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Formulation of Sub-Pollution Indices and Evaluation of Leachate Pollution Index of Pilot Scale Landfill Lysimeter

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Abstract: The principal concern of this study is to formulate the sub-pollution indices (sub-LPIs) and evaluate the individual and overall leachate pollutant index (LPI) of pilot scale landfill lysimeter at KUET campus, Bangladesh. To these endeavors, leachate samples from collection chamber of landfill lysimeter were sampling and the relevant parameters required for evaluating LPI were measured and monitored in the laboratory. Both the open dump and sanitary landfill conditions having a base liner and two different types of cap liner were simulated. Three sub-LPIs in terms of LPI in organic pollutant (LPI_{or}), LPI in inorganic pollutant (LPI_{in}) and LPI in heavy metals (LPI_{hm}) as well as overall LPI had been developed and reported. It can be noted that component of organic fraction in leachate for entire lysimeter operating system had highest against the other counter fraction i.e. inorganic and heavy metals fraction and consequently shows the highest LPI_{or} than that of LPI_{in} and LPI_{hm}. it can be observed that sub-LPIs and overall *LPI* has decreased in relation to the increasing of elapsed period of MSW deposited in landfill lysimeter. Results showed that collection system of sanitary lysimeter-A had the highest sub-LPIs and overall LPI than that of other lysimeter operating systems. Finally, it can be monitored that overall LPI was significantly high for entire lysimeter operating systems and proper treatment will be necessary before discharging the leachate into the water bodies.

Key words: Landfill lysimeter · Solid waste · Aggregation function · Sub-pollution indices · Leachate pollution index

INTRODUCTION

The term ‘landfill’ is used herein to describe a unit operation for final disposal of municipal solid waste (MSW) on land, designed and constructed with the objective of minimum impact to the environment [1]. The term ‘landfill’ can be treated as synonymous to ‘sanitary landfill’ of MSW, only if the latter is designed on the principle of waste containment and is characterized by the presence of a liner and leachate collection system to prevent ground water contamination. Sanitary landfill is one of the secure and safe facilities for the disposal of MSW [2]. Moreover, it is a well-suited method for managing of MSW all over the world and to investigate the performance of sanitary landfill the behavioral patterns namely; leachate generation, landfill gas (LFG) emissions etc. are required [3]. Lysimeter is a simulate form of sanitary landfill in the sense of control device. The word lysimeter is a combination of two Greek words *“Lusis” means “Solution”* and *“Metron” means “Measure”* and the original aim is to measure soil leaching [4]. As a result of the serious environmental problems associated with abandoned dump sites and the high costs of clean-up measures to deal with the contaminated sites, almost all countries have introduced regulations to safeguard the water aquifers from the leachate generated from the landfills [5].

Leachate is characterized by its high content of organic constituents, metals, acids, dissolved salts and microorganisms [6]. Containing hundreds of different chemicals, the characteristics of leachate vary significantly with respect to its composition, volume and

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Table 1: Specifications, operational conditions of lysimeter used to simulate different landfill conditions

lysimeter	*Operating condition*	*Refuse (kg)*	*Liner specification*	*Simulation*
A	Open dump lysimeter with leachate detection (A_1) system Open dump lysimeter with leachate collection (A_2) system	2860	400mm thick CCL as a barrier between leachate detection and collection system of lysimeter-A	present practice of open dumping
B	Sanitary landfill lysimeter with gas	2985	Cap liner-I (300mm thick CCL)	applicability of designed
C	collection and leachate recirculation system	2800	Cap liner-II (900mm thick natural top soil)	top cover

the presence of biodegradable matter and with time [7]. Leachate constitutes a flow that is highly aggressive and dangerous to the environment, with a contamination potential exceeding that of several industrial-waste materials. The indices allows for the representation of a complex set of information about ecosystem variables in a simple fashion [8]. A technique to quantify the leachate contamination potential of landfills on a comparative scale by using an index known *LPI,* has been developed and reported elsewhere [9]. LPI provides an overview of leachate contamination potential of a landfill on a comparative scale. In an effort to effectively communicate the dominating pollutants present in leachate sample, it was decided to subgroup the pollutants considered in the LPI. The formulation and applications of the sub-indices of the LPI (sub-LPIs) and the overall LPI using leachate characteristics of landfill lysimeter at KUET is presented in this paper.

