Journal of Environmental Sciences and Engineering
Volume 2 Issue 2

Treatment of Solidwaste Landfill Leachate

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Abstract

Leachate is highly complex and polluted waste water that is produced by the introduction of percolation water through the body of landfill treatment. Leachate treatment is essential as it could threaten the surrounding ecosystem when discharge as it is and when it mixes with groundwater. Various leachate treatment technologies like coagulation- flocculation, adsorption by activated carbon, biological treatment and reverse osmosis are reviewed and there treatment efficiency depending on operating condition of India is discussed. This paper presents, treatment of solid waste leachate using Electrocoagulation (EC) process. The sample of leachate was collected from Belgavi Municipal solid waste site. The effects of process variables such as pH, applied cell voltage, and operating time were investigated on pH, acidity, alkalinity, total solids, turbidity, BOD and COD removal. The Electrocoagulation process was carried out in a batch reactor of 1.5 liter capacity and samples of 1000 ml were taken out for batch at 30, 45 and 60 minutes of operation. Results obtained from the experiments showed that BOD (93.1%) ,Total suspended solids(91.17%) ,COD(84.42%) removal was strongly influenced by the initial pH. The highest BOD and COD Removal efficiency of 93.1% and 84.42% were obtained.

Keywords: *Electrocoagulation, Aluminium Electrodes, Voltage, Biochemical Oxygen Demand*

INTRODUCTION

Sanitary landfill is the most common urban solid waste disposal method (Mojiri et al., 2014). In areas with sufficient available land, sanitary landfill is widely used for the disposal of municipal solid wastes. However, even with numerous economic benefits, the sanitary landfill method poses a number of environmental shortcomings, such as generation of landfill leachate.

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. Leachate has a complex structure and high pollutant load, and its treatment is quite hard to meet the discharge standards. The leachate is highly toxic liquid with dissolved organic compounds, heavy metals and also contains different soluble materials. It can potentially contaminate the nearby surface and ground water if left untreated. Therefore leachate must be treated before discharging to environment. 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. 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.

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. The heavy metals that commonly found in high concentrations in leachate are iron, manganese, zinc, chromium, lead, copper and cadmium.

The treatment of the Leachate depends upon the composition of the Leachate. For the prevention of the pollution, some of the treatment methods includes Adsorption using different Adsorbents, precipitation, Ion exchange, Coagulation-flocculation, Chemical oxidation, Electro-coagulation etc.

In the present study electrocoagulation process is adopted to treat the leachate. Electrocoagulation (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 Electro coagulation (EC) technology has been successfully adopted for the treatment of the textile dye wastewater, purification of wastewater tannery wastewater and domestic wastewater. Electrocoagulation uses an electrical current and produces several metal ions in electrolyte solution to purify the wastewater. As a matter of fact, the electrocoagulation system is very effective in removing suspended solids, dissolve metals, tannin and dyes. With increasing water quality standards the requirements on leachate treatment also increases. Treatment procedures must consider the small flow rates and the complex composition which often results in special operation problems. These metal hydroxide species neutralize the electrostatic charges on suspended solids and oil droplets to facilitate coagulation and resultant separation from the aqueous phase. A growing research interest is reported on the treatment of various wastewater types: metal processing wastewaters semiconductor production waste water , textile dyeing wastewaters , tannery wastewater pre-treatment , olive mill wastewater, The mechanism of EC is extremely dependent on the chemistry of the aqueous medium, especially its conductivity. In the present study Aluminum is used for the treatment of Leachate using the Electrocoagulation process.

Advantages

The advantages of EC compared with chemical coagulation are as follows (Mostafa Mohammadizaroun and Mohd Suffian Yusoff, 2014)

EC requires no addition of chemicals and provides better removal capabilities for the same species than chemical coagulation

EC removes many species that chemical coagulation is unable to remove

EC produces less sludge, thus lowering the sludge disposal cost

EC sludge is easily filterable and can be utilized as a soil additive

EC sludge contains metal oxides that pass the leachability test

EC technique needs minimal startup time, and the process can be started by turning on a switch.

EC has short Retention period.

