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EMPLOYING ALUMINIUM ELECTRODES TO REMOVE COLOUR AND CHEMICAL OXYGEN DEMAND FROM LANDFILL LEACHED EFFLUENT

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Abstract: Electrocoagulation (EC) has been used in this study to investigate landfill leachate colour and chemical oxygen demand (COD) removal percentages. The anode and cathode of an EC process were both aluminium electrodes. Material, electrolysis duration, starting pH, applied voltage and inter-electrode distance are the primary focus of the research. Experiment results show that the BOD/COD ratio increased from 0.11 to 0.66, and the highest percentages of COD and Color removal were reached at 78.4% and 77.0%. Inter-electrode spacing of 1cm with electrode surface area of 35 cm2 and optimum electrolysis period of 90 minutes at an optimum applied voltage of 10V, stirring speed of 250 rpm, and pH of 9.3 are the ideal conditions for optimal electrolysis. According to these findings, the EC process is a suitable and well-organized method for the treatment of landfill leachate.

Keywords: Landfill leachate; Electrocoagulation; Aluminium electrode and Process parameters.

I. INTRODUCTION

Rainwater percolates through garbage and decomposes to generate leachate. Heavy metals, biodegradable/non-biodegradable carbon, organic/inorganic salt, and recalcitrant may all be found in landfill leachate discharge. Due to a variety of variables (such as landfill age and seasonal weather), leachate quality might be affected.

The composition of the leachate mostly relies on the landfill's age. Carbon dioxide (CO2) and other organics concentrations fall as waste ages, but levels of ammonia nitrogen rise. Dumpsite leachates are often orange or yellow murky liquids with an overpowering odour owing to the abundance of nitrogen, hydrogen, and sulfur-rich organic species in the landfill.

Basic metrics of the landfill leachate include pH, suspended particles, BOD, COD, the BOD/COD ratio, and ammonia nitrogen, for example. As the leachate circulates, it becomes stabilised and degradable of carbon compounds but more concentrated in ammonia, improving COD and BOD, and removing it entirely. Leachate from old landfills is classified and characterised in Table 1. Coagulation-flocculation [1], membrane processes [2-3], activated carbon adsorption [4], combined physicochemical-nanofiltration [5], and biological therapy [6] have all been documented in the literature, according to a review of the available evidence. Different kinds of wastewater are treated using the electrocoagulation (EC) technique, such as electroplating wastewater [7], distillery wastewater [8], and dairy wastewater (EC) (see below). For landfill leachate treatment utilising an EC method with aluminium electrodes, it is critical to tune parameters such as the starting pH, the electrolysis duration, the current density, and the inter-electrode spacing.

Table 1 Landfill leachate classification of landfill age

Parameters	Leachate Type		
Landfill age (Years)	<5 Young	5-10 (Medium)	>10 (old)
BOD_5/COD	>0.5	0.1-0.5	<0.1
pH	<6.5	6.5-7.5	>7.5
COD (mg/l)	>10,000	<10,000	<5,000

II. EXPERIMENTATION

A. Study Area

The city of Mysore is situated at an average elevation of 770 metres at 12.30°N 76.65°E. Mysore city is only 8 kilometres distant from the dumping ground at vidyaranyapuram.

Fig 1 Landfill leachate collection tank

About 2,50,000 cubic metres of rubbish have been dumped at this location during the previous six to seven years. The dumpsite has about 41.4 acres of land, which is utilised to store waste.

The Electrocoagulation technique is being used to remediate landfill leachate in this research. As an example, Figure 1 shows the tank where landfill leachate is collected and evaluated for a variety of physical and chemical characteristics. Table 2 shows the sample's first characteristics.