Overview of Landfill Lysimeter: Three lysimeters designated as A, B and C were designed and hence constructed at KUET campus. The operational condition, liner specifications, simulation behaviour and the total weight of MSW deposited in each lysimeter can be obtained in Rafizul *et al*. [1] and presents in Table 1. The MSW deposited in each lysimeter mainly consists of 93 (w/w) organic (food and vegetables), 3 (w/w) of plastic/polythene and 2 (w/w) of leather/rubber, 1 (w/w) of animal bone and rubber/leather as well as 1 (w/w) of rope/straw and egg pill. However, the organic and moisture content of MSW was found 52 and 65%, respectively and the total volume was 2.80 m^3 (height 1.6 m) with a manual compaction to achieve the unit weight of 1,064 kg/m^3. At the bottom of each lysimeter, a concrete layer of 125 mm thickness was provided then the lysimeter was filled with stone chips (diameter 5-20 mm) and coarse sand (diameter 0.05- 0.4 mm) to the height of 15cm of each to ensure uniform and uninterrupted drainage. At the base of each lysimeter after placing the perforated leachate collection pipe, a geo-textile sheet having 0.60 m wide and 1.65 m length was placed to avoid a rapid clogging by the sediments.

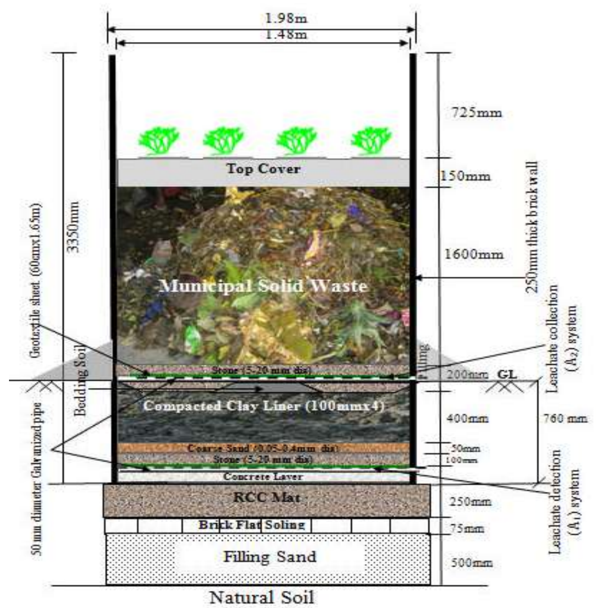

Fig. 1: Schematic diagram of open dump lysimeter-A

Landfill lysimeter-A (Open Dump: In open dump lysimeter-A, a compacted clay liner (CCL) of 400 mm thickness was placed as the base liner and a layer of compost of 150 mm thick was used as the top cover to simulate the behaviour of present practice of open dumping in Bangladesh shown in Fig. 1. This lysimeter was operated at two operational condition in terms of leachate detection (A_1) and collection (A_2) system. In lysimeter-A, MSW was not covered by a top cover to pervert the movement of air, water and LFG. Moreover, the thickness of MSW is such that it is expected the atmospheric air can move in the entire MSW deposited in this cell with negligible inference. Due to the mentioned practical situations, lysimeter-A represents an open dump condition.

Sanitary Landfill lysimeter-B (Cap liner I): In sanitary lysimeter-B, characteristics and volume of MSW was similar to that of open dump lysimeter-A. However, it differs with open dump lysimeter-A, by a top cover and without a base liner, because this cell aims to examine