Table.1 Typical Data on the Composition of Leachate from New And Mature Landfills

	New landfill (less than 2 years) in mg/L		**Mature landfill(greater than 10 years)**
Constituent	Range	Typical	
BOD(3-day)	2000-30000	10000	100-200
TOC	1500-20000	6000	80-160
COD	3000-60000	18000	100-500
Totalsuspended solids	200-2000	500	100-400
Organic nitrogen	10-800	200	80-120
Ammonia nitrogen	10-800	200	20-40
Nitrate	5-40	25	5-10
Total phosphorous	5-100	30	5-10

Ortho phosphorous	4-80	20	4-8
Alkalinity as CaCo3	1000-10000	3000	200-1000
Ph	4.5-7.5	6	6.6-7.5
Total hardness as $CaCO_3$	300-10000	3500	200-500
Calcium	200-3000	1000	100-400
Magnesium	50-1500	250	50-200
Potassium	200-1000	300	50-400
Sodium	200-2500	500	100-200
Chloride	200-3000	500	100-400
Sulfate	50-1000	300	20-50
Total iron	50-1200	60	20-200

II. LITERATURE REVIEW

Sl. No.	**Author**	**Wastewater**	**Electrodes**	**Results**
1.	Ugurlu *et al.*, 2006	Paper mill wastewater	Graphite and powder-activated carbon	Removal of COD, lignin and phenol were higher than 90%.

2.	Vaezi *et al.*, 2007	Industrial wastewater containing Algae	Aluminium	TSS removal-99.5% Chlorophyll removal-100%
3.	Kurt *et al.*, 2008	Domestic wastewater	Iron	COD and suspended solids removal efficiency was more than 60 and 70% respectively.
4.	Srirangsan *et al.*, 2009	Biodiesel wastewater	Aluminium, Graphite and iron	Optimum efficiency was shown by aluminium electrodes with removal efficiencies of 97.8% for oil and grease, 96.9% for suspended solids and 55.4% for COD.
5.	Umran Tezcan Un *et al.*, 2009	Vegetable oil refinery wastewater	Aluminium	COD removal- 98.9%
6.	Budiyono *et al.*, 2010	Slaughterho use wastewater	Combination of titanium and stainless steel	One and two pairs of Fe-Al electrode gave SS removal efficiency of 97.2 and 99.6% respectively.
7.	Ngameni *et al.*, 2010	Dairy wastewater	Aluminium	COD, phosphorus, nitrogen, turbidity removal was 61, 89, 81 and 100% respectively.

III.MATERIALS AND METHODOLOGY

Leachate collection: The leachate is collected from Municipal Corporation Belgavi, which is located in Turmuri Village of Belgaum District.

Experimental Setup

The experimental setup of bipolar electrocoagulation AC unit is shown figure

4.1. The container is made up of glass material with the volume of 1000mL measuring 10cm*10cm*10cm, the experiment was performed with four Aluminium electrodes connected to AC power supply. The space between all the electrodes maintained to 1.5cms in all the experiments. In each run the voltage was varied to desired value of 5, 10, 15 and 20volts. Magnetic stirrer was used in all the tests to ensure homogenous solution in batch reactor containing waste water. The leachate concentration was reduced accordingly in order to obtain better efficiency. The electro coagulation experiments were performed for some detention time such as 30min, 45min and 60min respectively and in each run samples were collected at every fixed interval for necessary analysis such as BOD, COD, pH etc. A minimum of 45min the sample was allowed to settle. The different parameters were analysed such as pH, conductivity, turbidity, COD, BOD, total dissolved solid, total suspended solids, chlorides etc.

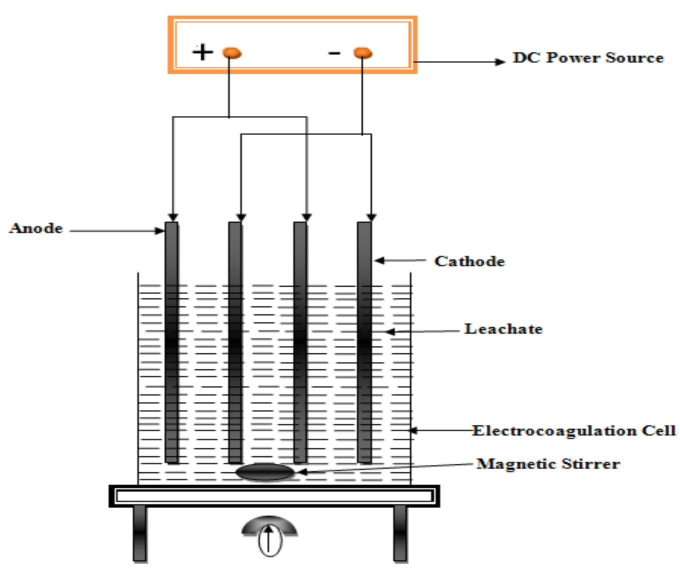

Fig 1: Shows Electrocoagulation process

IV.RESULT AND DISCUSSION

Leachate treatment performance was determined by ElectroCoagulation processes. This section deals with some considerations about the processes. Moreover, an evaluation of EC process was made via a lot of distinct operational conditions such as pH, current density, etc.

