

TREATMENT OF SOLID WASTE LEACHATE BY ELECTROCOAGULATION TECHNOLOGY

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Abstract

This paper presents, treatment of solid waste leachate by Electrocoagulation (EC) technique using aluminum electrodes. The sample of leachate was collected from Bagalkot Municipal solid waste (MSW) site. The effects of process variables such as pH, applied cell voltage, and operating time were investigated on COD and turbidity removal. The EC process was carried out in a batch reactor of 1 liter capacity and samples of 750 ml were taken out for batch at 05, 10, 15, 20, 25, 30, 35 and 40 minutes of operation. Results obtained from the experiments showed that COD and turbidity removal was strongly influenced by the initial pH. The highest COD and turbidity removal efficiency of 95.8% and 96.6% were obtained at an applied cell voltage of for 9V, 40 minutes of operation.

Keywords: Electro coagulation (EC), Leachate, Chemical Oxygen Demand (COD), Turbidity and Aluminum electrode.

1. INTRODUCTION

Land filling is one of the most popular methods of MSW disposal due to its relative simplicity in terms of disposal procedures and low cost [1]. The degradation of the organic fraction of the municipal solid waste in landfill in combination with the percolation of rain water produces a liquid called leachate. One of the main problems with the solid waste landfill sites is leachate depending on large amounts of organic matter, ammonia nitrogen, heavy metals, and chlorinated organic and inorganic salts [2]. Leachate has a complex structure and high pollutant load, and its treatment is quite hard to meet the discharge standards. Therefore, many pretreatment and combined treatment methods are biological treatment methods, membrane processes, advanced oxidation techniques, coagulation-flocculation methods, lagoon and wetland applications have been examined in the literature [3]. Chemical composition of landfill leachate depends on several factors including waste composition, site hydrogeology, specific climatic conditions, moisture routing through the landfill, landfill age as well as design and operation of the landfill [1]. The rapid increase in the waste generation has increased the land usage also. In solid waste management, the most common technique for final disposal of solid waste over the world is sanitary landfill. However, leachate becomes an issue as a wastewater sources since it may cause serious pollutions to ecosystem [4]. The heavy metals that commonly found in high concentrations in leachate are iron, manganese, zinc, chromium, lead, copper and cadmium. Therefore, more technological development had been done in various countries to treat the landfill leachate [4].

Electro coagulation (EC) is an electrochemical wastewater treatment technology that has been used in treating effluents containing suspended solids, oil and grease, and even organic and inorganic pollutants that can be flocculated. In India EC technology has been successfully adopted for the treatment of the textile dye wastewater [5], purification of wastewater [6], tannery wastewater [7] and domestic wastewater [8]. This method is characterized by simple equipment and easy operation. The EC processes have lesser amount of sludge and the EC process have been successfully used in removal of COD as high as 81% from landfill leachate [9], 74.08% from landfill leachate [4] and the removal efficiency of turbidity were high as 95% [10].

The objective of the present paper is to investigate the influencing parameters which can contribute to high removal of COD and turbidity in landfill leachate by EC processes using aluminum electrodes.

2. MECHANISM OF EC

Water is also electrolyzed in a parallel reaction, producing small bubbles of oxygen at anode and hydrogen at the cathode. Electro coagulation, precipitation of ions (heavy metals) and colloids (organic and inorganic) using electricity has been known as an ideal technology to upgrade water quality for a long time and successfully applied to a wide range of pollutants. Electro coagulation is the technique to create conglomerates of the suspended, dissolved or emulsified particles in aqueous medium using electrical current causing production of metal ions at the expense of sacrificing electrodes and hydroxyl ions as a result of water

splitting. Metal hydroxides are produced as a result of EC and act as coagulant/flocculent for the suspended solids to convert them into flocs of enough density to be sediment under gravity. Destabilization of the contaminants, particulate suspension, breaking of emulsions, and aggregation of the destabilized phases to form flocs. The reactions occurring in an EC process using aluminum anode and cathode can be referred in Eqn. 1, 2 and 3 as represented below.

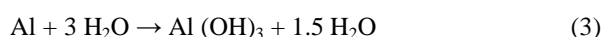
The oxidation reaction at the anode,



The reduction reaction at the cathode,



Net Equation;



3. MATERIALS AND METHODS

The experimental setup of monopolar parallel EC unit is shown in Fig. 1. The EC container was made of plastic and has dimensions 80 mm diameter and 100 mm height. The aluminum electrodes with dimensions of 90mm x 30mm x 1mm were used as cathode and anode. After the initial characterization of leachate, batch experiments were conducted to optimize the various parameters. The studies were performed with four electrodes connected to the DC power supply to determine optimum condition. The space between electrodes was maintained 1.5cm in all the experiments. In each run the voltage was varied to a desired value of 3, 6, and 9V. The volume of solution in each batch experiment was 0.75L. To maintain homogenous mixing of the reactor content, magnetic stirring unit was used. Electrodes should be washed before every experiment. EC experiments were performed for 40 min and in each run samples are retrieved at every 5 minutes interval for analysis.