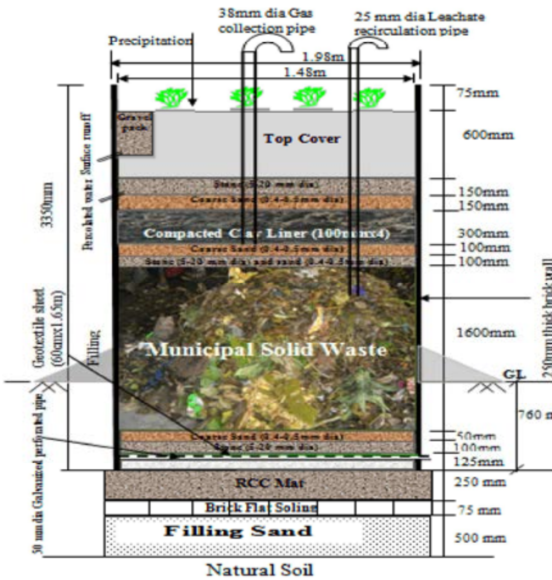

Fig. 2: Schematic diagram of sanitary landfill lysimeter-B

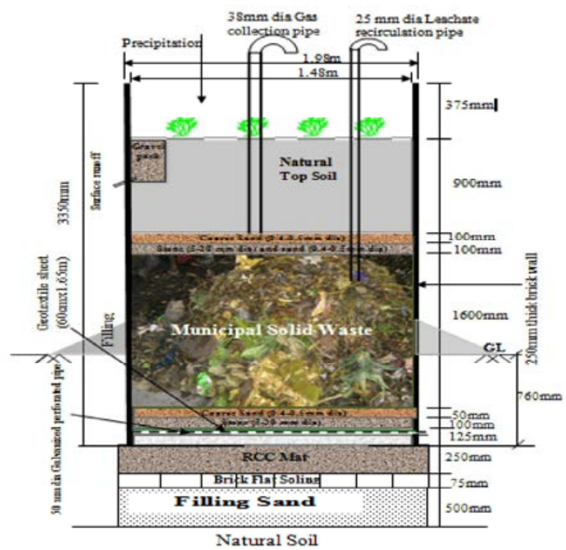

Fig. 3: Schematic diagram of sanitary landfill lysimeter-C

the applicability of the designed top cover to simulate the sanitary landfill condition. The top cover consists of stone chips (diameter 5-20 mm) and coarse sand (diameter 0.05- 0.4 mm) layer each of 100 mm thickness, then a 300 mm CCL was provided. On the CCL, there were 150 mm thick coarse sand (diameter 0.05-0.4 mm) and 150 mm thick stone chips (diameter 5-20 mm), which was followed by 600 mm thick top soil shown in Fig. 2. Due to the above mentioned practical situations, lysimeter-B represents a sanitary condition and flow rate and composition of LFG is measure. In lysimeter-B, 38 mm dia. of gas collection and 25 mm dia. of leachate recirculation pipe were installed.

Sanitary Landfill Lysimeter-C (Cap liner II): In sanitary landfill lysimeter-C, there was also no base liner and the provided top cover was different than that of sanitary landfill lysimeter-B. In this lysimeter no CCL was used; however, 900 mm thick natural topsoil was used instead of 300 mm thick CCL and 600 mm thick top soil shown in Fig. 3. Moreover, the drainage and gas collection layers were remained same as the sanitary landfill lysimeter-B. Designated compaction of the CCL in the lysimeter means the degree of compaction which was provided in the pilot scale sanitary landfill (PSSL) at Rajbandh, Khulna. To achieve the designated compaction at the CCL of lysimeter, locally manufactured hammer similar to that used in the PSSL was employed.

MATERIALS AND METHODS

In this study, to derive sub-leachate pollution indices as well as individual and overall pollutant rating of landfill lysimeter, the detailed procedure advocated by Kumar and Alappat [9] was followed and hence discussed in followings.

Concept of Leachate Pollution Index: The LPI represents the level of leachate contamination potential of a given land?ll. It is a single number ranging from 5 to 100 (like a grade) that expresses the overall leachate contamination potential of a land?ll based on several leachate pollution parameters at a given time.

Variables Weight Facors and Curves: The weight factor indicates the importance of each pollutant variable to the overall LPI provided in Table 1.The averaged sub-index curves for all the pollutant variables have been reported by Kumar and Alappat [9].

Variable Aggregation Function: The weighted sum linear aggregation function was used by Kumar and Alappat [9] to sum up the behavior of all the leachate pollutant variables. However, Panelists suggested that if the concentrations of the *eighteen (18)* selected variables are known, the following *Equation (1)* is used. Otherwise, *Equation (2)* is used.

$$LPI = \sum_{i=1}^{n} w_i p_i \quad (1)$$

LPI = the weighted additive leachate pollution index, w_i = the weight for the I^{th} pollutant variable, p_i = the sub-index value of the I^{th} leachate pollutant variable, number of leachate pollutant parameters, n =18 and ? w_i=1.