Initial pH value of leachate before treatment was 7.40. Then after treatment it has been reduced up to 6.75 when Al-Al electrodes combination used.

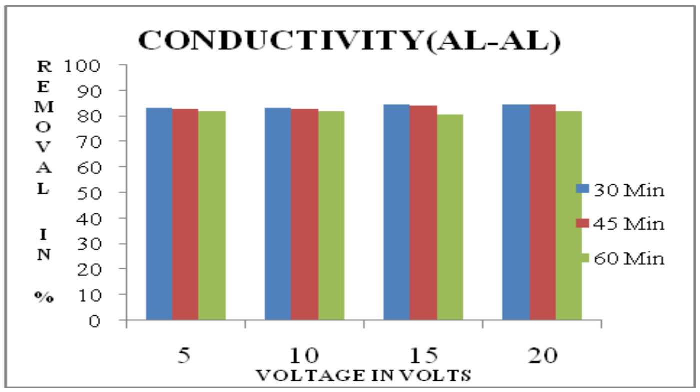

Fig 2: Percentage Removal of Conductivity

From the figure Shows that the Leachate was treated with Aluminum Electrodes and the result shows that there is reduction of 84.69% Conductivity

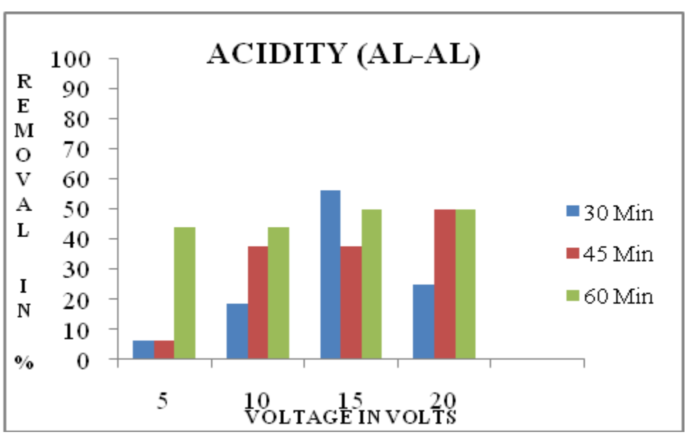

Fig 3: Percentage Removal of Acidity

From the figure Shows that the Leachate was treated with Aluminum Electrodes and the result shows that there is reduction of 56.25% Acidity

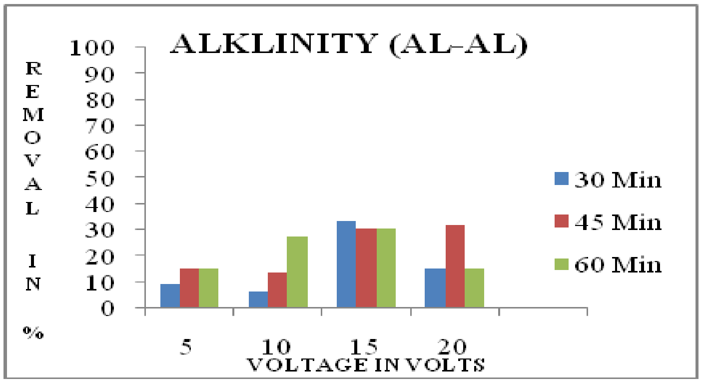

Fig 4: Percentage Removal Of Alkalinity

From the figure Shows that the Leachate was treated with Aluminum Electrodes and the result shows that there is reduction of 33.33% Alkalinity.

