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Leachate Characters and Impact at Bhalswa Landfill Site in Delhi, India

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ABSTRACT

A liquid which drained or leaches through the waste at a landfill site is known as leachate. Leachate from a landfill varies widely in composition depending on the age of the landfill and the type of waste that it contains. It can usually contain both dissolved and suspended material. This study concentrate on the composition of various parameters of leachate collected from a highly saturated sanitary landfill sites at Bhalswa, Delhi. it has been found that Bhalswa landfill leachate have highest concentration of different parameters such as total dissolve solid, total solid and electrical conductivity i.e., 9890 mg/l, 12580 mg/l and 14892 mho/cm respectively. These results will be helpful in future for determination of expected impact on ground water and biodiversity due to generation and percolation of leachate. This study will also be helpful to deal with the possible low cost treatment methods.

Keywords: *Organic Matter; Heavy Metals; Landfill; Leachate; TDS, TSS.*

1.0 Introduction

The fast urbanization and economic growth in recent years leads to excessive municipal solid waste generation in the cities and creating a serious environmental problem in the world. It needs to be focused urgently for environmental protection. Almost all the countries collected their Municipal solid waste to be disposed to any landfill site[1-6] solid waste undergoes many physical chemical and biological changes on a landfill site, this process degrade the organic fraction of the waste along with the moisture content and suitable temperature. The percolating rain water leads to generation of a highly contaminated liquid called leachate, which contain large amount of organic matter like Ammonia nitrogen, heavy metal and chlorinated organic compound with inorganic salt. The composition and characteristic of landfill leachate varies with the age, precipitation waste type and composition and weather variation. That can be classified into three types based on the landfill leachate: old, intermediate and young. The classification and characteristic of landfill leachate is given in the table-1, (30). BOD and COD of young leachate is generally found high (4000-13000 mg/l) and (30000-60000 mg/l) respectively. BOD/ COD ratio ranging from 0.4 to 0.7, ammonium nitrogen varies 500 to 2,000 mg/l The pH found to be very low up to 4 with VFAs (10) As the landfill age increases and the fatty acid decomposition buy anaerobic bacteria it's about a period of 10 years it changes the characteristics of the leachate with a low COD ,less than 4000 mg per liter and pH range is 7.5 - 8.5 with low biodegradability(BOD5/COD <0.1) and high molecular weight compound[7-11]. For toxic analysis, different test organisms were used like Vibrio fischeri, Daphnia similes Artemia Salina and Brachydanio Rerio, which the standard for receiving water. In the early 1970 so many studies in Laboratories has been carried out for the effectiveness of various treatment method like biological physical and chemical processes on landfill leachate Biological treatment process is including anaerobic and aerobic processes are quite effective for leachate generated in the early stage with a high BOD/COD. However, for very low BOD/ COD ratio and higher concentration of toxic metals an aerobic process is not very effective [12-21]. Hence the physical and chemical processes are being used as a pre-treatment or the post treatment for this type of

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landfill leachate. After so many experiments and study is done by the researcher it concluded that the advanced oxidation process (AOPs) is the most suitable and easy chemical process by which the quality of landfill leachate can be improved. The advanced oxidation process can grade a variety of refractory compounds in landfill leachate [17]. The concept of the advanced oxidation process is based on the generation of highly reactive hydroxyle radical (.OH) as an oxidant. The different method like Ozone oxidation fenton oxidation and electrochemical oxidation system can generate or produce the radicals. Hydroxyl radical with an oxidation potential of 2.80 V (Table 1) can degrade recalcitrant organic such as aromatic, chlorinated and phenolic compound [18]. As soon as ozone or H_2O_2 initiate free radical a series of Oxidation reaction occurs in the solution and the radical rapidly react with the most of the target compounds, the rate of reaction depends upon the concentration of radical and pollutants, temperature, pH as well as the presence of scavengers such as bicarbonate ion [19]

Table 1: Landfill Leachate Classification Versus Age [8, 9]

TYPE OF LEACHATE		YOUNG	INTERMEDIATE	OLD
1.	AGE (YEARS)	<5	5-10	>10
2.	PH	<6.5	6.5-7.5	>7.5
3.	COD (MG/L)	>10000	4000-10000	<4000
4.	BOD_5/COD	0.5-1.0	0.1-0.5	<0.1
5.	ORGANIC COMPOUND	80% VFA	5% TO 30% VFA+ HUMIC AND FULVIC ACID	HUMIC AND FULVIC ACIDS
6.	AMMONIA NITROGEN (MG/L)	<400	N.A	>400
7.	TOC/COD	<0.3	0.3-0.5	>0.5
8.	HEAVY METAL (MG/L)	LOW TO MEDIUM	LOW	LOW
9.	BIODEGRADABILTY	IMPORTANT	MEDIUM	LOW

