OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

ASSESSMENT OF LEACHATE POLLUTION INDEX FOR DELHI LANDFILL SITES, INDIA

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Abstract: **Managing municipal solid waste is a serious environmental problem degrading the air, water and soil. The increased generation of the solid waste on daily basis is result of increased population as well as economic activities due to industrialization. In most of the countries the solid waste is not managed scientifically starting from generation point to the landfill sites. In Delhi, the municipal solid waste generation presently is about 9000 metric tons (MT) per day and it has been projected that by 2021 it will be around 18000metric tons. The Physico-chemical characterization has been documented and based on these the Leachate Pollution Index (LPI) have been estimated for three landfill sites in Delhi i.e. Gazipur, Okhla and Bhalswa. From this analysis it has been estimated that Bhalswa landfill site located in North Delhi has the highest LPI followed Okhla and Gazipur landfill sites. However, there is no significant difference between the LPI values for these landfill sites. The application of LPI provides a better insight for the strength of various pollutants and can be useful to the experts in deciding various leachate treatment and management practices.**

Keywords *– Municipal Solid Waste, Landfil, Leachate; Leachate Pollution Index.*

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I INTRODUCTION

Municipal solid waste landfills are major contamination threats to water body's resources throughout the world. Increased population growth particularly in the cities due to various reasons and development and growth of industries in the manufacturing hubs of the country significantly contributed to the increased solid waste generation per capita per day. The daily solid waste per capita has been documented by various investigators though their estimates vary. Also, due to improper waste disposal and collection systems dwellers are facing negative environmental impacts in Indian cities. The major problems facing in the municipal solid waste management is related to the production and treatment of the landfill leachate [1].

From the landfill sites, the leachate, a contaminated liquid, varying in composition and characteristics seeps out and percolate through the underlying soils contaminating the groundwater resources. This leachate consists of inorganic and organic compounds as well as suspended particles. Based on the climatic conditions the leachate flow drastically increases (during rainy season) or reduce (during dry season). The municipal solid waste landfill leachate discharge may cause environmental degradation of soil and water resources especially when the landfill are not scientifically design mainly the design and specification of liners used in this landfill. The organic matter present in the MSW undergoes degradation mainly due to the physical, chemical and biological processes contribute to the damage to the liners leading to leakage of the leachate to the soil and ultimately to the water bodies [2].

As the solid wastes of different composition are dumped daily over an area, the solid waste composition varies from location to location within the landfill and also it varies with respect to time at the same locations within the landfill sites. Which leads to leachate discharge of the different composition and characteristics with respect to space and time. Also, the rainfall amounts occurring over the landfill sites also contribute to variation in the leachate composition. The leachate characteristics mainly depends of MSW penetration such as segregation of dry waste like metals, plastic, batteries, paper, cardboard, glass, rubber, leather, etc.

Besides these, there are other factors which have been documented by several researchers. The generated

leachate from a landfill may tend to migrate in surrounding soil and may lead to contamination of soil and water bodies. Once groundwater is contaminated it is very difficult or if not possible to treat. As the leachates from the landfill sites degrades the quality of the water sources and the use of this resources discontinued particularly the shallow wells as appropriate technologies and practices have not been adopted properly and well in time. Therefore, identification of the landfills which need urgent attention should be made by assessing them with respect to their potential effects due to leachate hazards. The potential hazards of the leachate can be estimated by an index knows Leachate Pollution Index (LPI). Thus the purpose of this study was for evaluation of the leachate pollution index for three Delhi landfills: Okhla, Gazipur and Bhalswa.

II METHODOLOGY

LPI is a simple and tool for assessing the potential hazards of the leachate from the landfill sites located in Delhi i.e. Okhla, Gazipur and Bhalswa landfill sites. The concept and development of LPI has been documented properly elsewhere by Kumar and Alappat [3]. The brief description of LPI is as under:

$$LPI = \sum_{i=1}^{n} WiPi \qquad (1)$$

Where, Wi and Pi are the weight and sub-index values of the i^{th} leachate pollutant variable, respectively and n is the total number of pollutant variables. If the number of total pollutant variables is equal to 18 then the total weight of the pollutant is equal to 1 and the LPI can be estimated using Eq. (1). In case, the number of pollutant variables less than 18 then for the estimating the LPI, Eq. (1) is divided by the total value of weights of the pollutant variables and so the LPI under this circumstances is described as under:

$$LPI = \frac{\sum_{i=1}^{m} WiPi}{\sum_{i=1}^{m} Wi} \qquad (2)$$

Where m is less than n.

