Evaluation of Leachate Treatment System at Gohagoda Dumpsite

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Abstract

Leachate management is one of the major concerns in the rehabilitation efforts of the Gohagoda dumpsite. Leachate collection network was designed after detailed investigation of leachate generation points of the dumpsite and drainage pattern. Interceptor leachate drains was laid on the periphery of the dumpsite to capture all subsurface flows in the upper strata that normally discharge into surface flow streams at different point in the dumpsite. A leachate treatment bioreactor (LTB) and constructed wetlands (CW) and a subsurface charcoal filter bed were constructed to treat the leachate collected from the dumpsite. This paper is aimed to evaluate the performances of existing leachate treatment system and compare the results with the previous studies on leachate quality of the dumpsite. Before commencement of rehabilitation of the dumpsite, the biochemical oxygen demand (BOD) value reported was 7,500mgL^{-1} and average chemical oxygen demand (COD) value was 33,900±14,100mgL^{-1}. The drastic reduction of treatment parameters at the inlet to the LTB, like BOD and COD of 367.5±237mgL^{-1} and 1,905±1,092mgL^{-1}, respectively nullified the performance of it. In fact sometimes, the LTB performances were negative for conductivity, salinity, BOD and TDS, indicating washing out of ions. Nevertheless, in spite of higher influent concentrations than the designed values for the CW, the removal efficiencies of BOD and COD were over 67% and 31%, respectively. Therefore, incorporation of an activated sludge process (ASP) and algal pond after the LTB could reduce the influent parameters, thus improve removal efficiency of the CW to meet the desired discharge standards.

Key words: Constructed wetlands, Dumpsite, Leachate treatment bioreactor

Introduction

Gohagoda dumpsite in Kandy is situated in the Central Province of Sri Lanka and it is one of the disposal sites, which has been used since 1960s for open dumping of MSW collected within Kandy city limits and Harispaththuwa Pradeshiya Shabha (HPA). At present, about 150tonnes of MSW is disposed daily. A project was developed by EcoTech Lanka Limited to rehabilitate the Gohogoda dumpsite and establish an integrated solid waste management system. Leachate management is one of major concerns in the rehabilitation efforts of the dumpsite, since the pollution loads from the top of the dumpsite to the Mahaweli river is alarming.

The estimated leachate generation was 30,810m^3/year. The highest leachate formation of the dumpsite could be 273m^3/day for a rainfall of 400mm/day. Leachate collection network was designed after detailed investigation of leachate generation points of the dumpsite and drainage pattern. Interceptor leachate drains was laid on the periphery of the dumpsite to capture all subsurface flows in the upper strata that normally discharge into surface flow streams at different point in the dumpsite. The subsurface drains were specifically designed to cater for the rate of leachate permeating from the sides of embankments (Ariyawansha *et al.*, 2011). A leachate treatment bioreactor (LTB) and constructed wetlands and a subsurface charcoal filter bed were constructed to treat the leachate collected from the dumpsite. At

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present, 75% of leachate generated in the dump is treated through a re-circulating LTB followed by two subsurface flow constructed wetlands (CW) and the charcoal filter bed. The remaining 25% leachate quantity will be collected and directed to the treatment system in the near future while setting back of embankments in North East side of the dump. It is proposed to establish an activated sludge process reactor and algae reactor for improving the performance of system. This paper is aimed to evaluate the performances of existing leachate treatment system and to compare the results with the previous studies on leachate quality of the dumpsite.

Materials and Methods

Evaluation of performances of existing leachate treatment system

In order to evaluate the performances of existing leachate treatment system samples were taken from the inlet and outlet of the LTB and outlet of the constructed wetlands on weekly basis from February, 2013 to June, 2013. The collected samples were analyzed for parameters of pH, conductivity, salinity, dissolved oxygen (DO), total dissolved solids (TDS), total solids (TS), volatile solids (VS), total suspended solids (TSS), volatile suspended solids (VSS) and chemical oxygen demand (COD) and biochemical oxygen demand (BOD). Laboratory analysis was done at Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya. The results were compared with the reported lechate quality of the Gohagoda dumpsite of previous studies. Removal efficiency of conductivity, salinity, COD, BOD, TS, TDS, TSS, VS and VSS by the existing leachate treatment system during the study period was determined by using the following equation.

$$\text{Removal efficiency} = \frac{\text{inlet concentration - outlet concentration}}{\text{inlet concentration}} \times 100$$

Results and Discussion

Leachate quality of the dumpsite

The leachate quality and quantity generated from dumpsite are strongly affected by hydrological conditions and the conditions of the dumpsite. In an earlier study, before commencement of rehabilitation of the dumpsite, the BOD value reported was 7,500mgL^{-1} and the COD values were 33,900±14,100 mgL^{-1}(Menikpura *et al.,* 2008) as given in Table 1. According to Widanagamage, 2010, the BOD and COD values in leachate puddles on top of the dumpsite were 4,800 mgL^{-1} and 32,000mgL^{-1}, respectively in 2010. As reported by Widanagamage, 2010 the conductivity measurements of the dumpsite leachate were within the range of 1.12 to 9.32 ms. TDS was within 2,000-6,000 mgL^{-1} range.

