Research Article

LEACHATE RECIRCULATION TECHNIQUE FOR TREATMENT OF LEACHATE

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ABSTRACT

The aim of this project was to conduct a study on leachate characterization and to treat it by leachate recycling or recirculation to achieve the highest MSW biodegradation rate and to observe the BOD, COD levels. To this end the various chemical characteristics of the waste were studied. Initially tests were carried out on Municipal solid waste. The tests were conducted in order to check the pH, volatile solids. Next, soil analysis was done to check the type of soil. Tests were conducted like pH, moisture content, permeability, density and specific gravity. The resulting soil was found to be the Black Cotton soil. Lastly the significant parameters (via, pH, BOD, COD, Alkalinity, hardness, TS and TDS) were analyzed to check the effects of recirculation on leachate. .This was carried out over a period of 110 days. The experiment to generate leachate artificially and recirculation was conducted in a lab scale model. The generated leachate parameters were analyzed. All the tests were carried out at GHRC Laboratory. These tests showed a significant change in the levels of pH, BOD,COD, hardness, TDS. A few of tests on the leachate were carried out at the Water Quality Lab level 2, Hydrology Department, Irrigation Department Laboratory.

KEYWORDS Landfill, leachate recirculation (LR), leachate management, chemical characterization

1. INTRODUCTION

Landfill leachate is a complex wastewater with considerable variation in both quality & quantity. The composition and concentration of pollutants are influenced by the types of waste deposited, hydrological factors, and more significantly by the age of the landfill site. Past visual images of municipal solid waste landfill leachate have typically been on the order of toxic sludge or black ooze. Earlier national studies have reported extremely wide ranges in leachate pollutants concentrations, with very high figures of both organic compounds/constituents and metals, and low pH values. So, landfill leachate is an important issue of the waste management system in municipal areas because high contents of ammonia nitrogen and COD/BOD ratio present difficulties in treatment of landfill leachate.

A traditional landfill is a facility engineered for the final disposal of the municipal solid waste that is designed

to minimize the negative impacts on the environment and on public health [17], but needing 20 or more years for stabilization [18, 19]. Leachate recirculation (LR) is one of many techniques employed for rapid and cost effective way of stabilizing landfill leachate. The scientific interest towards leachate recirculation strategies have been fueled mainly because of claims of its numerous economic and environmental advantages in leachate stabilization as opposed to conventional leachate treatment, as it converts a dry conventional landfill into a bioreactor .The Solid Waste Association of North America (SWANA) defines the landfill bioreactor as "any permitted Subtitle D landfill or landfill cell where liquid or air is injected in a controlled fashion into the waste mass in order to accelerate or enhance bio stabilization of the waste" [6, 20]. The advantages of leachate recirculation in a landfill include: (a) The settlement of cell before the final cover is placed thus decreasing possible damage to it; (b) Increase of the effective density of the MSW and thus of the landfill capacity; (c) The in situ treatment of generated leachate; (d) The increase of methane production rates; and (e) The acceleration of bio degradation of MSW, which may shorten the post closure monitoring and reduce the global costs of the landfill. [7, 21].

Looking at the Indian scenario the practice of leachate recirculation is not carried out in the landfills according to some studies. Because of this, whatever the leachate generated in the landfills percolates and mixes with the groundwater table contaminating the water there. So if we adhere to the process of creating a bioreactor instead of a dry tomb landfill we can limit the harmful effects of the leachate on our future water needs. This paper will discuss how the LR will help to treat the leachate on site without any transferring to ETP or wastewater treatment plant.

2. MATERIALS AND METHODS

2.1 Municipal Solid Waste Sampled

The quantity of solid waste taken was 15kg which was collected from the vegetable market and were sampled and sorted out in different categories like compostable, rubbish, plastic, metal, leather etc. The refuse was analyzed for pH moisture content total solids and volatile solids. Only the compostable waste plus rubbish were shredded and filled in the container. Table 1 shows the typical composition of MSW.

2.2 Experimental Set Up

2.2.1 Laboratory Scale Model (Drum bioreactor)

The process was carried out using a prototype of bio-reactor landfill see figure 1.