III SITE DETAILS

Delhi is a massive metropolitan area in the northern India and these 3 landfill sites are located at different places i.e. Gazipur, Okhla and Bhalswa landfill sites located in East Delhi, South Delhi and North Delhi, respectively. The climate of Delhi is extreme and average rainfall is about 500mm which is about half the national average. The city has a population of around 27 million as per census of India 2016, second most crowded city after Mumbai and third biggest urban range on the planet. Delhi city generates about 9,000 metric tons of solid waste per day out of which 60% is disposed in the landfill. The main waste generated in Delhi is from the markets, retail and commercial markets, hospitals, slaughter houses, industries and construction and demolition wastes. Location of three landfill site in Delhi map is shown in figure 1. The details of the landfills sites as shown in table 1:

Table 1 Details of landfill sites

Name	Area hectares	MSW received tons per day
Gazipur	29.62	2100
Bhalswa	26.22	3200
Okhla	22.89	1200

Figure 1 Location of Landfill site in Delhi map (Courtesy: Google earth images)

IV RESULTS AND DISCUSSION

LPI values were calculated for various landfills site of Delhi. In the month of October the leachate sampling and analysis was carried out for three Delhi landfill sites viz Bhalswa, Okhla and Gazipur. The Physico chemical analysis of Delhi landfill leachate were collected and analyzed in Jamia Millia Islamia Lab by Syed et al. [4].

The LPI values as estimated are tabulated in Tables 2, 3 & 4 for different landfill sites. From the results of the samples it was observed that they were not even traces of cyanide, mercury and arsenic. Therefore, in this analysis the weight age for these leachate pollutants have not been taken into consideration while estimating the LPI values for these landfill sites.

The concentrations of organic and inorganic compounds parameters were found to be high in Bhalswa landfill leachate sample. Also, BOD and COD of the Bhalswa landfill site were high and its range varies from 3300mg/l to 5840mg/l, Gazipur an Okhla landfill leachate samples have relatively less BOD and COD. Furthermore, high concentration in Okhla landfill leachate sample such as chlorides and TKN in comparison to Bhalswa and Gazipur landfill leachate samples were observed.

Table 2 LPI for the landfill leachate of Bhalswa

Pollutant, ppm	Leachate	Wi	Pi	PiWi
pH	8.1	0.055	5	0.276
TDS	11284	0.050	8	5.020
BOD_3	3300	0.061	55	4.781
COD	5840	0.062	80	5.727
Total Kjehldahl nitrogen	46.1	0.053	95	0.529
Ammonia Nitrogen	34.6	0.051	100	0.510
Iron	41.6	0.044	5	0.445
Copper	0.95	0.050	5	0.249
Nickel	0.45	0.052	5	0.313
Zinc	1.35	0.056	5	0.338
Lead	0.56	0.063	5	0.316
Chromium	1.84	0.064	10	2.422
Chlorides	49.1	0.048	5.3	0.967
Final LPI value			30.80	

Table 3 LPI for the landfill leachate of Gazipur

Pollutant ppm	Leachate	Wi	Pi	(PiWi)
pH	7.6	0.055	5	0.275
TDS	9636	0.050	100	5.02
BOD_3	2757	0.061	70	4.29
COD	4400	0.062	82	5.10
TKN	46.2	0.053	10	0.529
Ammonia Nitrogen	25.9	0.051	12	0.613
Iron	7.5	0.044	5	0.222
Copper	0.6	0.050	5	0.249
Nickel	0.25	0.052	6	0.313
Zinc	0.4	0.056	6	0.338
Lead	ND	0.063	0	0
Chromium	0.4	0.064	5	2.42
Chlorides	38.4	0.048	17	0.82
Final LPI value			28.41	

The results revealed that the Bhalswa landfill leachate sample has high LPI value when compared with Gazipur and Okhla landfill leachate samples. However, Gazipur and Okhla landfill leachate samples found to be relatively same order of LPI.

Table 4 LPI for the landfill leachate of Okhla

Pollutant, ppm	Leachate	Wi	Pi	(PiWi)
pH	8.1	0.055	5	0.275
TDS	11135	0.050	100	5.02
BOD_3	2825	0.061	70	4.29
COD	4560	0.062	80	4.98
TKN	53.3	0.053	13	0.688
Ammonia Nitrogen	29.5	0.051	8	0.408
Iron	10.2	0.044	5	0.222
Copper	0.54	0.050	5	0.249
Nickel	0.31	0.052	5	0.261
Zinc	0.56	0.056	5	0.282
Lead	ND	0.063	5	0.0
Chromium	0.75	0.064	5	0.319
Chlorides	56.8	0.048	30	1.450
Final LPI value			**25.95**	

V CONCLUSION

Bhalswa landfill leachate sample has high LPI value followed by Gazipur and Okhla landfill leachate samples.

Based on the physicochemical characteristics of these landfill sites it has been observed that the solid waste dumped at Bhalswa landfill site is mostly the municipal solid waste.

The LPI value was observed to be 30.80 at Bhalswa landfill site followed by Okhla and Gazipur landfill site. However, the LPI values at all the three landfill sites lies in the same range.

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