

Study of Leachate and its Characteristics obtained from Leachate Model; Designed in Laboratory for MSW of Sangamner City, Dist. Ahmednagar (MS) India: A Case Study

Pondhe G.M¹, Thitame S.N²

Department of Environmental Science, P.V.P. College, Pravaranagar, Tal- Rahata, Dist. Ahmednagar (MS), India

(Affiliated to Savitribai Phule Pune University, Pune)¹

Asst. Professor, Centre for Social Medicine, Rural Medical College, Pravara Institute of Medical Sciences (DU), Tal- Rahata, Dist. Ahmednagar (MS) India²

ABSTRACT: The leachate collected from Municipal Solid Waste (MSW) in laboratory was analyzed for the chemical parameters. It reveals that, pH of leachate is acidic. The high values of electrical conductivity ($5662 \mu\text{mhos cm}^{-1}$) and TDS (4606 ppm) in the leachate indicate presence of inorganic constituents. Significant higher concentrations of Calcium (547 mg/l) and Magnesium (183 mg/l) was observed in the leachate. The chloride and Sulphate ion concentration was found 1606 and 111.8 mg/l respectively. Sulphate content of leachate mainly depends on the decomposition of organic matter present in solid wastes and it is expected to decrease with refuse age. This decrease is caused by the reduction of sulphate to sulphide coincident with the initiation of anaerobic conditions in the landfill. Hence, the sulphate concentration in leachate can also be used as an indicator of waste stabilization within landfill. Concentration of phosphate is very low, which is 76 mg/l. Low phosphorous concentration is indicative of anaerobic condition in the solid waste. The concentration of nitrate is 91 mg/L. It can be explained as, in the solid waste, it is expected that eventually a small amount of ammonium will be nitrified during the leachate passage through waste bed. The rate of sodium ion leaching was high as compare to the potassium ion. Leachate has high BOD and COD showing a high organic and inorganic load. The concentrations of the metals such as Cd, Fe, Cr and Zn were recorded are 0.103, 148.5, 31.08 and 12.257 mg/L respectively along with bacterial contamination.

KEYWORDS: MSW, Leachate, Concentration, Indicator and Metal.

I. INTRODUCTION

According to 'Indian Municipal Solid Waste Management and Handling Rule 2000' the MSW i.e. Municipal Solid Waste; includes commercial and residential wastes generated in a municipal or notified area in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes. Though the term MSW is universal, it has different concern depending upon the location and living standard of people.

In the early days the disposal of MSW or human and other waste did not pose any significant problem because the population was small and the amount of land available for accumulation of waste was large. Now, the scenario has changed quite a lot owing to rapid urbanization and industrialization. This has resulted in tremendous increase in the migration of public towards urbanized pocket and considerable change in socioeconomic status as well as the subsequent infrastructural requirement for their safe, healthy and comfortable living, result into generation of large amount of waste in urban area. 'Open dumps' are the oldest and the most common way of disposing of solid wastes. In many cases open dumps are located wherever land is available, without regard to safety, health hazard and aesthetic degradation (Sabahiet.al. 2009(a)). Apart from open dump 'landfill' is another method used for the disposal of waste materials by means of burial. This also one of the oldest form of waste treatment. 'Landfill' sites which usually hold large quantities of MSW, are chiefly responsible for contaminating the ground water table. The dumped solid wastes on open dump or landfill gradually release its initial interstitial liquid/leached water and some of its decomposed by-products. Such liquid containing innumerable organic and inorganic compounds is termed as a 'leachate' (Christensen and Stegmann, 1992). This leachate accumulates at the bottom of the landfill and percolates through the soil and subsoil. Therefore, areas near landfills have a greater possibility of groundwater contamination because of the potential pollution source of leachate, originating from the nearby site. Such contamination of groundwater resource poses a substantial risk to local user and to the natural environment (MorSumanet.al. 2006). There are several factors affecting the composition of leachates and their production. According to Johansen and Carlson, 1975 the most important of these are, solid wastes composition, climate and hydro geological conditions as well as those inside the landfill (biochemical activity, moisture, temperature, pH and age of landfill/open dump). However, these mentioned factors

vary considerably from landfill to landfill (Slomczynska and Slomczynski, 2004). This results in varied leachate characteristics from different wastes at different sites. The pollution potential of the waste and that of leachate depends on the characteristics of the waste and that of leachate. The main products of landfills are the leachate and landfill gas. Among the two, greater threat to ground water is posed by the 'Leachate' (Khitoliya *et al.* 2009). Therefore, it is of immense importance to see the characteristics of leachate generated which can pose the problem of pollution.

