Leachate Treatment by Soil Aquifer System(Sas)

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***Abstract*— Leachate contains high concentrations of many types of substances that can be dangerous to human beings and environment, if they are allowed to enter the water or the soil around or below the landfill without proper treatment. Many researchers have tried various physicochemical methods and conventional biological systems to treat leachate from landfill site of municipal solid waste. In this paper an attempt has been made to evaluate the potential of different soils in treating leachate. Variables considered include pH, flow rates and COD concentrations.**

Based on the experimental results it is inferred that out of three soils tried , gravelly soil has got high potential to treat leachate followed by silty and clayey soils. COD removal efficiency of 74.8% has been recorded for the optimum conditions of experimental parameters.

***Keywords*— Soil aquifer system, leachate, COD, flow rate**

INTRODUCTION

One of the major pollution problems caused at municipal solid waste dumping sites is landfill leachate. Leachate is generated as a consequence of precipitation, surface runoff and infiltration of ground water percolating through landfill, biochemical process in waste's cells and inherent water content of waste themselves. Its composition varies from sites to sites depending on nature of deposited wastes, soil characteristics, rainfall patterns, age of landfill and environmental problems. Landfill leachate normally contains high concentrations of organic matter, nutrients, pathogens and heavy metals which if not properly collected and treated can cause serious pollution of surface and ground water sources. Hence landfill leachate treatment has been given significance attention in recent years. The type of treatment that can be used will depend primarily on the characteristics of leachate and secondarily on the geographic and physical location of the landfill. Various physicochemical and biological treatments that are practiced/tried include activated carbon adsorption, reverse osmosis and evaporation, electrochemical treatment, coagulation & precipitation, oxidation, stripping, ASP, fixed film reactors, stabilization ponds and anaerobic digestion(Vishvanathan et al:2006, Quasim:1994, ,Nishapriya et al : 2005 ,Xian et al:2012,Tonni et al:2005,Amokrane et al:1997, Shahin et al:2009) Eventhough these methods are available to treat the leachate, they have their own merits and demerits.

Land treatment is a cost effective and environmentally sound method to achieve treatment goals. The major benefit of land treatment is to engage the natural assimilative capacity of the land for disposal. The complexities of waste, soil and natural processes, interactions must be understood if land treatment is to be an acceptable practice.(Chiemchaisri et al:2003 , Adnan et al:2014, Masatomo et al:2010,Hossein et al:2010). In this paper an attempt has been made to investigate the fate of solid waste leachate using soil columns under varied experimental conditions.

MATERIALS AND METHODOLOGY

Solid wastes with major composition of food wastes, paper and plastic collected from municipal landfill site near Davangere was placed in a 15l closed oil tin with lid having holes of different diameters at the top and bottom. The water was poured from top of the tin and the leachate from the bottom of the tin was collected and used for the experimentation. Typical characteristics of leachate generated are shown in table 1. Three soil samples belonging to three classes were used to assess the suitability of soils in treating leachate. The soil samples were selected from three different sites as per standard procedure given in SP36 part 2. Further based on the analysis of soil samples, they were classified as silty, clayey, gravelly soil as per classification procedure. Geotechnical properties and physicochemical characteristics of soils used for experimentation are shown in table 2 & 3.

TABLE1: CHARACTERISTICS OF LEACHATE

Sample	pH	COD, g/l	TS, g/l	Hardness, g/l	Chlorides, g/l
1	6.8	9.940	17.958	5.033	2.092
2	7.0	10.200	17.740	5.320	1.980
3	7.1	10.08	17.813	5.240	2.210
Average of three samples	7.0	10.07	17.837	5.198	2.094

TABLE 2: GEO-TECHNICAL PROPERTIES AND CLASSIFICATION OF SOILS

Sl No	Parameter	Soils		
		1	*2*	*3*
1	Field density, In place density(gm/cc) In place dry density(gm/cc)	 1.85 1.70	 1.80 1.72	 1.67 1.46
2	Specific gravity(g)	2.62	2.70	2.65
3	Differential free swell(%)	4.89	20	14.11
4	Liquid limit(%)	22	30.45	25.82
5	Plastic limit(%)	Non plastic	22.80	19.92
6	Plasticity Index(%)	Non plastic	7.65	6.60
7	Permeability (cm/sec)	$0.8x10^{-3}$	$0.78x10^{-3}$	$1x10^{-7}$
8	8 Direct Shear Test: C(kg/m^2) Ø(Degree)	 0.2 30^0	 0.24 30^0	 0.41 40^0
9	Compaction Test(Light) √Max(gm/cc) OMC(%)	 1.85 11.3	 1.94 13.22	 1.75 11.2
10	Sieve analysis, % of Gravel % of Sand % of Silt & clay Cu Cc	 8.50 59.10 32.5 2.5 1.3	 2.20 69.00 29.00 2.52 0.92	 47.0 24.0 29.0 4.9 2.2
11	Hydrometer analysis, % of clay, % of silt	 5.05 27.5	 19.0 10.0	 _ _
12	Classification of Soil	Silty	Clayey	Gravel