The chief probable ecological impact linked to landfill leachate is pollution of under groundwater and surface water. The hazard of groundwater the pollution is perhaps the most severe environmental impact from landfills because in the past most landfills were built without engineered liners and leachate gathering systems. More recently, regulations in many countries have required the installation of liners and leachate collection systems as well as a plan for leachate treatment reviewed the characteristics of leachate plumes down gradient of landfills. Delhi has 3 Landfill sites for the Municipal Solid Waste Disposal generated in all over Delhi on daily basis. The name of these landfill sites are – Bhalswa, Gazipur and Okhla. The largest Bhalswa landfill site was commissioned in the year 1993, Gazipur in 1984 and Okhla in 1994.

Table 2: Location and Capacity

Name	Location	Area (hectares)	Starting year	Initial amount of MSW T/day	MSW received T/day	End of landfill life
Bhalswa	North Delhi	26.22	1993	1200	3200	2005
Gazipur	East Delhi	29.62	1984	800	2100	2008
Okhla	South Delhi	22.89	1994	400	1200	2005

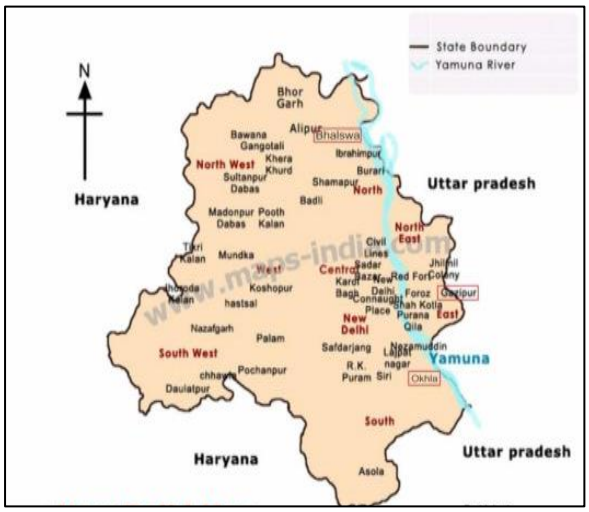
These landfill sites are not designed as per the schedule 3 of MSWs rules which came into effect in year 2000. Even DPCC has not authorized to these landfill sites. The Bhalswa landfill site is used for disposal about 2150 MTD, which is the largest about all 3 landfill sites and overall MSW generated is about 8370 MTD. The solid waste including all commercial municipal, industrial and agricultural activities may contain different types of hazardous pollutants. Land filling is the preferred method for MSW disposal due to its favorable economics. Therefore it is required to have full proof designed landfill sites to prevent contamination of groundwater though Leachate, soil and air. The vicinity of this landfill site has reported the contamination of groundwater (Bharat Jhamnani and SK Singh-

IJCEE1:32009) .The people residing in surrounding areas has reported to have different types of diseases and infections like Gastro intestinal diseases , Musculoskeletal pain , skin and eye irritation and respiratory problems (Amita Bhaduri

08-2015 India Water Portal) This 40-45 acre landfill site was confirmed tired in 2006 but still the municipal corporation of Delhi continued to dumpe the solid waste in this site.

2.0 Geology of the Area

Fig 1: Delhi Map



3.0 Characteristics of Leachate

The systematic study has revealed that the groundwater contamination at Bhalswa landfill is significantly high due to landfill leachate. The parameter for iron, copper, nickel, zinc and oxide are 20mg/Lt, <10mg/Lt, <3mg/Lt, <10mg/Lt and 4000mg/Lt respectively. The concentration Of BOD volatile solid and COD are much higher in the Bhalswa landfill sites in Delhi. These are approx. as follows:

1. BOD = 3300mg/Lt
2. Volatile Solids = 3100mg/Lt
3. COD = 5840 mg/Lt

The higher values of organic matter indicate that the groundwater has been highly contaminated due to landfill leachate and Bhalswa. It requires an efficient and economic method for the treatment. Here is a list of parameters tested for ground water at Bhalswa [4].