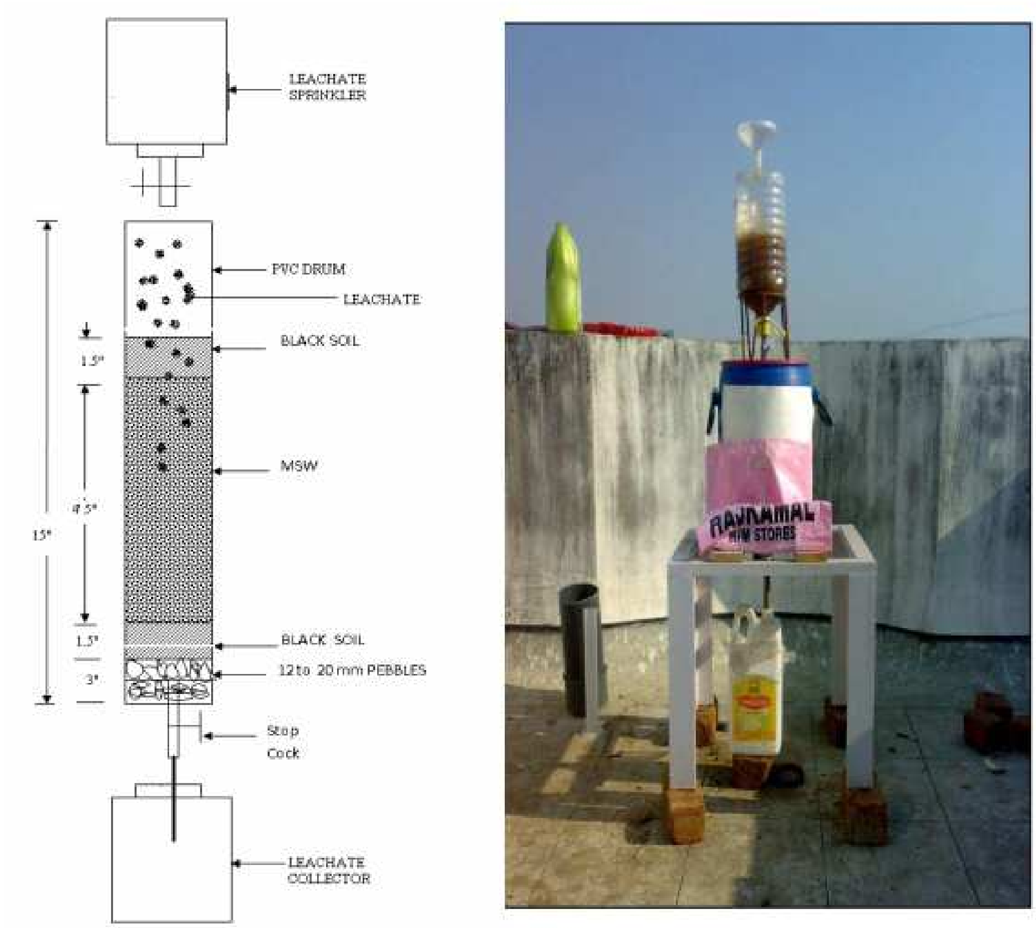

Figure 1. Lab Experimental Setup (right) and Phase diagram (left) representing the inner layers of material fill in the drum reactor

TABLE 1: The Composition of MSW

Sr. No.	Constituent	% by wet weight
1.	Compostable waste	67.00
2.	Rubbish	20.00
3.	Rubber/plastic	7.00
4.	Metals (Iron, Tin etc.)	1.00
5.	Glass	3.00
6.	Leather	2.00

The prototype was constructed by taking 20 liter capacity cylindrical container of the following dimension: Height 381 mm, Diameter 305 mm. The materials filled in the reactor from bottom are gravel layer (78 mm), BC soil layer, then MSW was filled and compacted at a density of 278 kg/m^3 and then a final cover (FC) of BC or landfill soil of 70 mm thick was placed on top of the refuse after which LSM was closed. Two containers mounted on top of the LSM and one at bottom was kept for the collection.