TABLE3: PHYSICO- CHEMICAL CHARACTERISTICS OF SOILS USED FOR EXPERIMENTATION

Sl No	Parameter	Soil -1	Soil-2	Soil-3
		Silty	**Clayey**	**Gravel**
1	pH	7.2	7.2	7.2
2	TS mg/l	0.350	0.84	0.45
3	COD mg/l	102.50	110	123.5
4	Chlorides mg/l	25.4	30.20	35.5
5	Hardness mg/l	0.25	0.74	0.52

Column of 15cm diameter and 1.5m height was used for experimentation(Fig1). A metal screen mesh at the bottom of the column was attached in order to prevent the soil plunging. Further a funnel was mounted at the bottom of the column for the smooth collection of leachate through attached valve on the funnel. The each soil sample collected from the field was so filled into the column such that dry density of soil filled in the column will be same as that of soil in the field.

Leachate to be tested was fed into the column by overhead tank at different flow rates viz 10,20 &30ml/min. Leachate before and after treatment were analyzed for various characteristics viz COD, pH, total solids, hardness and chlorides according to standard method for the examination of water and wastewater treatment 20th edition(APHA:1992) Three soils samples used for the experimentation were analyzed using standard methods for varying parameters viz pH, Total solids(TS), Hardness, Chlorides, COD. The results of analysis are shown in Table 4. pH of all the three samples were found.

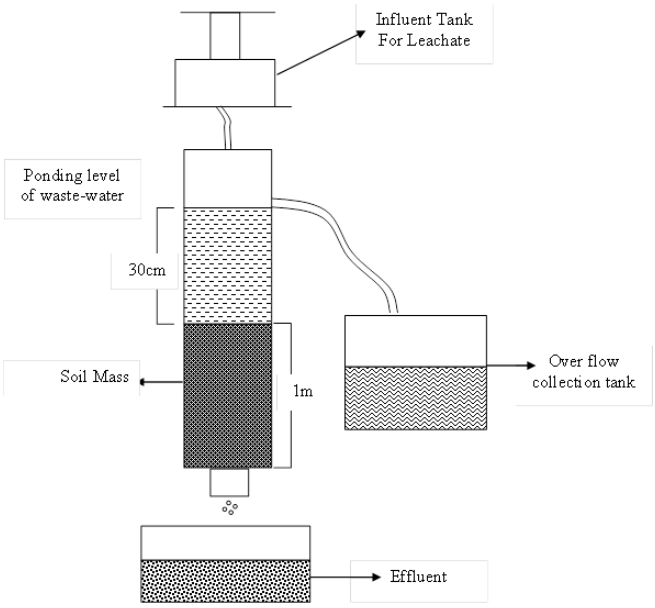

Fig –1 : Line Diagram of Experimental Set Up

RESULTS AND DISCUSSIONS

The characteristics of treated leachate and removal efficiency of different soils used under varied experimental conditions are recorded and summarized in table 4. Based on the results of experimentation the following inferences were drawn:

Maximum COD removal efficiency of 74.8 % has been recorded with gravelly soil at flow rate of 10 ml/min. Corresponding value at this flow rate with silty and clayey soil were found to be 73.5 and 64.2% respectively. Further at flow rates of 20 and 30 ml/min the gravel exhibited COD removal efficiency of 71.6 and 63.5 % respectively. 68.4 and 59.3 % removal efficiencies were recorded at 20 ml/min of flow rate by silty and clayey soil respectively. These values for flow rate of 30 ml/min were found to be respectively 61.6 and 52.5%.

But minimum TS removal of 49.8 % with clayey soil at flow rate of 30 ml/min was recorded. Accordingly of this soil 60.5 % was TS removal efficiency at flow rate 10 ml/min. However with gravelly soil maximum and minimum removal efficiency of TS at flow rate of 10 ml/min and 30 ml/min observed were 70.3 and 57 % respectively.

Removal of hardness ranging from 46.3 to 72.1 % was observed under all conditions of experimentation. Lower value recorded corresponds to clayey soil and flow rate of 30 ml/min. Higher value refer to gravelly soil, flow rate being 10 ml/min.

Similarly 51.8 and 74.5 % were the removal efficiencies recorded for chlorides at flow rates of 30 ml/min respectively for Clayey and Gravelly soil. Within the practical limitations pH of the leachate before and after the treatment found to be un altered. However it is opined that even though higher removal efficiencies for various parameters/ contents were observed with Gravelly soil compared to other two soils, the results obtained with Silty and Gravelly soils within the statistical limitations were found to be same.(Variation is within 5 %). Thus it was inferred that the order of performance of soils is Gravelly >Silty>Clayey.