Table 2: Weight factors of leachate parameters (after Kumar and Alappat [9])

Index	Parameters	Weight factor
$LPI_{organic}$ (LPI_{or})	Chemical oxygen demand (COD)	0.267
	Biological oxygen demand (BOD_5)	0.263
	Phenol compound	0.246
	Total coliform bacteria (TCB)	0.224
	Summation	1.000
$LPI_{inorganic}$ (LPI_{in})	pH	0.214
	Total kjeldahl nitrogen (TKN)	0.2060
	Ammonia nitrogen (NH_4-N)	0.198
	Total dissolved solid (TDS)	0.195
	Chloride (Cl^-)	0.187
	Summation	1.000
$LPI_{heavy\ metal}$ (LPI_{hm})	Total chromium (Cr)	0.125
	Lead (Pb)	0.123
	Mercury (Hg)	0.121
	Arsenic	0.119
	Cyanide	0.114
	Zinc (Zn)	0.11
	Nickel (Ni)	0.102
	Copper (Cu)	0.098
	Total iron (Fe)	0.088
	Summation	1.000

$$LPI = \frac{\sum_{i=1}^{m} w_i p_i}{\sum_{i=1}^{m} w_i} \quad (2)$$

Pollutant parameter for which data is available in this study, m < 18 and $\sum_{i=1}^{m} w_i < 1$.

Sub-indices of Leachate Pollution Index: To make LPI is more informative and useful among the scientific community and field professionals, the LPI may be subdivided into three sub-indices in terms of LPI in organic pollutant (LPI_{or}), LPI in inorganic pollutant (LPI_{in}) and LPI in heavy metal (LPI_{hm}) provided in Table 2. In the group of LPI_{or}, organic compounds are normally composed of a combination of carbon, hydrogen and oxygen, with nitrogen in some cases. In this group, pollutants selected for sub-LPI are BOD_5, COD, phenol compounds and TCB. The weight factors for the pollutants in *LPIor* have been recalculated on a scale of 1 (Table 2). In contrary, chlorides, alkalinity, various forms of nitrogen, phosphorous, sulphur, pH, heavy metals, gases like hydrogen sulphide and methane, etc. constitute the inorganic component of leachate. The LPI inorganic component consists of Cl^-, pH, NH_4-N, TKN and TDS. The weight factors for the pollutants in LPI_{in} have been recalculated on a scale of 1 as if LPI_{in} is an absolute index. Moreover, many metals such as Cr, Pb, Zn, Ni, Cu, Fe and Hg are important constituents and considered in LPI_{hm} group. Two non-metal pollutants, arsenic and cyanide have also been included in this sub-group.

Calculation of Sub-Pollution Indices and Overall LPI: For calculating sub-LP) and overall LPI, the following steps were followed:

- Concentration of fifteen (15) parameters were measured and monitored in the laboratory at a regular interval of time up to the elapsed period 900 days. Moreover, the concentration of leachate at elapsed period 7 days is provided in Table 3, column 4.
- Then evaluating sub-index scores (*pi*) of all the pollutants based on variables rating curves with respect to their concentration (Table 3, column 5).
- The sub-pollution indices in terms of LPI_{or}, LPI_{in} and LPI_{hm} are calculated using the weight factors given in Table 2 based on the aggregation function from Equation (2) (Table 3, column 6).
- Finally, the aggregation of three sub-*LPIs* gets the overall *LPI*. The three sub-*LPI* are aggregated for calculating overall *LPI* using Equation (3).

Table 3: Characteristics of leachate, sub-*LPI* and overall *LPI* landfill lysimeter at elapsed period 7 day