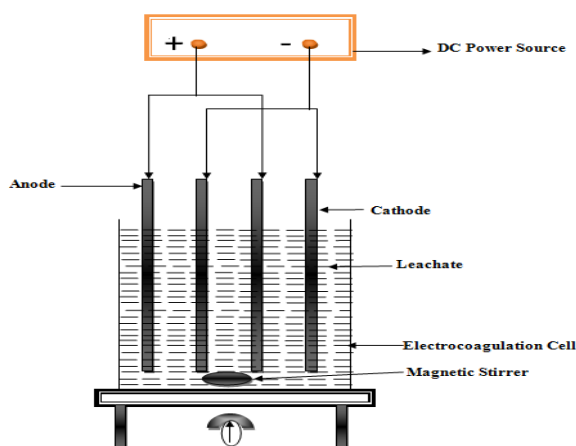


Fig.1 Experimental setup

The study was carried out using leachate collected from Bagalkot MSW site which is situated 4 km away from the city centre. The characteristics of the leachate are shown in Table1.

Table.1 Characteristics of solid waste leachate

Particulars	Concentration
pH	5.8
Color	yellow
Total suspended solids (mg/L)	718
COD (mg/L)	4820
Conductivity($\mu\text{S}/\text{cm}$)	2441
Total solids (mg/L)	900
Turbidity (NTU)	89
Total Dissolved Solids (mg/L)	182

4. RESULTS AND DISCUSSION

4.1 Effect of Cell Voltage and pH on COD Removal

The experimental setup is shown in Fig. 1. It describes the effect of cell voltage on COD removal efficiency. When leachate was treated without pH adjustment i.e. at pH 5.8 (Fig.2), the COD removal efficiency increased with electrolysis time (ET) up to 35 minutes afterwards no change was observed. However the figure showed that, maximum COD removal of 95.8% was obtained at ET of 35 minutes at cell voltage 9V, during this period COD reduced from 4820 to 198 mg/L. When pH was reduced to 4.0 (Fig.3), COD removal increases with ET however maximum COD removal efficiency of 73.6% was obtained be at ET of 35 minutes of at 9V, COD reduced from 4820 to 1270 mg/L. When pH was increased moving towards alkaline condition at pH 8.0 (Fig.4), maximum COD removal efficiency 82.3% was obtained at ET of 35 minutes at cell voltage of 9V, during this period COD reduced from 4820 mg/L to 850 mg/L. Comparing all the three figures, maximum COD removal efficiency of 95.8% was obtained at pH 5.8 with voltage of 9V during an ET of 35 minutes.

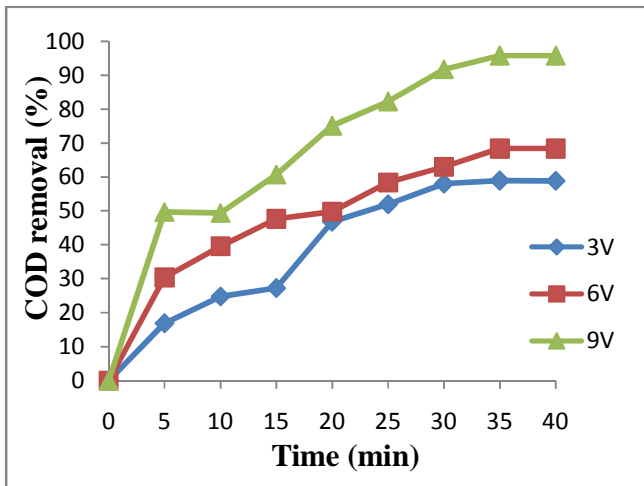


Fig. 2 COD removal with ET at different voltages (pH: 5.8)

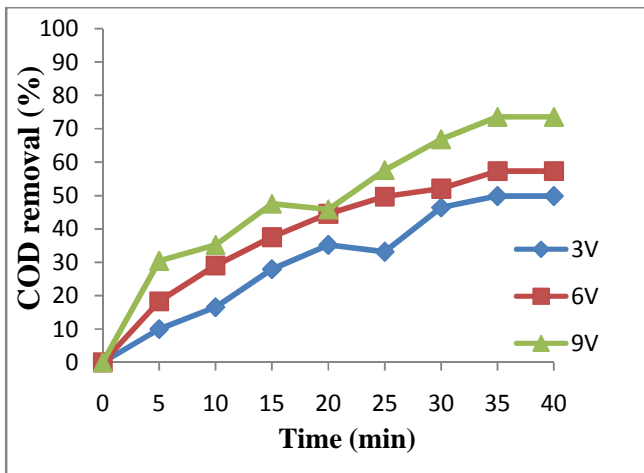


Fig. 3 COD removal with ET at different voltages (pH: 4.0)

