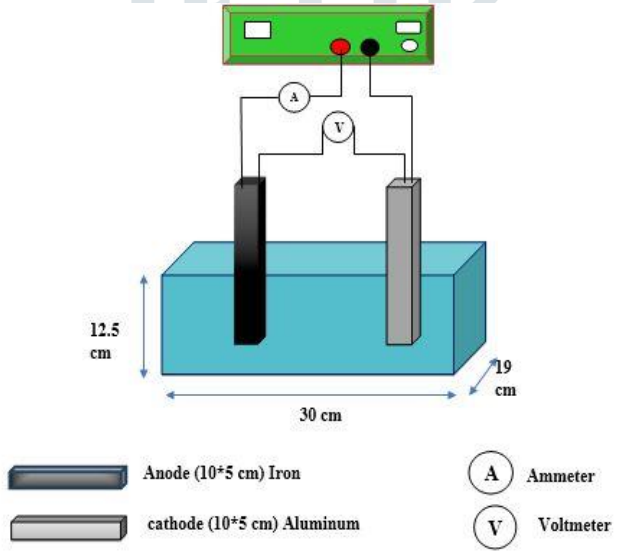

Figure 2: Experimental setup of Electrochemical Oxidation

Coagulation

Coagulation experiments were conducted at room temperature 30–33°C, The experiments were performed by using a Jar-test apparatus, equipped with six beakers with 1 liter volume. The pH values of samples were adjusted to the desired levels by the addition of appropriate amounts of H_2SO_4 95–97% (w/w). In this set of tests, different dosages of coagulant $FeCl_3$ were added (corresponding to range from 100 to 650 mg $FeCl_3$/ L) and different pH conditions (pH of 4,5,6 and 7.5) for the 30 min. of stirring time at 80 rpm. Then the samples were allowed for settle for 1 hour. After the samples were settled down supernant was collected for the analysis of COD.

Figure 3: Jar test Apparatus

IV. RESULTS AND DISCUSSION

Results of Electrochemical Oxidation

Table 2: Removal of COD from secured landfill leachate

Initial COD (mg/L)	Current (A)	Voltage (V)	Contact time (min.)	% Removal of COD
14500.8	5	5	10	8.77
			20	30.52
			30	28.42
			45	41.05
			60	41.57
			90	52.63
			120	42.10
14500.8	2	10	10	22.63
			20	17.36
			30	28.42
			45	36.84
			60	36.31
			90	56.89
			120	57.59

COD removal efficiency was increased with increasing contact time. As the contact time increase, the metal ion and their hydroxide concentration were increased. Consequently, the pollutant of leachate was eliminated. Also, the COD removal efficiency was increase with increasing current. At lower current removal of pollutants decrease.

From the above results maximum COD removal was achieved 52.63 % at 90 min. of contact time at applied Voltage 5 V and current 5 A. Optimum COD removal was achieved 57.59 % at 120 min. of contact time at applied voltage 10 V and 2 A.

Table 3: Removal of COD from secured landfill leachate

Initial COD (mg/L)	Current (A)	Voltage (V)	Contact time (min.)	% Removal of COD
14500.8	0.5	15	10	22.8
			20	17.5
			30	35.08
			45	29.8
			60	43.85
			90	35.78
			120	37.36
14500.8	2	30	10	35.08
			20	37.36
			30	35.78
			45	26.31
			60	22.80
			90	5.26
			120	14.03

As the voltage increased COD removal was not increased but the removal rate was decreased. At higher Voltage COD removal efficiency was decreased which is shown in results. At higher voltage removal efficiency was decreased from 43% to 37%.

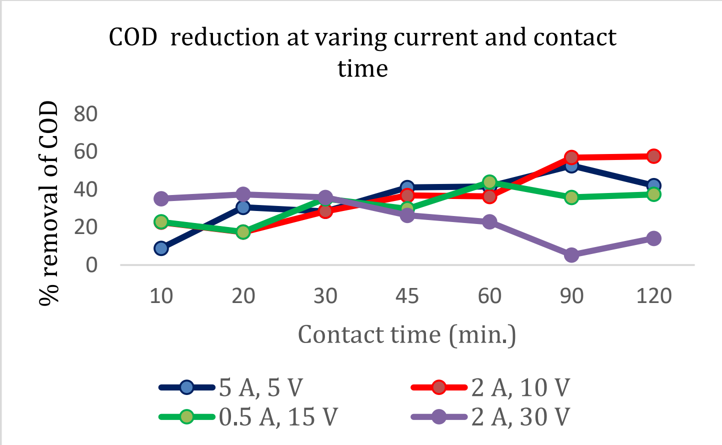

Figure 4: COD removal from secured landfill leachate at varying Current and contact time

As shown in graph 4 optimum COD removal was obtained 57.59 % at applied current 2 Amp. and voltage 10 V with contact time 120 min at the Original pH of leachate 7.5.