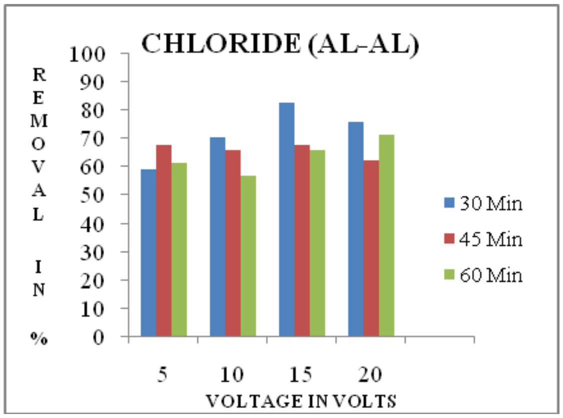

Fig 5: Percentage Removal Of Chlorides

From the figure Shows that the Leachate was treated with Aluminum Electrodes and the result shows that there is reduction of 82.22% Chloride.

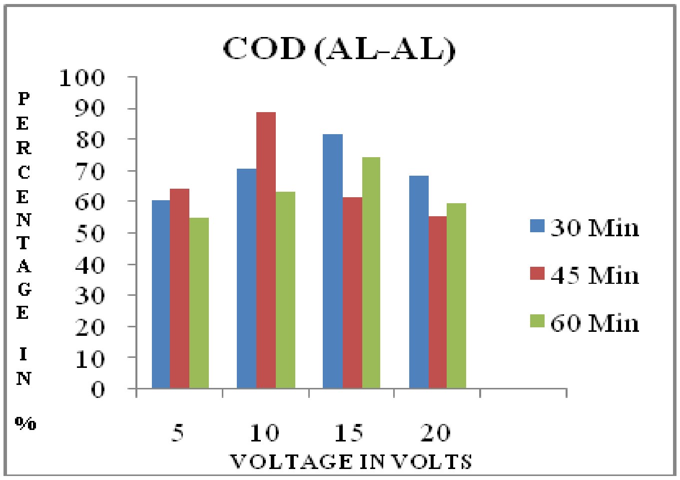

Fig 6: Percentage Removal Of COD

From the figure Shows that the Leachate was treated with Aluminum Electrodes and the result shows that there is reduction of 88.25% COD

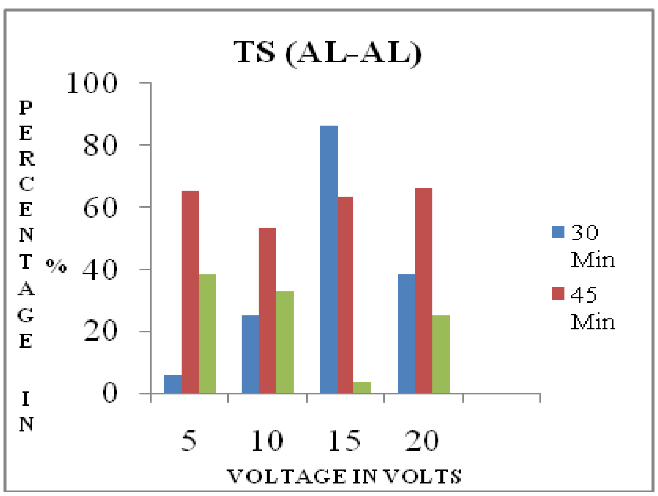

Fig 7: Percentage Removal Of Alkalinity

From the figure Shows that the Leachate was treated with Aluminum Electrodes and the result shows that there is reduction of 86.52% of Total Solids.

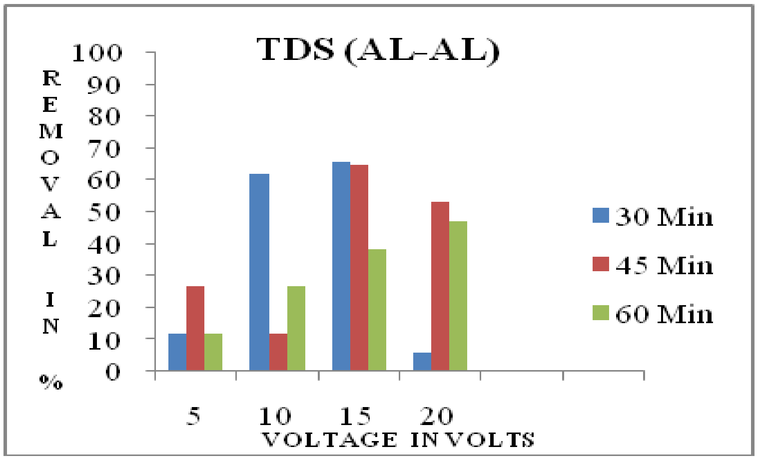

Fig 8: Percentage Removal Of TDS

From the figure Shows that the Leachate was treated with Aluminum Electrodes and the result shows that there is reduction of 65.54% of Total Dissolved Solids.