Fig 2: Characterization of Solids at Bhalaswa Site

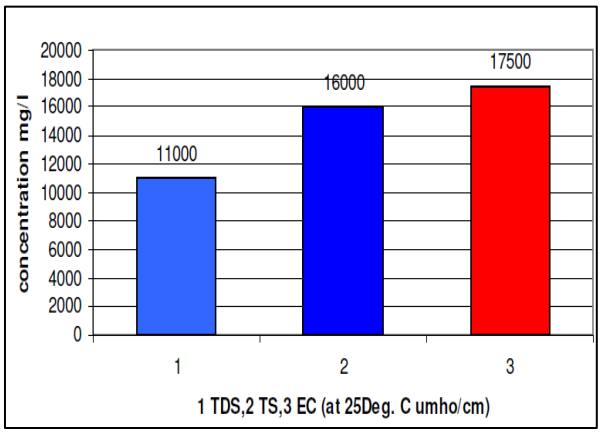


Fig 3: Heavy Metals at Bhalswa

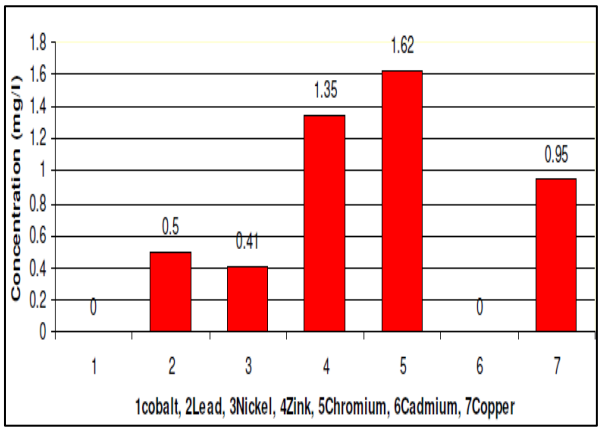


Fig 4: Organic Matter

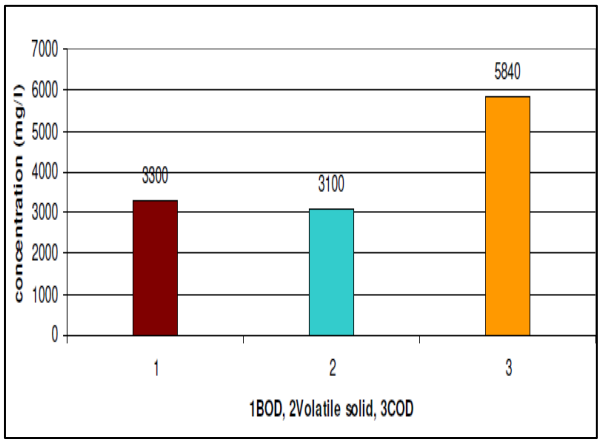
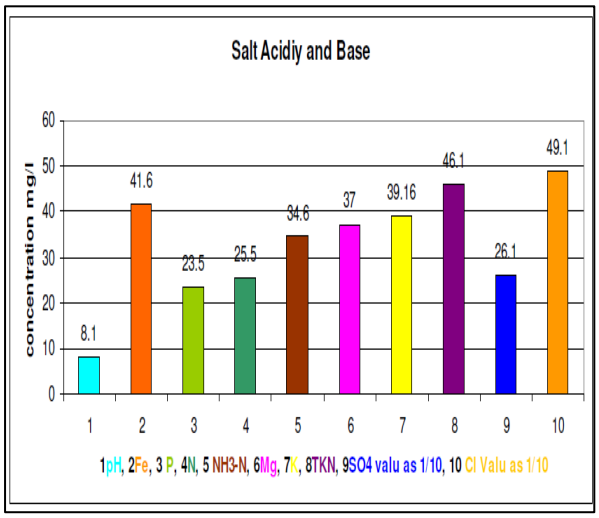


Fig 5: Salt Acidiy and Base



4.0 Methodology

Leachate Pollution Index (LPI) can be used in a number of conducts together with landfill ranking, allocation of resources for landfill remediation, trend analysis, standard enforcements, scientific research and public information.

Leachate pollution potential of a landfill is known by assigning a single number grading from 5 to 100 on the basis of various leachate pollution parameters at a given time.

The trend study developed based for the landfill can be used to decide the post closure monitoring periods.

The overall pollution potential of landfill leachate is calculated by using Rand Corporation Delphi Technique for Leachate pollution index (Arif ahmad et. al. Elsevier 2018) LPI is an easy and means for assess the probable hazards of the leachate from the landfill sites located at Bhalswa landfill sites in Delhi.

The concept and development of LPI has been accepted properly to another place by Kumar and Alappat [3]. The brief description of LPI is by eq. (1):

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

Where, Wi and Pi are the weight and sub-index values of the ith leachate pollutant variable, respectively and n is the total number of pollutant variables.

If the numeral 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 conditions is describe by eq 2:

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

Where, m is less than n.

