ELECTROCHEMICAL TREATMENT OF WETLAND WATER CONTAMINATED BY LANDFILL LEACHATE

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Introduction

Leachate is a major environmental problem affecting the surroundings of landfill sites of municipal solid waste. The Leachate if not properly disposed in the landfill (with liners) might enter the ground water table and contaminate the water. The Leachate which has high concentration of organics, which is very harmful for human and child life. This also affects the aquatic flora and fauna when enter into River body.

The Leachate has spoiled entire Natural wetland (Pallikaranai) and also contaminated the ground water aquifer of surrounding areas making water unfit for drinking. Raju, 2009

Electrochemical oxidation is the passage of a direct electric current through an ionic substance that is either molten or dissolved in a suitable solvent, resulting in chemical reactions at the electrodes and separation of materials. Electrochemical technology offers ideal tools for addressing environmental problems. The main reagent used here is electron and therefore no need for adding extra reagent.

Fig. 1. Photograph of Pallikaranai Wetland Filled with Bunds of Solid waste.

Materials and Methods

CATHODE

Stainless Steel	10 x 5 cm	50.0 cm^2

ANODE

Aluminum	10 x 5 cm	50.0 cm^2
Titanium/Platinum	10 x 5 cm	27.7 cm^2

The experiments were conducted by batch process. 500mL capacity (Glass Beaker) was used throughout the study. The anode and cathode were positioned vertically and parallel to each other with an inner electrode gap of 3 cm. These electrodes were dipped in the electrolyte solution (i.e. Leachate). Copper wire was used for making connections between the electrodes and D.C power system (0 to 6 A). The positive Terminal was connected to the anode and negative to the cathode. The solution was constantly stirred with a magnetic stirrer in order to maintain uniform concentration of the electrolyte solution. Deng and James, 2006

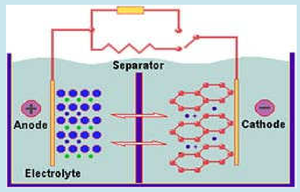
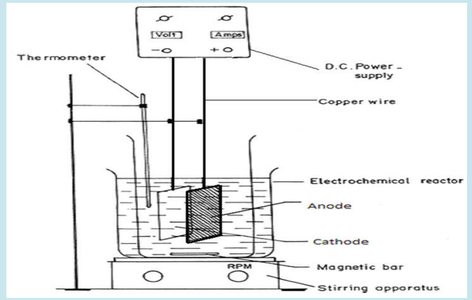


Fig. 2. Mechanism of Electrochemical Process



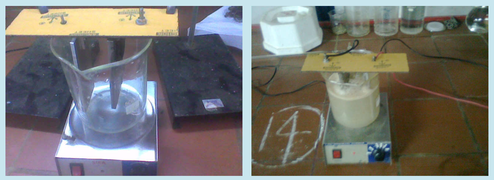


Fig. 3. Photograph of Electrochemical Process

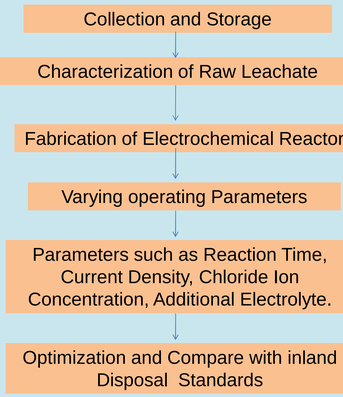


Fig. 4. Methodology flowchart

The ranges of reaction time were from 0 to 1 hour with 10 minutes interval. The current intensity was varied as 1.4 A/dm^2, 1.65 A/dm^2, 1.8 A/dm^2, 2.05 A/dm^2, 2.2 A/dm^2, 2.45 A/dm^2, 2.7 A/dm^2, 2.95 A/dm^2 and 3.2 A/dm^2. The chloride addition was in the range of 0 mg/L to 3000 mg/L, with 500 mg/L interval concentration. The concentration of (H_2SO_4) electrolyte was in the range of 0 mg/L to 3000 mg/L, interval of 250 mg/L. Priya, 2005

Advantages:

The advantages of electrochemical Treatment are: Priya, 2005

- Less land area required
- Pollution free
- Does not leave any residue
- No additional reagents are required
- Continuous process with relatively high flow rates can be designed
- No phase changes are required and
- High current efficiencies can be attained.