2.2.2 Operation of Reactor

Initially water was added to satisfy the field capacity of MSW in the drum at the rate 1 lit/day for 3 days. So, the quantity of water required for saturation of waste is 3.4 liters. The amount of moisture necessary for saturation of the solid waste (before leachate generation) requires in between 100-140 mm/m/m^2; it is taken 120 mm/m/m^2 for this study. After this when the field capacity was achieved 500 ml water was added 2 times in a week for leachate generation. The reason to add this much quantity of water is that sufficient amount of leachate is to be generated and collected for recirculation. The reactor has to be kept close for 10-15 days so as to prevent the water logging situation which may results in the failure of treating the leachate. Various parameters of leachate were analyzed in the laboratory.

2.3 Analytical Methods

2.3.1. Analysis of refuse

The refuse was analyzed for moisture content (MC), pH, volatile solids and total solids table 2 shows the analysis of waste. Table 3 indicates the analysis of Black Cotton soil used as FC; it was analyzed for pH, specific gravity, moisture content, permeability and density.

TABLE 2: Physical Analysis of MSW

Sr. No.	Parameter	Values
1.	Moisture content (%)	63.41
2.	pH	6.9
3.	Volatile Solids (%)	8.2
4.	Total Solids (%)	36.59

TABLE 3: Analysis of Experimental Black Soil

Sr. No.	Parameters	Values
1.	pH	7.5
2.	Specific gravity	2.18
3.	Liquid limit (%)	46.25
4.	Plastic limit (%)	39.55
5.	Shrinkage Limit (%)	27.66
6.	Moisture content (%)	24.74
7.	Permeability (cm / sec)	0.00018
8.	Density (kg/m³)	1176

2.3. Analysis of leachate

Leachate analysis was done **2** after every week or whenever the leachate is generated. Leachate samples were collected in plastic containers and sent to check the parameters like pH, BOD_3, COD, TDS, Hardness (Ca and Mg) and alkalinity in the laboratory of GHRC. The above tests were carried out as per the IS code IS 3025 (part 44).

3. RESULTS AND DISCUSSION

COD and BOD are the two critical indicators of organics in leachate. The changing profiles of these two parameters of leachate from the reactor are illustrated in Figure 2 and 3.