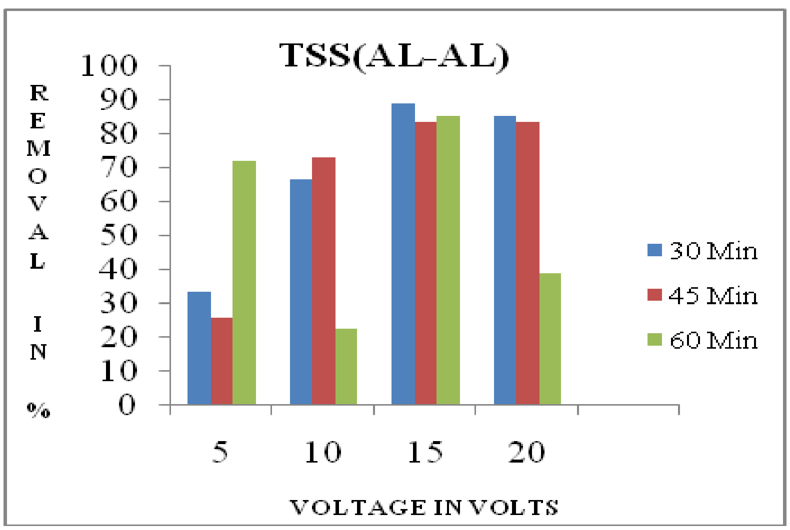

Fig 9: Percentage Removal Of TSS

From the figure Shows that the Leachate was treated with Aluminum Electrodes and the result shows that there is reduction of 88.88 % Total Suspended Solids

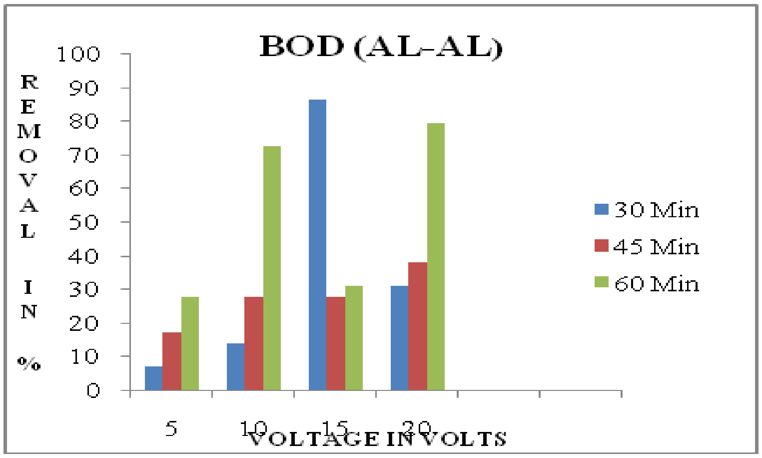

Fig 10: Percentage Removal Of BOD

From the figure Shows that the Leachate was treated with Aluminum Electrodes and the result shows that there is reduction of 86.2% BOD

CONCLUSION

Leachate is a very complex liquid with high concentration of pollution that makes its treatment very hard and providing the removal standards is difficult. Among other types of wastewaters, leachate is the most difficult one to treat because it contains complex structure that is produced within a landfill. Accordingly, the variety types of pre-treatment and mixed methods of treatment were used to treat leachate. Based on the conducted investigation, the best method for leachate treating is electrocoagulation technique because leachate consists of high toxin mater such as heavy metal, cyanide, Colloid particle some of which cannot be removed by other techniques. Accordingly, due to the mentioned advantages of Electrocoagulation technique as well as its adaptability with the environment, it has been employed as a practical method for industrial effluent and leachate treatment.

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TS, TDS, TSS, Chloride and COD concentrations. It was found that, operating parameters such as electrolysis time and Voltage significantly affected the treatment of landfill leachate. Aluminium has shown the maximum efficiency in treating the Leachate.

The results showed that the removal of Conductivity, Acidity, Alkalinity, Chlorides, COD, TS, TDS,TSS and BOD of 84.3%, 56.25%, 33.33%, 82.22%, 81.44%,86.52%, 65.54%,88.8% and 86.2% respectively with the electrolysis time of 45 min with voltage of 10volt. Thus from the results we can conclude that Aluminium is the efficient Electrode in treating the Leachate.

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