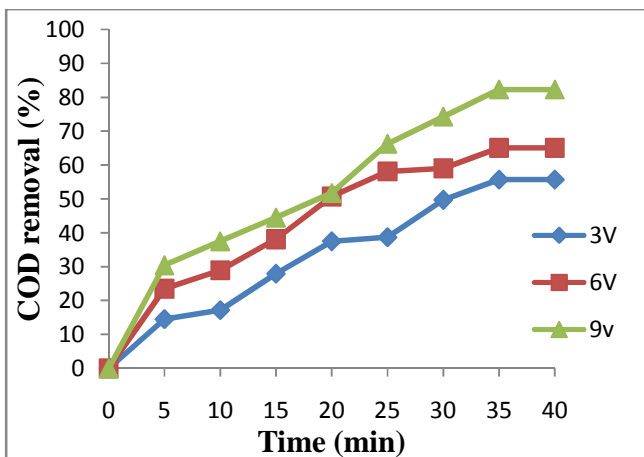


Fig. 4 COD removal with ET at different voltages (pH: 8.0)

4.2 Effect of Cell Voltage and pH on Turbidity Removal

Removal

The effects of pH and cell voltage at varying ET are presented in the following section. In all the cases (Fig. 5, 6 and 7) the turbidity removal increased with ET and cell voltage up to 35 minutes. However maximum turbidity removal of 96.6% was obtained at pH 5.8 and cell voltage 9V. At this condition the turbidity reduced from 89 NTU to 3 NTU.

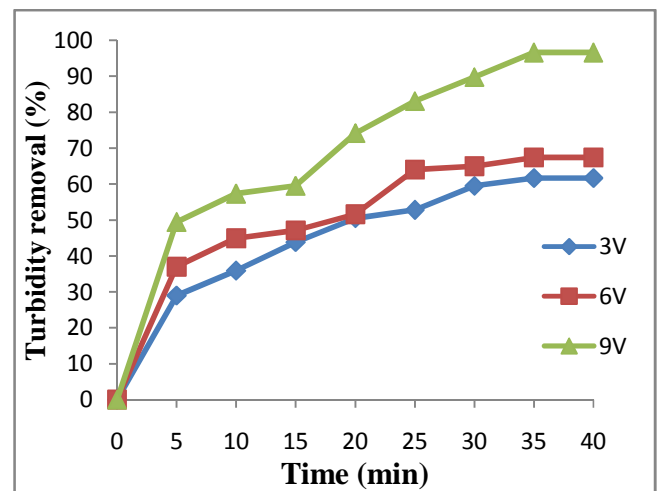


Fig. 5 Turbidity removal with ET at different voltages (pH: 5.8)

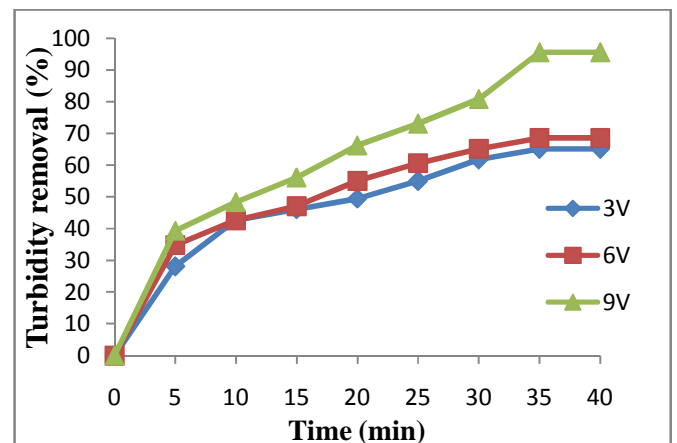


Fig. 6 Turbidity removal with ET at different voltages (pH: 4.0)

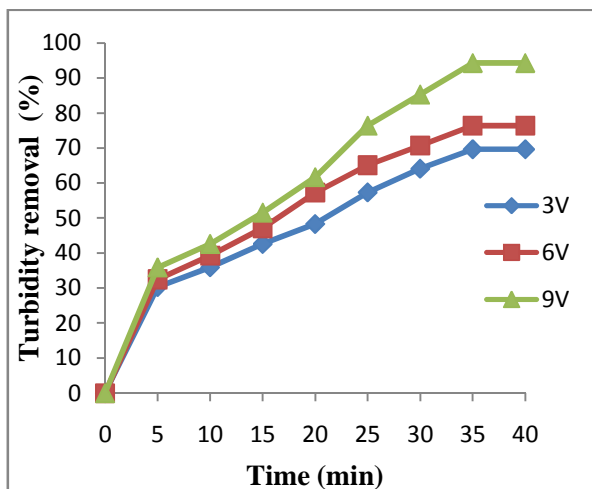


Fig. 7 Turbidity removal with ET at different voltages (pH: 8.0)

CONCLUSIONS

The study investigated the removal of COD from a landfill leachate characterized by high COD concentration. It was found that, operating parameters such as electrolysis time, pH and voltage significantly affected the treatment of landfill leachate. The optimum COD and turbidity removal of 95.8% and 96.6% respectively were obtained at a very short ET of 35 minutes cell voltage of 9V with leachate pH as 5.8. Further, use of aluminum as sacrificial electrode material in the treatment of landfill leachate was found to be very sensitive for changes in pH. Finally the results of study showed that, EC technology could be applied for the cost effective treatment of landfill leachate.

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