Results

The Table 1 shown below represents the raw Leachate characteristics taken at two different locations at the wetland. Sample 1 is taken at 2 m from the landfill site and Sample 2 is at the landfill site.

Table 1: Characteristics of Raw Leachate

Sl. No	Constituents	Sample 1	Sample 2	Disposal Standards (Inland surface water)
1.	pH	6.86	7.35	5.5 to 9.0
2.	Conductivity (µS/cm)	7830	8250	5000
3.	Ammonia (mg/L)	120	95	50
4.	TSS (mg/L)	268	320	100
5.	TDS (mg/L)	5664	9180	2100
6.	COD (mg/L)	340	540	250
7.	Chloride (mg/L)	1505	1667	1000
8.	BOD 3 days at 27^0 C (mg/L)	85	135	30
9.	Sulphate (mg/L)	127	102	-
10.	BOD/COD ratio	0.25	0.25	-
11.	Nitrate (No_3^-) (mg/L)	15	26	-
12.	Colour			
	436 nm (% Absorbance)	0.157	0.132	-
	525 nm (% Absorbance)	0.063	0.050	
	620 nm (% Absorbance)	0.032	0.026	

High conductivity is suitable for electrolysis, with a high TDS of 9180 mg/L. The sample also contained significant amount of chloride that contributed to conductivity. The Leachate has high value of ammonical nitrogen (120 mg/L) and chloride (1667 mg/L). In electrochemical oxidation (indirect oxidation) the ammonical nitrogen removal was studied. The influence of Aluminium and Ti/pt anode , SS cathode on the removal of ammonical nitrogen and chloride removal are studied.

The colour of the Leachate from the % of absorbance value is found to be in the wavelength range of Greenish yellow. The Leachate is Subjected to electrolysis until the Yellow colour of the Leachate is faded to give a clear solution.

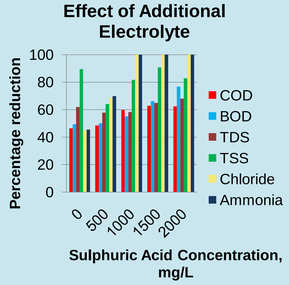


Fig. 5. Graph showing Effect of Sulphuric Acid with Al and SS

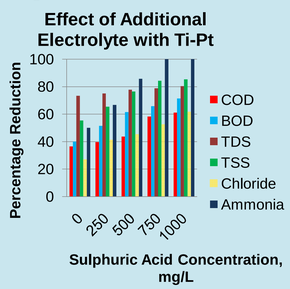


Fig. 6. Graph showing Effect of Sulphuric Acid with Ti/Pt and SS

Para / Ano. mat.	Optimum Reaction time			Optimum Current density			Optimum Chloride ion concentration			Optimum Sulphuric Acid Concentration		
Al	**60 min**			**2.95A/dm²**			**1500 mg/L**			**1500 mg/L**		
	COD	TDS	Cl	COD	TDS	Cl	COD	TDS	Cl	COD	TDS	Cl
	Percentage Reduction											
	63.0	71.0	51.0	68.0	80.0	50.0	47.0	76.0	29.0	63.0	65.0	100
Ti-Pt	**40 min**			**2.2 A/dm²**			**1500 mg/L**			**750 mg/L**		
	COD	TDS	Cl	COD	TDS	Cl	COD	TDS	Cl	COD	TDS	Cl
	Percentage Reduction											
	54.0	78.0	55.0	51.0	79.0	42.0	61.0	81.0	59.0	59.0	79.0	62.0

Conclusions

The Chloride and ammonia were removed to the extent of 100% from its initial concentration of 1667 mg/L and 95 mg/L respectively, by employing Aluminium anode material with optimum Current density of 2.95 A/dm^2, with 60 minutes Reaction time and 1500 mg/L of Sulphuric acid Concentration.

With Ti-Pt anode the optimum conditions were 40 minutes Reaction time, Current Density 2.2 A/dm^2, chloride ion concentration 1500 mg/L and Sulphuric acid concentration 750 mg/L. The percentage removal of COD, TDS, Ammonia and Chloride were 61%, 80%, 100% and 62% respectively.

Hence it is concluded from the above study is that Titanium coated with Platinum with Stainless Steel is the better electrodes than Aluminum and Stainless Steel in the aspect of treating the pollutant efficiently, at quicker rate and with lesser chemical utilization.

Literature cited

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