The leachate pollution changes in a particular landfill over a period of time and higher LPI number implies a poor environmental condition. It can be used to determine whether a landfill requires immediate attention in terms of introducing remedial actions.

5.0 Results and Discussion

LPI values were calculated for Bhalaswa landfills site of Delhi. The leachate sampling and analysis was carried out for landfill sites of Bhalswa. The Physical and chemical analysis of Bhalaswa 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 (1) for different landfill sites.

The results of the samples illustrate that they were not found traces of cyanide, mercury and arsenic. So, in this study the weight age for these leachate pollutants have not been taken into thought while estimating the LPI values for this landfill site [5]. The concentrations of organic and inorganic compounds parameters were establish to be elevated in Bhalswa landfill leachate sample. Also, current (in Year 2018) BOD and COD of the Bhalswa landfill site were elevated and its range varies from 4100mg/l to 6540mg/l when test conducted in DTU lab,

Table 3: LPI Value at Bhalswa

Pollutant, ppm	LEACHATE	Wi	Pi	PiWi
pH	8.1	.055	5	0.276
TDS	11284	.050	8	5.020
BOD3	3300	.061	55	4.781
COD	5840	.062	80	5.727
Total kjehldahl nitrogen	46.1	.053	95	0.529
Ammonia Nitrogen	34.6	.051	100	0.510
Iron	41.6	.044	5	0.445
Copper	0.95	.050	5	0.249
Nickel	0.45	.052	5	0.313
Zinc	1.35	.056	5	0.338
Lead	0.56	.063	5	0.316
Chromium	1.84	.064	10	2.422
Chlorides	49.1	0.048	5.3	0.967
Final LPI= 30.88				

Source :-B.P Naveen et al [5]

Table 4: Source :- (Arif ahmad et. al. 2018)

Variation of leachate pollution index (LPI) in pre-monsoon and post-monsoon seasons adopted by (Kumar and Alappat, 2005) calculated as LPI = $\frac{\sum_{i=1}^{m} WiPi}{\sum_{i=1}^{m} Wi}$ Where m is the number of leachate pollutant parameters for which data are available, but in that case, m < 18 and $\sum_{i=1}^{m} Wi < 1$.

S.N.	Leachate constituent	Average value		Individual Pollution Rating (p_i)		Weight (W_i)		Overall Pollution Rating (p_i W_i)	
		Premonsoon	Postmonsoon	Premonsoon	Postmonsoon	Premonsoon	Postmonsoon	Premonsoon	Postmonsoon
1	pH	7.92	8.38	5	5	0.055	0.055	0.275	0.275
2	TDS	22395	19500	50	46	0.05	0.05	2.5	2.3
3	BOD_5	10800	7975	60	58	0.061	0.061	3.66	3.538
4	COD	25400	22960	85	83	0.062	0.062	5.27	5.146
5	Fe	11.87	10.92	5	5	0.045	0.045	0.225	0.225
6	Cu	1.00	0.91	7	6	0.05	0.05	0.35	0.30
7	Ni	0.83	0.62	7	6	0.052	0.052	0.364	0.312
8	Zn	3.96	3.68	7	7	0.056	0.056	0.392	0.392
9	Pb	0.18	0.11	6	5	0.063	0.063	0.378	0.315
10	Cr	4.06	3.87	25	24	0.064	0.064	1.6	1.536
11	Cl^-	9150	7500	85	72	0.048	0.048	4.08	3.456
Total						0.606	0.606	19.094	17.795
Final LPI value by dividing Total Overall pollution rating by Total W_i								31.51	29.36

6.0 Conclusions

Due to the higher LPI value of Bhalswa landfill leachate sample, this site has been identified as the most contaminating site for solid waste dumping. It has already reached to its optimum capacity in 2006 but still it is being used by Municipal Corporation of Delhi which may leads very dangerous situation in terms of contamination and health to the surrounding biodiversity.

High value of LPI in both the seasons shows that waste in the dumping site is not stabilized yet and it has more potential to deteriorate the quality of groundwater. The poorly managed dumping of municipal solid waste, in the speedy urbanizing Delhi region, at Bhalswa landfill site affected the groundwater quality of the shallow aquifers close to the site.

To organize or reduce the crash of MSW leachate on groundwater resources around the landfill sites, construction of lined engineered dumping site and leachate collection ponds are the best way to protect the movement of the leachate into the shallow groundwater of the study area. A new site for dumping should be preferred as an substitute away from any residential settlement, river and agricultural field to minimize the environmental impact (Arif ahmad et. al. 2018).

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