			Pollutant concentration, c_i(4)				Individual pollutant rating, p_i(5)				Overall pollutant rating, w_ip_i(6)			
Index (1)	Parameter (2)	Weight factor, w_i(3)	A_1	A_2	B	C	A_1	A_2	B	C	A_1	A_2	B	C
LPI_{or}	COD	0.267	22650	60000	60000	56490	84	94	94	93	22.43	25.10	25.10	24.83
	BOD_5	0.263	2080	2860	2790	2286	41	46	45	42	10.78	12.10	11.84	11.05
	Phenol	-	-	-	-	-	-	-	-	-	-	-	-	-
	TCB	0.224	6540	8280	8200	8230	85	89	90	90	19.04	19.94	20.16	20.16
	Total	0.754									52.25	57.13	57.09	56.04
LPI											69.30	75.77	75.72	74.32
LPI_{in}	pH	0.214	6.87	7.87	7.92	7.38	6.0	5.0	5.0	6.0	1.28	1.07	1.07	1.28
	TKN	0.206	1010	2180	1430	1340	33	78	50	45	6.80	16.07	10.30	9.27
	NH_4-N	0.198	705	897	997	920	77	95	99	97	15.25	18.81	19.60	19.21
	TDS	0.195	9876	35670	29120	26580	21	83	69	63	4.10	16.19	13.46	12.29
	Cl^-	0.187	3037	3572	1350	760	23	31	12	8	4.30	5.80	2.24	1.50
	Total	1.000									31.72	57.93	46.67	43.54
LPI											31.72	57.93	46.67	43.54
LPI_{hm}	Cr	0.125	0.08	0.21	0.17	0.09	5.0	5.0	5.0	5.0	0.63	0.63	0.63	0.63
	Pb	0.123	0.41	0.55	0.92	0.65	7.0	7.0	9.0	8.0	0.86	0.86	1.11	0.98
	Hg	-	-	-	-	-	-	-	-	-	-	-	-	-
	As	0.119	0.01	0.04	0.03	0.02	5.0	5.0	5.0	5.0	0.60	0.60	0.60	0.60
	Cn	-	-	-	-	-	-	-	-	-	-	-	-	-
	Zn	0.11	1.40	1.50	0.98	0.65	5.5	5.0	5.0	5.0	0.61	0.55	0.55	0.55
	Ni	0.102	0.10	0.19	0.13	0.12	5.0	5.0	5.0	5.0	0.51	0.51	0.51	0.51
	Cu	0.098	1.30	1.60	1.10	1.20	7.0	7.0	7.0	7.0	0.69	0.69	0.69	0.69
	Fe	0.088	25.90	45.70	43.50	38.70	5.5	6.0	6.0	6.0	0.48	0.53	0.53	0.53
	Total	0.765									4.37	4.36	4.60	4
LPI											5.71	5.69	6.01	5.85
	LPI	$(0.175LPI_{or}+0.257LPI_{in}+0.391LPI_{hm})/0.823$								*27.35*	*36.91*	*33.53*	*32.18*	

All values in mg/L except pH and total coliform unit (cfu/100ml)

$$LPI = (0.175LPI_{or}+0.257LPI_{in}+0.391LPI_{hm})/0.823 \quad (3)$$

Where *LPI* is the overall *LPI*, LPI_{or} is the sub-leachate pollution index of organic component; LPI_{in} for inorganic component and LPI_{hm} for of heavy metal in leachate. Here, it can be noted that Equation 3 has been derived based on weight factors of pollutants and their contribution to each sub-*LPI*. However, component of organic, inorganic and heavy metal is 17.5, 25.7 and 39.10 % for evaluating overall *LPI* and used to derive the Equation 3.

RESULTS AND DISCUSSIONS

Table 3 illustrates the calculation of sub-LPI and overall *LPI* for a particular elapsed period of 7 days of leachate sampling. The detection (A_1) and collection (A_2) system of open dump lysimeter-A as well as the collection system of sanitary landfill lysimeter-B and C had the highest component of organic fraction against the other counter fraction i.e. inorganic and heavy metal fraction (Table 3). Consequently, all the lysimeter operating system shows the highest LPI_{or} than that of LPI_{in} *and* LPI_{hm} provided in Fig. 4. Moreover, Table 2 reveals that organic fraction for A_2 system of lysimeter-A was highest and consequently the highest LPI_{or} than the other operating system provided in Fig. 5.

Table 3 shows that values of BOD_5, TKN, TCB, TDS, chloride, Cr, As, Zn, Ni, Cu and Fe was highest and consequently the highest individual and overall LPI for collection (A_2) system of lysimeter-A. A significant difference between individual and cumulative pollution ratings for both the collection system of open dump lysimeter-A and sanitary lysimeter-C was observed due to the distinct difference in their concentrations (Table 3). All the concentrations except Cl^-, Zn and Cu were lower for the A_1 system of lysimeter-A than that of collection system of lysimeter-A, B and C and has lowest individual and cumulative pollution rating and consequently lower LPI shown in Fig. 6. Here, it can be established that variation of leachate concentration in case of A_1 and A_2 system may be occurred due to the providing of 400 mm thick CCL as a barrier between the detection and collection system of lysimeter-A. As the A_2 system of lysimeter-A was provided just below the MSW deposited in lysimeter-A and the followed A_1 was seperated with the 400 mm thick CCL and this operational mode may be