After the installation of leachate collecting piping network, the strength of the dumpsite leachate reduced. For instance, according to Wijesekara, (2012) average values for BOD and COD values were 380mgL^{-1} and 1,835 mgL^{-1} respectively in 2012. It can be deduced that biofilms have been formed with time on the inner surfaces of the leachate collecting system of backfill and slotted pipes. Thus, leachate itself is being treated within the dumpsite. Therefore, the strength of the dumpsite leachate during the study period was low as given in Table 01. The average COD concentration of dumpsite leachate was only 2,112±1,245 mgL^{-1}. The pH remained within 8.23±0.32, which indicates that the dumpsite is under methanogenic conditions.

Performance of the existing leachate treatment system

As reported by Gunarathne *et al.* (2010) the landfill bioreactor with clay-polythene-clay composite liner is capable of reducing the BOD concentration of leachate to less than 500 mgL^{-1}or even 250 mgL^{-1}. In the process of mineralization in the liner system, the COD reduced to 1,500 mgL^{-1} and as the required solid retention time (SRT) is achieved, it can even reach 800 mgL^{-1}. Therefore, the LTB was designed to treat high concentrated leachate. However, within in the dumpsite the leachate itself is purifying and treating to a great extent. So, the resulting strength of the leachate was not adequate to activate the LTB in an efficient and effective manner. Consequently, the treatment efficiency of the LTB is erratic and recorded low values as shown in Table 1. In fact negative performances were recorded in conductivity, salinity, BOD and TDS, indicating washing out of ions. The pH of the LTB effluent ranged between 6.6-9 thus indicates favourable conditions for anaerobic microbial activity. Further, the DO concentration of the LTB was very low (0.84±0.5 mgL^{-}). Therefore, the methanogenic activity of the LTB will be enhanced with the stabilization of the reactor, thus expected levels of treatment efficiency of the reactor will be achieved in the near future.

Table 1. Performances of the leachate treatment system during the study period

Parameter	Before rehabilitation[1]	Sampling point			Removal efficiency %		
		Inlet of LTB	Outlet of LTB	Outlet of CW	LTB	CW	Total
pH	8.2±0.1	8.23±0.32	7.8±1.2	7.98±0.24			
Conductivity (ms)	23.87±4.9	17.02±3.3	17.69±2.39	12.06±3.6	-7.9±25.54	30.09±26.07	30.09±26.07
Salinity (‰)	14.51±3.3	10.07±2.1	10.6±0.71	6.84±2.2	-10.36±23.82	35.76±19.78	29.33±25.76
DO (mgL^{-1})		0.67±0.55	0.84±0.5	1.71±1.32			
COD (mgL^{-1})	33,900±14,100	1905±109	1153.3±78	831±723	20.53±17.4	57.31±26.06	69.56±15
BOD (mgL^{-1})	7,500	367.5± 237	167.7±104.	42.7±25.48	-23.92±118.3	71.16±3.8	68.8±29.38
TS(mgL^{-1})		10.22±2.3	9.6±1.935	7.151±1.96	2.19±19	22.83±20.46	26.05±26.18
TDS (mgL^{-1})	13,3998±2,735	9557±201	10332±658	6723.04±215	-12.49±24.02	35.18±19.76	27.88±26.3
TSS (mgL^{-1})	39.51±28.3	0.951±0.6	0.643±0.41	0.358±0.279	48.06±21.83	27.02±61.82	59.95±30.7
VS (mgL^{-1})		2.531±0.9	2.093±0.4	1.664±0.265	4.77±48.9	19.55±15.79	21.7±49.57
VSS (mgL^{-1})		0.204±0.1	0.099±0.10	0.070±0.0229	68.97±30.74	60.02±28.06	63.77±18.8

[1]Menikpura *et al.*, 2008

At present, the effluent from the LTB is sent through subsurface CW and subsurface charcoal filter beds. In these wetlands, Cattail (*Typha latifolia*) plants were recently established. Although, porcupines attacked the plants many times, yet fast and vigorous growth could be observed. Therefore, the pollutant removal efficiency of the CW and the charcoal filter bed is improving with time. The CW is working better with the low inlet pollutant concentrations. Therefore, in order to reduce the incoming pollutant concentration to the wetlands, an activated sludge process reactor (ASP) followed by an algal pond in between LTB and CW were designed and now being constructed. The experience and knowledge gained in developing this low cost system could pave the way for rehabilitating dumpsites elsewhere in the country.

After the installation of leachate collecting piping network at Gohagoda dumpsite, the strength of the dumpsite leachate reduced indicating leachate itself is being treated within the dumpsite. It can be deduced that biofilms have been formed with time on the inner surfaces of the leachate collecting system of backfill and slotted pipes. Consequently, the resulting strength of the leachate was not adequate to activate the LTB in an efficient and effective manner that was designed to treat high concentrated leachate. Therefore, incorporation of an activated sludge process (ASP) and algal pond after the LTB could reduce the influent parameters, thus improve removal efficiency of the CW to meet the desired discharge standards.

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