Table 2 Initial characterization of the landfill leachate Parameters

Sl. No.	Parameters	Concentration
1	pH	8.67
2	Conductivity	38.5 mS/cm
3	Turbidity	140NTU
4	Total solids	15800(mgL^{-1})
5	Total Dissolved Solids	14240(mgL^{-1})
6	COD	13760(mgL^{-1})
7	Phosphate	198.5(mgL^{-1})
8	Total suspended solids	1560(mgL^{-1})
9	Nitrates	95.5(mgL^{-1})
10	BOD	1503(mgL^{-1})
11	Chloride	6098(mgL^{-1})
12	BOD/COD	0.109 (mgL^{-1})
13	Colour	8750 PCU

B.Experimental Setup for Electrocoagulation

A Batch electrochemical reactor of 2L capacity with a working volume of 1.75L at room temperature is used for the experimentation. To eliminate concentration gradients, a magnetic stirrer speed of 250 rpm was used to keep the reactor's contents completely mixed. Anode and cathode electrodes are made of aluminium plates that measure 5cm x 7cm and have a 35 cm2 effective surface area. The electrode bottoms were separated by a 2cm space to make stirring easier. Table 3 presented the analytical information.

Table 3 Analytical Details

Parameters	Analytical technique/Method	Instruments/Equipment's Used, Make
pH	Digital pH meter	-------
BOD	27^o C, 3 days incubation/ Titrimetric/ Modified Winkler's method	
COD	COD digester (Open reflux system)/Titrimetric	Hach 389, USA
Color	Platinum-cobalt method	------
Solids	Gravimetry	Hot air oven
Chlorides	Argentometric method	Standard method
Conductivity	Conductivity meter	-----
Sulphate	Spectrophotometric method	UV spectrophotometer
Nitrate	Phenoloic disulphonic Acid Method	UV spectrophotometer
Phosphate	Ammonium Vandate/Molybdate	UV Spectrophotometer
DC Power Supply Unit	0-10 A, 0-15 V, DC power supply unit	APLAB, Regulated dual DC power supply LD3210.

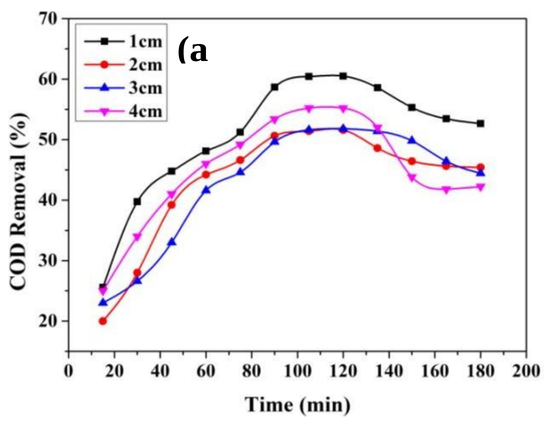
The electrodes were thoroughly cleaned and degreased before each treatment. Using a DC power source, the distance may be changed between 1cm and 4cm while retaining 4V. Samples were taken every 15 minutes throughout electrolysis for a total of 180 minutes. Variations in operational parameters such as electrode distance, electrolysis time, and voltage were used to perform the experiments (current density). Figure 2 depicts the experimental setup for electrocoagulation.

Fig 2 Experimental set-up of electrocoagulation treatment on a lab-scale

III. RESULT AND DISCUSSION

A. Effect of inter-electrode distance on landfill leachate treatment by EC:

Figure 3 (a-b) shows that the electrolysis time increases with an increase in COD and Color removal. Various inter-electrode distances, such as 1cm, 2cm, 3cm, and 4cm, are used in experiments. With an inter-electrode distance of 1cm, better performance can be achieved. It is possible to remove 60% of COD and 47.50% of colour in this circumstance, which is a significant achievement.