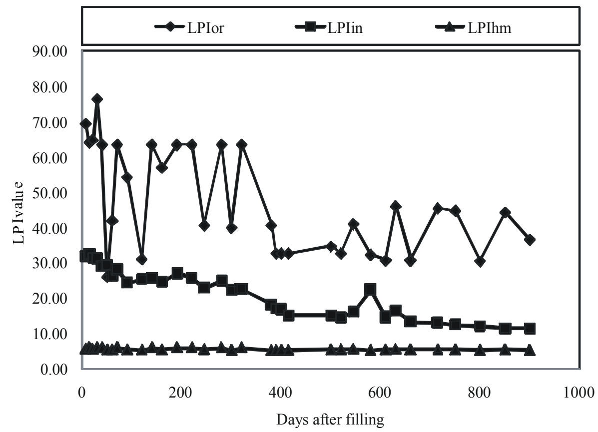

Fig. 4: Sub-pollution indices of lysimeter.

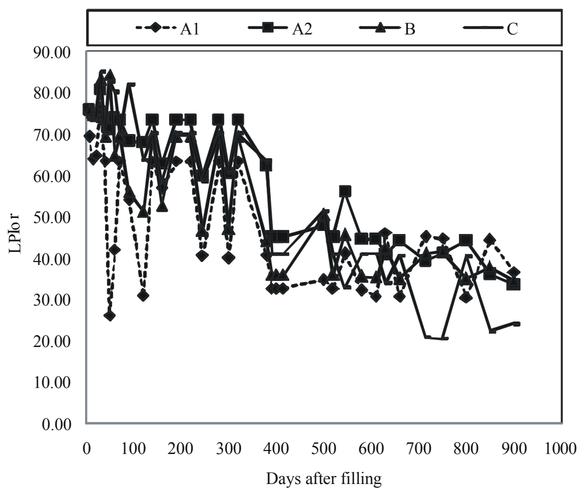

Fig. 5: LPI in organic pollutant of open dump and sanitary lysimeter.

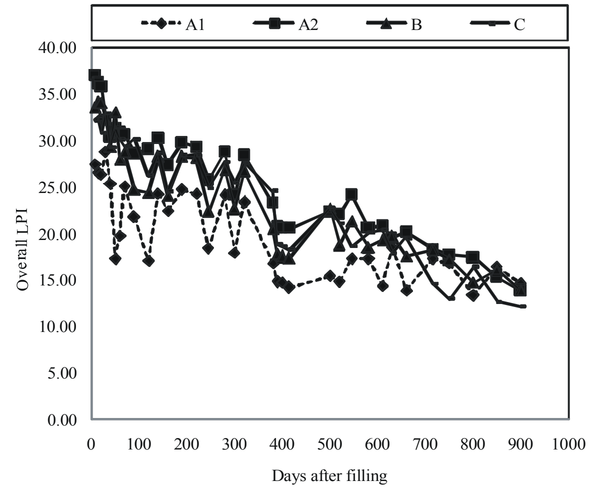

Fig. 6: Overall LPI of open dump and sanitary landfill lysimeter.

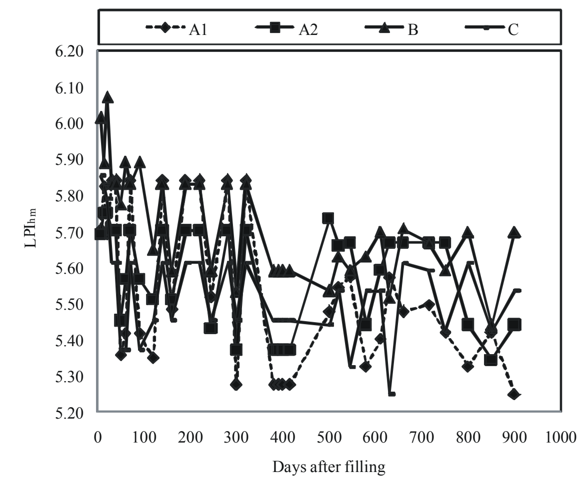

Fig. 7: LPI in heavy metal of open dump and sanitary landfill lysimeter.

considered for the variation of leachate concentration. Moreover, the variation for the collection system of lysimeter-A and B may be occurred due to the simulation behaviour of open dumping and providing the base liner in open dump lysimeter-A as well as sanitary landfill and providing the cap liner in lysimeter-B. In contrary, the variation of leachate concentration (Table 3) for collection system of sanitary lysimeter-B and C may be occurred due to difference of lysimeter-B and C in terms of thickness and compaction conditions of cap liner.