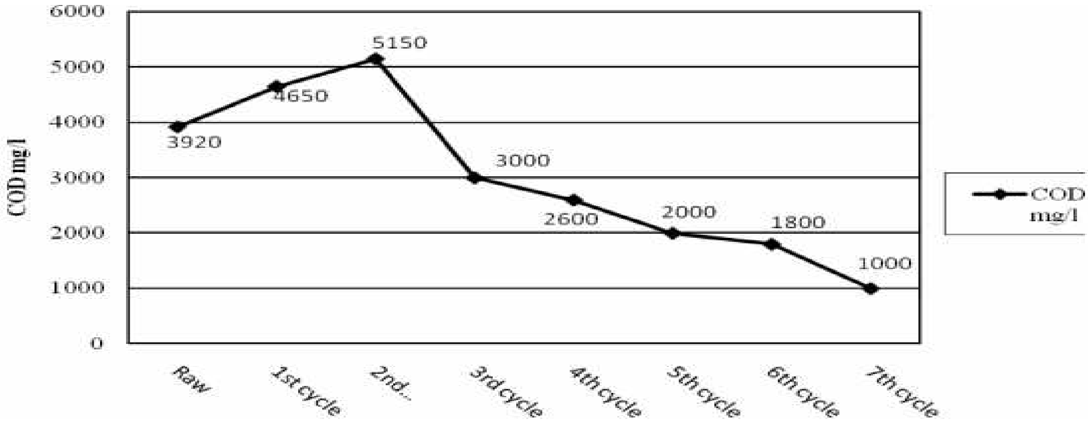

Figure 2. Variation in COD concentration

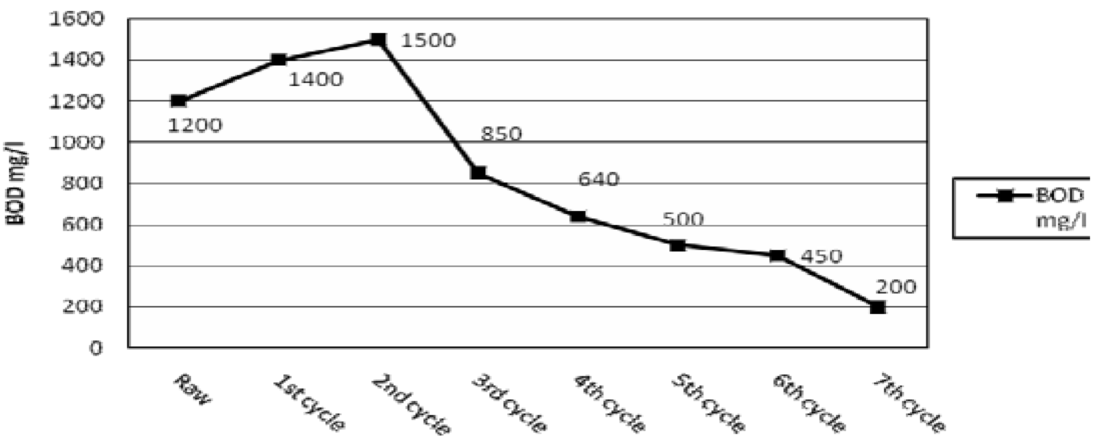

Figure 3. Variation in BOD concentration

In the initial three cycles the values of BOD and COD increases up to 1500 mg/l and 5150 mg/l respectively. The reason behind it was continuous solubilization of solid waste, followed by the microbial conversion of biodegradable organic content, result in the production of volatile fatty acids and COD at high concentration. The pH value can be observed at the lowest value i.e. 6.6-5.8. After the third cycle the value of BOD and COD started decreasing to 800 mg/l and 3000 mg/l respectively and they were observed in reducing manner upto 275mg/l (BOD) and 1023mg/l (COD). The conversion of volatile fatty acids and H_2 gas to CH_4 and CO_2 is a predominant event due to strict anaerobes. Organic contents in leachate transform to CH_4 and CO_2 gas, which make COD decrease significantly.

Occurrence of heavy metals in the leachate tends to decrease because of high pH value that causes complextion, precipitation and transition to solid phase. The increase in pH 8.3 resulting in the transition of acidic phase to alkaline phase can also be observed in the Figure 4.

Alkalinity in a leachate is due to carbonates, bicarbonate, silicates, borates, ammonia, organic base, sulfides and phosphate. Alkalinity in the soil is affected mainly by dissolution and precipitation of metals carbonates which is observed in Figure 5.

Cation exchange and precipitation are the major attenuation mechanisms for magnesium. Under neutral to alkaline pH, magnesium may form a carbonate precipitate under favorable conditions. Magnesium attenuates moderately in a clayey soil (Figure 8). The major attenuation mechanisms for calcium are precipitation and cation exchange. It readily forms carbonate precipitation under alkaline pH. Since calcium is the dominant ion in the soil or other material exchange complex, it is not adsorbed but in the most cases is elute (Figure 7). Total solid is the combination of suspended solids, dissolved solids and volatile solids. Mechanical staining, precipitation, ion exchange and biological processes (Figure 5 & 6).