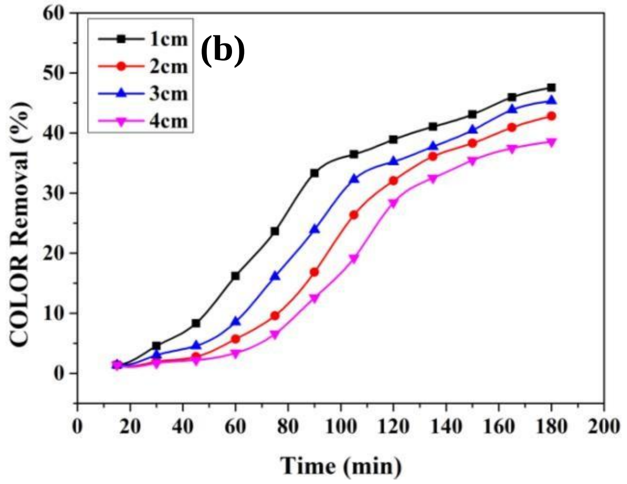


Fig 3 (a-b) Percentage removal of COD and Color with different distance

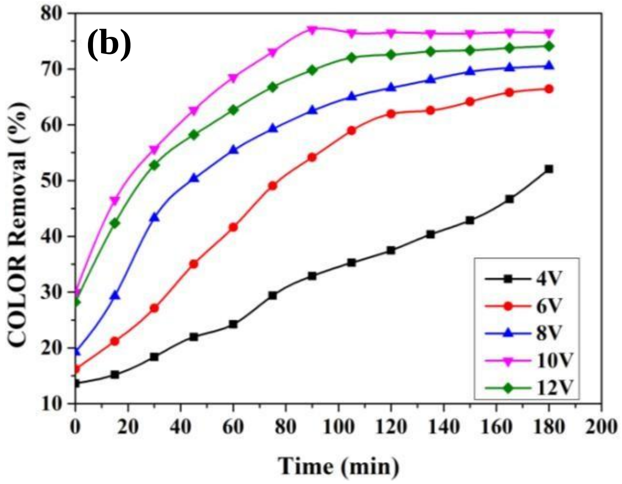
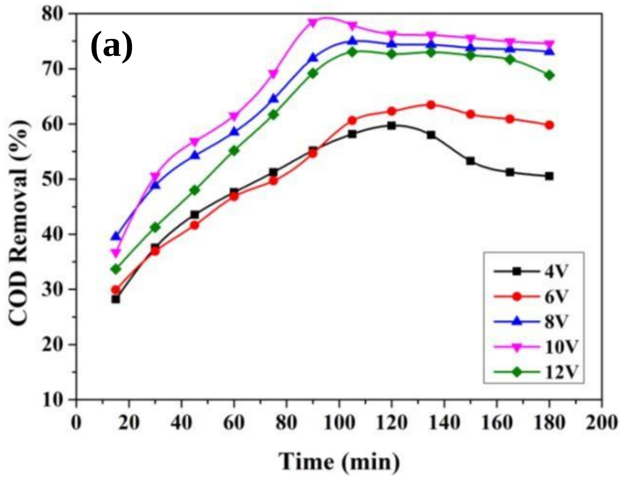


Fig 4 (a-b) Percentage removal of COD and Color with different voltage

Due to the enhanced removal efficiency made possible by the short travel distance, this is the case. According to certain studies, increasing the distance between electrodes results in greater power consumption and higher running costs. The density of current is influenced by the distance between the electrodes and their positioning. Increased electrical resistance occurs when the flow of liquids and solids is obstructed by an electrode distance that is too near.

B. Effect of applied voltage on leachate treatment byEC Applied:

Electrolysis time rises with an increase in COD and Color removal from Fig 4 (a-b). At voltages of 4, 6, 8, 10, and 12 volts, EC studies have been conducted. The removal effectiveness of 10V was shown to be greater in the experiments, with a removal percentage of COD of 78.48 percent. A removal rate of 77.09 percent of the colour was obtained. For 90 minutes, suggesting that an increase in the length of electrolysis increases the instability of a colloidal particle.



Increasing the current density, as well as the pace at which bubbles are generated and the amount of coagulant used, further improve treatment efficiency [12]. Due to rapid disintegration, the operating voltage was not elevated over 12V.

C. Effect of pH changes during an electrocoagulation process:

The initial pH of the leachate is 8.67 and is greatly influenced by the electrocoagulation method. Increases in electrolysis time lead to a rise in the pH level.