The LPI of A_2 system of lysimeter-A is slightly higher than the collection system of lysimeter-C but both these lysimeters have higher LPI than the collection system of lysimeter-B (Fig. 6). This can be ascribed to the lower individual pollution ratings of A_1 system of lysimeter-A due to the relatively lower concentrations of all the pollutants except Cl^-, Zn and Cu. Here, it of interested to note that *LPI* has decreased in relation to the increasing of elapsed period provided in Fig. 6. The overall LPI was higher for A_2 system of lysimeter-A because of the higher concentration of pollutant has the highest individual and cumulative pollution rating and consequently the higher LPI than the other operational system. Here, it is important to note that standards for the disposal of treated leachate to water as per the Management and Handling Rules (The Gazette of India 2000) should not exceed 2.0, 0.1, 250, 0.01, 30, 0.20, 0.20, 1.0, 5.0, 5.5-9.0, 100, 3.0, 50.0, 2100, 3.0 and1000 for Cr, Pb, COD, Hg, BOD_5, As, Cn, Phenol, Zn, pH, TKN, Ni, NH_3-N, TDS, Cu and Cl^- concentration and their corresponding overall *LPI* of 7.38. The comparison of leachate characteristics with the standards for the disposal of treated leachate verifies the fact that the leachate generated from A_2 system of lysimeter-A is

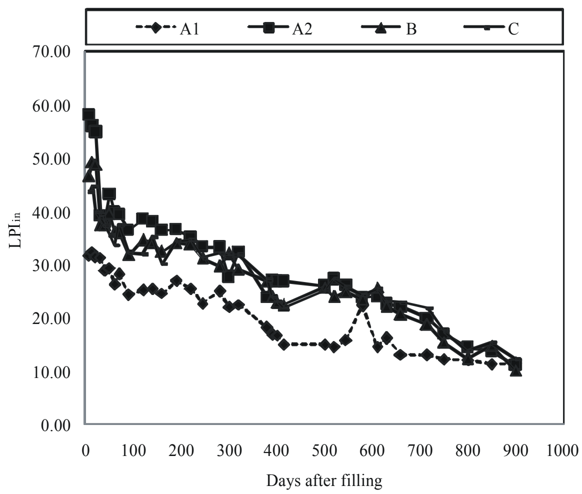

Fig. 8: LPI in inorganic pollutant of open dump and sanitary landfill lysimeter.

highly contaminated and *LPI* for entire lysimeter operating system exceed the *LPI* of treated leachate of 7.38. The high *LPI* demands that leachate generated from landfill lysimeter should be treated.

Moreover, it can be depicted that the comparatively lower LPI_{hm} for entire lysimeter operating system (Fig. 4) are attributable to low concentrations of heavy metals in leachate (Table 2). Moreover, due to the lower concentration of heavy metal for the A_1 system of lysimeter-A, consequently shows the lowest LPI_{in} provided in Fig. 7. In contrary, comparetively the higher inorganic compound than heavy metal implies the highest LPI_{in} than that of LPI_{hm} (Table 2). Moreover, comparatively the higher inorganic compounds implies the highest LPI_{in} for the A_2 system of lysimeter-A shown in Fig. 8.

CONCLUSIONS

LPI is a good tool and it provides an evocative method of evaluating contamination potential of solid waste disposal sites. Moreover, LPI can be a useful tool to monitor the leachate trends over the lifetime of landfill site and thus can help to take necessary decisions as deem fit. Result reveals that component of organic fraction in leachate for entire lysimeter operating system had highest against the other counter fraction i.e. inorganic and heavy metal fraction and consequently shows the highest LPI_{or} than that of LPI_{in} and LPI_{hm} Result reveals that open dump lysimeter had the highest LPI than other counterparts and it also found that the clay liner system of landfill lysimeter protect the migration of contaminant thus producing the lowest value of LPI. Finally, it can be concluded that entire landfill lysimeter is highly contaminated, so proper treatment of leachate must be ensured before discharging into natural streams to protect the environment.