Results of Coagulation

The results of coagulation are given below. Different dosages of coagulant Ferric (III) chloride ($FeCl_3$) were added (corresponding to range from 100 to 650 mg $FeCl_3$/L) as well as different pH conditions (pH of 4,5,6 and original pH of leachate 7.5) for the 30 min. of stirring time at 80 rpm. COD removal at different conditions were analyzed. At pH 4 average COD removal was observed 27% corresponding to dosage of 100-650 mg/L. The highest value of COD removal was obtained 55.6% using $FeCl_3$ dosage of 600 mg/L at pH 5. COD removal efficiency is decreased with increasing pH. As shown in results at pH 6 and 7.5 COD removal is decreased from 55.6% to 30%. From the results optimum conditions for COD removal from secured landfill leachate was 55.6% using $FeCl_3$ dosage of 600 mg/L at pH 5

Table 4: COD removal from Secured landfill Leachate at pH 4

Initial COD (mg/L)	pH	Coagulant dosage (mg/L)	COD after treatment (mg/L)	% Removal of COD
		100	11295	20
		200	10913	23
		300	10303	27
14271	4	400	10074	29
		500	9845	31.01
		600	9845	31.01
		650	9768	31.5

Table 5: COD removal from Secured landfill Leachate pH 5

Initial COD (mg/L)	pH	Coagulant dosage (mg/L)	COD after treatment (mg/L)	% Removal of COD
		100	10379	27
		200	10150	28
14271	5	300	10074	29
		400	8929	37
		500	7632	46
		600	**6334**	**55.6**
		650	6410	55.08

Table 6: COD removal from Secured landfill Leachate pH 6

Initial COD (mg/L)	pH	Coagulant dosage (mg/L)	COD after treatment (mg/L)	% Removal of COD
14271	6	100	11905	16
		200	11753	17
		300	11295	20
		400	11066	22
		500	10379	27
		600	10303	27.8
		650	10226	28

Table 7: COD removal from Secured landfill Leachate pH 7.5

Initial COD (mg/L)	pH	Coagulant dosage (mg/L)	COD after treatment (mg/L)	% Removal of COD
14271	7.5	100	11600	18
		200	11371	20
		300	10226	28
		400	10074	29
		500	9997	29.9
		600	9921	30
		650	9850	30.9

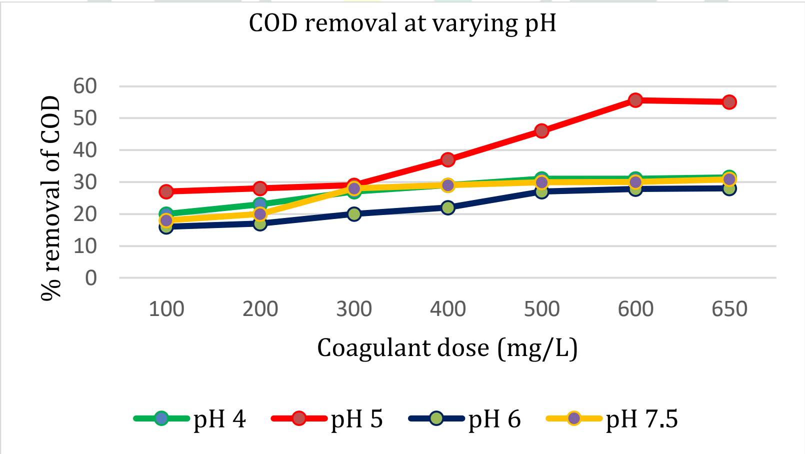

Figure 5: Removal of COD from secured landfill leachate at Different pH and Coagulant dosage

As shown in graph 5 the Optimum reduction in COD was obtained 55.6% using $FeCl_3$ dosage of 600 mg/L at pH 5. COD removal efficiency is decreased with increasing pH.

V. CONCLUSION

In the present study, experiments were performed at varying operating conditions to evaluate their performance on removal of COD. For the Electrochemical Oxidation COD removal efficiency is increase with increasing contact time and with increasing current density. At low current pollutant removal rate is decreased. It was analyzed that when applied voltage was 10 V and current 2 A where optimum COD removal was 57. 59% at 120 min of electrolysis time. At higher voltage 15 V and 30 V COD removal efficiency was decreased from 57 % to 43% and 37% respectively.

From the Coagulation experiments it was concluded that at pH 4 average COD removal was observed 27% corresponding to dosage of 100-650 mg/L. The highest value of COD removal was obtained 55.6% using $FeCl_3$ dosage of 600 mg/L at pH 5. COD removal efficiency is decreased with increasing pH. As shown in results at pH 6 and 7.5 COD removal is decreased from 55.6% to 30%. From the results optimum conditions for COD removal from secured landfill leachate was 55.6% using $FeCl_3$ dosage of 600 mg/L at pH 5. This technique produces significant amount of sludge.

Compared with conventional treatment, Advance treatment gave better removal efficiency of COD from landfill leachate and also sludge production was less for Advance treatment.

VI. REFERENCES

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