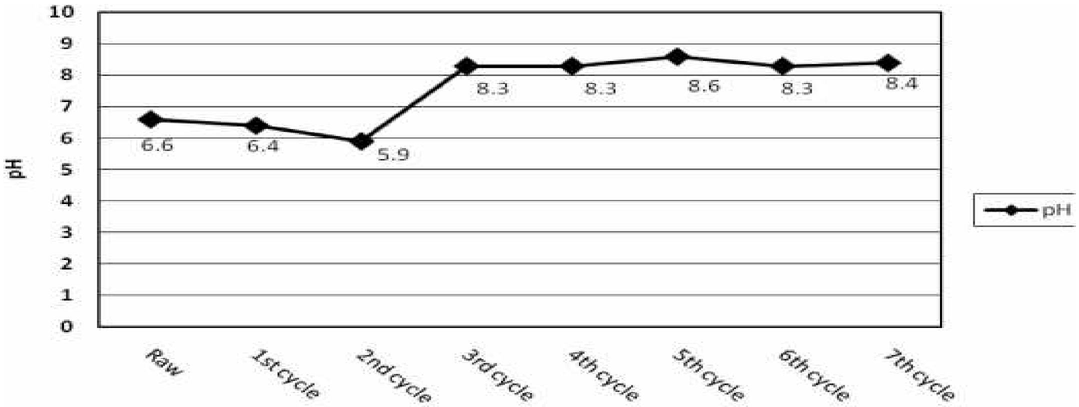

Figure 4. Variation in pH

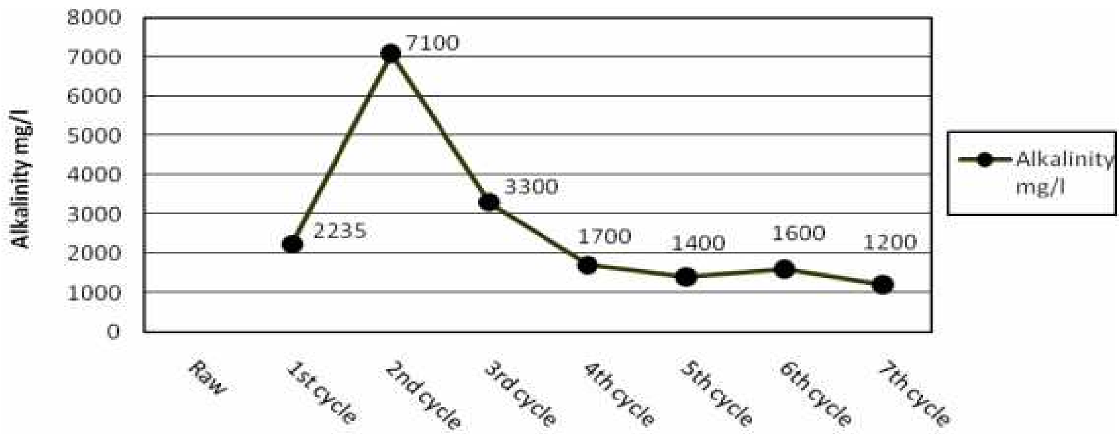

Figure 5. Removal of Alkalinity

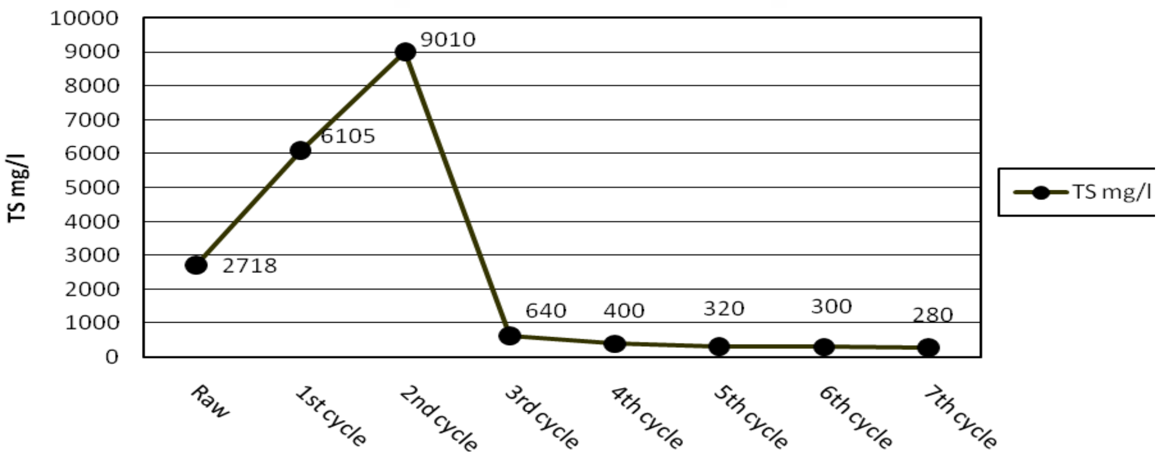

Figure 6. Removal of Total Solids

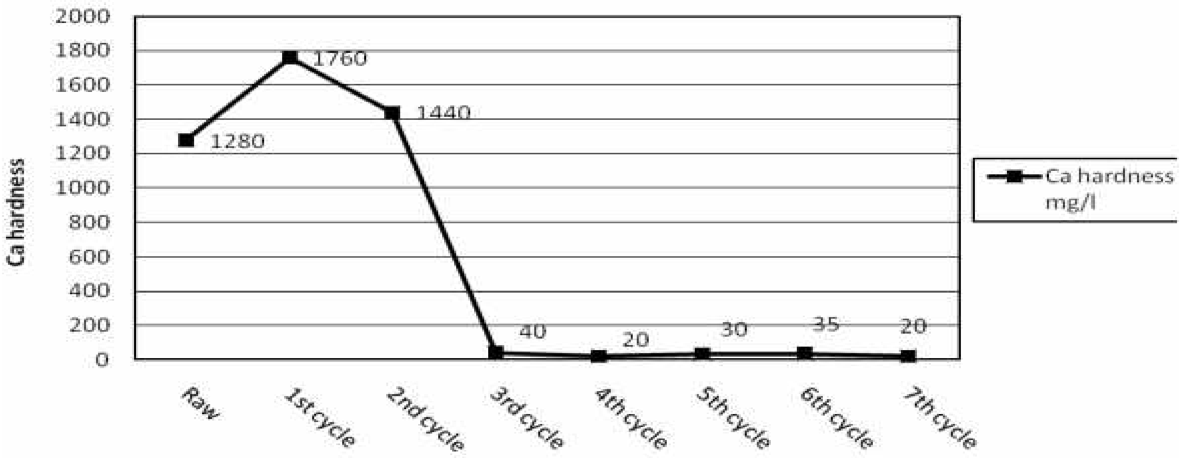

Figure 7. Removal of Calcium Hardness in Leachate

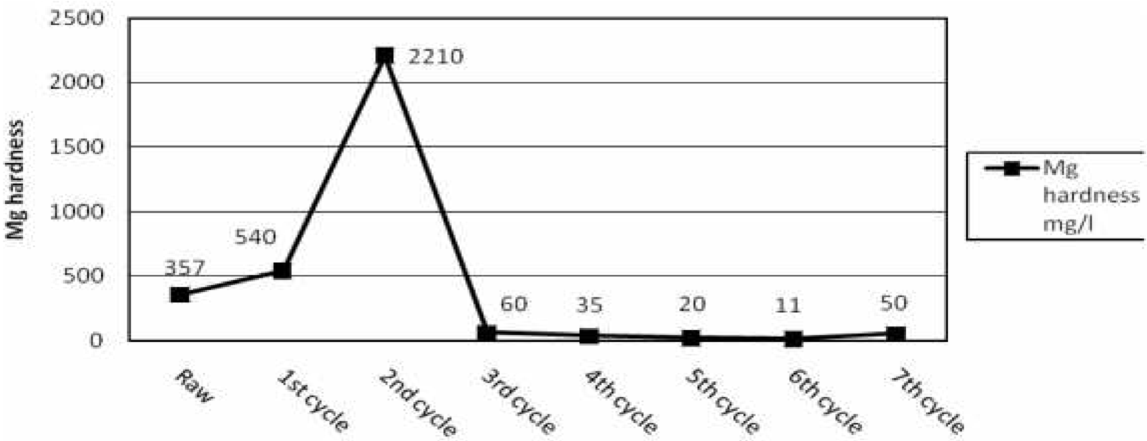

Figure 8. Removal of Magnesium Hardness in Leachate

4. CONCLUSION

Bioreactor operation was found to bring about extensive reduction in organic loads. Pollution indicators like COD and BOD were reduced by 80% and 88% respectively in this kind of operation. Removal of alkalinity achieved was upto 94%. Still it is a time consuming process but for the disposal of leachate on site it is a good technique if applied in a skilled manner.

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