REFERENCES

1. Rafizul, I.M. and M. Alamgir, 2012. Characterization and Tropical Seasonal Variation of Leachate: Results from Landfill Lysimeter Studied. Journal of Waste Management, 32(11): 2080-2095.
2. Davis, M.L. and D.A. Cornwell, 1998. Introduction to Environmental Engineering. Third Edition. New York, McFraw-Hill International.
3. Visvanathan, C., J. Trankler, P. Kuruparan and Q. Xiaoning, 2002. Influence of Landfill Operation and Waste Composition on Leachate Control: Lysimeter Experiments under Tropical Conditions. 2nd Asian Pacific Landfill Symposium, Seoul Korea, Session 4.
4. Rafizul, I.M., M. Alamgir, M.K. Howlader, E. Kraft and G. Haedrich, 2009. Construction and Evaluation of Sanitary Landfill Lysimeter in Bangladesh. International Conference on SWM, Technical, Environment and Socio-Economical Contexts, WasteSafe 2009, KUET, Bangladesh, pp: 475-484.
5. Rafizul, I.M., M. Alamgir and M.M. Islam, 2011. Evaluation of Contamination Potential of Sanitary Landfill Lysimeter using LPI. Thirteenth Int. Waste Management and Landfill Symposium, Sardinia 2011, Cagliari, Italy.
6. Orta, D.V., M.T.R.C. Cruz, N.R. Valencia, I.M. Ramirez and J.C. Gomez, 2003. Serial Water Balance Method for Predicting Leachate Generation in Landfills. Waste Management and Research, 21: 127-136.
7. Chu, L.M., K.C. Cheung and M.H. Wong, 1994. Variations in the Chemical Properties of Landfill Leachate. Environmental Management, 18: 105-117.
8. Zandbergen, P.A. and K.J. Hall, 1998. Analysis of the British Columbia Water Quality Index for Watershed Managers: A Case Study of Two Small Watersheds, Water Quality Research Journal of Canada, 33: 519-549.
9. Kumar, D. and B.J. Alappat, 2003. A Technique to Quantify Landfill Leachate Pollution. Proc. Ninth International Landfill Symposium, Cagliari, Italy.
10. Government of India (ed.), 2000. Municipal Solid Wastes (Management and Handling) Rules. The gazette of India, Ministry of Environment and Forests, Gov. of India, Delhi, India.

Persian Abstract

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چکیده

هدف اصلی این تحقیق فرمول بندی کردن شاخص‌های زیر مجموعه آلاینده‌ها (sub-LPIs) و ارزیابی شاخص آلاینده شیرآبه کلی و اختصاصی (LPI) lysimeter محل دفن زباله مقیاس پیلوت در محدوده کوئت بنگلادش می باشد. برای این منظور نمونه های شیرآبه جمع آوری و نمونه برداری شد و پارامترهای مرتبط مورد نیاز برای ارزیابی LPI اندازه گیری شد. دفن زباله روباز و دفن زباله با شرایط بهداشتی یک بستر پایه برای عدم نفوذ شیرآبه به بستر داشتند و دو نوع پوشش فوقانی متفاوت شبیه سازی شد. سه sub-LPIs به صورت LPI در آلاینده آلی (LPI_{or})، LPI در آلاینده معدنی (LPI_{in}) و LPI در فلزات سنگین و همچنین مجموع LPI تکامل یافته و گزارش گردید. قابل ذکر است که ترکیب اجزاء آلی در شیرآبه حاصل از سیستم‌های اجرایی بیشترین مقدار LPI را نسبت به اجزا معدنی و فلزات سنگین را داشته است و متعاقبا LPI_{or} بیشتری را نسبت به LPI_{in} و LPI_{hm} نشان داد. می توان مشاهده نمود که با افزایش دوره سپری شده زباله شهری ته نشین شده در شیرآبه، sub-LPIs و LPI کل کاهش یافته است. نتایج نشان داده است که سیستم جمع آوری بهداشتی sub-LPIs و مجموع LPI بیشتری نسبت به بقیه سیستم‌ها داشته است. بعلاوه مجموع LPI برای تمامی سیستم‌ها به طور قابل توجهی بالا بوده و تصفیه مناسب قبل از تخلیه شیرآبه به محیط آبی مجاور ضروری می باشد.