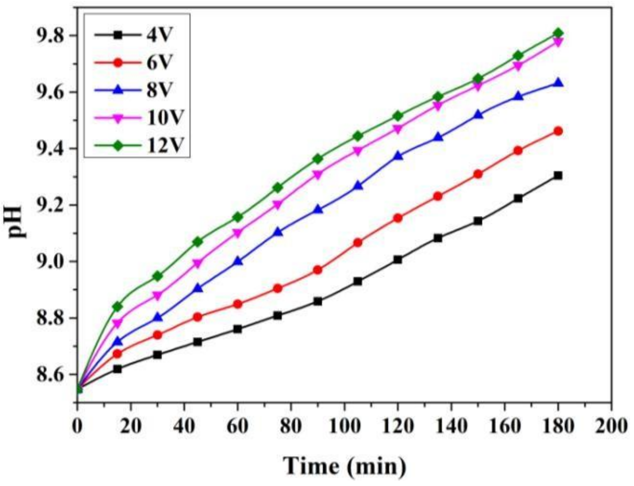


Fig 5 Effect of pH versus electrolysis time

At 10 volts, the pH is 9.3 at 90 minutes of electrolysis time, as indicated in Fig 5 of the experimental study. Color and COD can be removed to their full potential when the pH of the leachate solution is alkaline. This results in a slimy layer of floating pollutants being readily removed from the top. After electrocoagulation treatment, the pH of the leachate solution is predicted to rise because of the cathode's first actions [13]. The elimination of COD by some scientists was shown to not affect pH fluctuation. Landfill leachate wastewater is better treated in an alkaline environment [14]. In acidic pH conditions, leachate decolourization is relatively low; in neutral and alkaline pH conditions, it is quite high.

D. Effect of BOD/COD ratio changes during the EC process:

According to Fig. 6, the BOD/COD ratio increased from 0.11 to 0.66, indicating an improvement in landfill leachate biodegradability. The rising voltage is to blame for this. The reactor's performance was also influenced by the change in operating conditions at a different voltage. According to the effluent's low BOD/COD ratio (0.11), it comprises recalcitrant chemicals that were not readily biodegradable or non-biodegradable material.

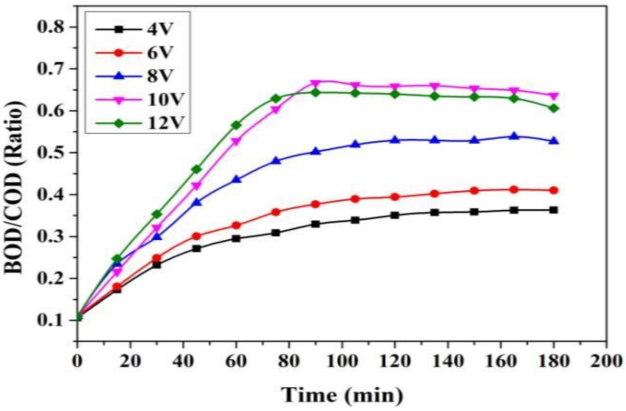


Fig 6 Effect of BOD/COD ratio vs. electrolysis duration

IV. CONCLUSIONS

Electrocoagulation was shown to be an effective treatment method for landfill leachate in this investigation. Electrocoagulation was performed using aluminium electrodes. By adjusting the electrolysis duration and distance between electrodes as well as adjusting the applied voltage and starting pH. Some conclusions can be derived from the experiments. In terms of COD and Color removal, the smallest inter-electrode spacing of 1cm was the most effective. Optimal inter-electrode spacing of 1 cm and optimal electrolysis period of 90 minutes resulted in the highest COD and Color elimination effectiveness (78.48 and 77.09 percent, respectively). 10V, 250 RPM and pH 9.30 are at their best.The BOD/COD ratio rises from 0.11 to 0.66 while using electrocoagulation to remove colour and COD.

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