Table-4 :Performance Of Experimental Column,(pH : 7.0)

Sl.No.	Parameters	Effluents for stated flow rate(ml/min)								
		Silty soil			Clayey soil			Gravel		
		10	20	30	10	20	30	10	20	30
1	TS g/l	5.53	6.69	8.0	7.09	7.82	9.01	5.33	6.57	7.72
2	Hardness g/l	1.49	1.85	2.37	1.78	2.15	2.70	1.40	1.78	2.35
3	Chlorides g/l	0.573	0.736	0.89	0.73	0.87	1.00	0.53	0.72	0.84
4	COD g/l	2.63	3.141	3.81	3.55	4.04	4.72	2.50	2.82	3.62

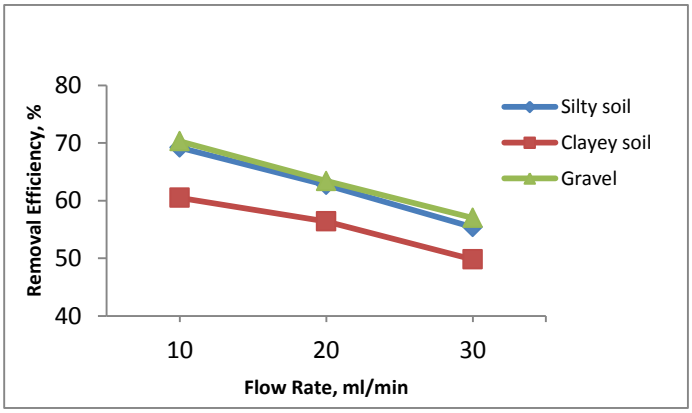

Fig. 2 : Effect of Flow Rate on Removal Efficiency of TS

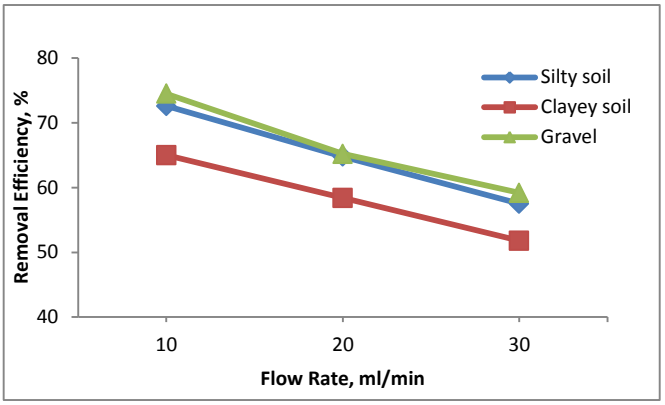

Fig. 4 : Effect of Flow Rate on Removal Efficiency of Chlorides

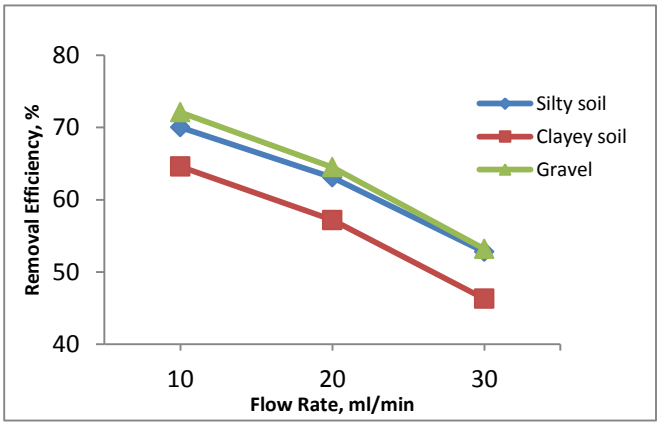

Fig. 3 : Effect of Flow Rate on Removal Efficiency of Hardness

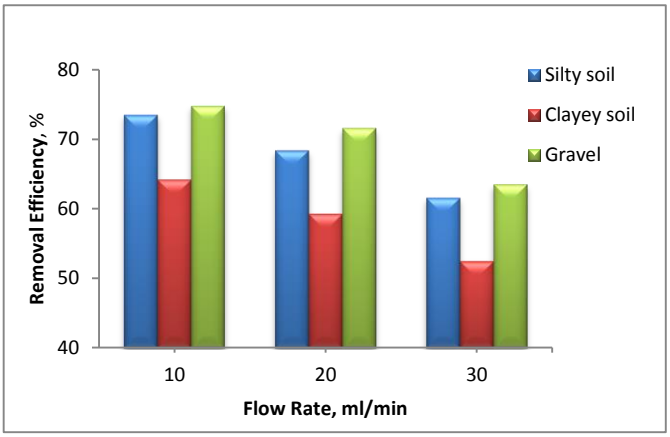

Fig. 5 : Effect of Flow Rate on Removal Efficiency of COD

CONCLUSIONS

Based on the discussions made and inferences drawn, the following conclusions have been drawn:

- It is concluded that out of three soils tried Gravelly soil has got high potential to treat leachate followed by, Silty and Clayey soils
- It is concluded that flow rate has direct influence on removal efficiency. Thus at flow rate of 10 ml/min the better efficiency was observed followed by flow rates of 20 and 30 ml/min.
- It is concluded that maximum of 74.8%, 73.5% and 64.2% of COD can be removed at flow rate of 10ml/min by Gravelly, Silty and Clayey soils respectively.

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