II. STUDY AREA AND MSW

The study area i.e. Sangamner is one of the densely populated and well known towns in Ahmednagar district of Maharashtra state in India and geographically located on 74°11'25" to 74°13'35" E Longitude and 19°32'50" to 19°35' N Latitude. The city is situated on river Pravara a major tributary of Godavari river. It has an average elevation of 549 meters. It is famous for its cloth market, educational facilities, sugar and allied industries and agriculture as well as tobacco products. The city has population around 65,804 as per 2011 census. As on today the population of the city must have reached up to 90,000 (including floating and unauthorized population).

There are various developmental activities in the city contributing the solid waste generation which in return make heterogeneous quality and quantity. The city is generating 40 ton of solid waste per day which increases up to 45 ton at the time of festivals and celebrations. This waste is being carried to the disposal site. There is no treatment facility for the solid waste at the dumping site except few attempts of the land filling which is also unsanitary landfill. Hence due to continuous accumulation of waste the hills are rising day by day. The most important things need to mention here that, when rain falls on the dumped waste and landfill; results in the generation of leachate which carries harmful chemicals, metals etc. in surface stream as well as in the ground water, resulting into contamination of resource and making it unsuitable for the consumption and agriculture as well. Therefore, in present paper an attempt has been made to study the characteristics of MSW leachate to know its characteristics.

III. MATERIAL AND METHODS

III. a) Leachate Model and Generation: The composite (fresh and partly degraded), representative and required amount of samples was collected from waste disposal site of town. The generation of leachate was carried in the laboratory by designing 2x1x1 ft box model (Fig.1) having 1 cm slope at the base with outlet to collect the leachate. For this the acrylic material was used. The only objective behind this model was to collect the leachate in the laboratory for analysis of various physicochemical characteristics.

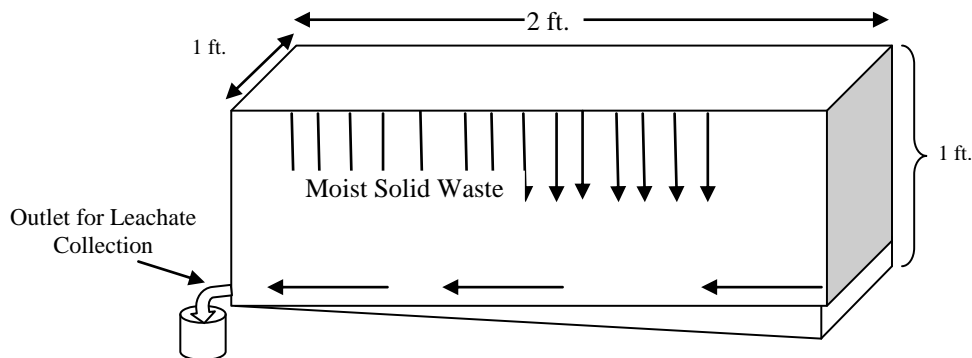


Fig.1: Showing Overview of Leachate Generation Model Designed at Laboratory.

The collected sample of solid waste (fresh and partially degraded) was mixed manually in the laboratory to make it homogeneous. This waste sample was then chopped into small pieces and 28 kg solid waste from this was used to fill the leachate box model. Before filling up the waste into model the moisture content was measured which was 32%. It is generally considered that the waste decomposition generally starts on the 8th to 9th day when it contains sufficient moisture. Hence, pilot study was conducted to know the amount of water required per kilogram of waste to get the leachate from the waste on 9th day. Accordingly, 560 ml distilled water was added daily to maintain the moisture content in the leachate model and the leachate generation was observed for 74 days. During the study upper side of the model was kept open, to compensate the evaporation loss of dump at field. The study was conducted in rainy season because the dumping site receives water only in rainy season.

Actual leachate generation from the experimental model was started on 9th day. It means approximately 5.5 liter distilled water was absorbed by solid waste to attain 100% moisture in the waste. This excludes the evaporation



losses of 28%, that of reported by JICA and CMU, 1992. It is evident that the solid waste (landfill/open dump) first attains 100 % moisture content and then start to release the leachate. Hence, moisture content was mentioned during the study. The leachate collected on first day was dusty (dark brown) in color and contains the earthen material from the solid waste. On 10th day the leachate generation was increased to 75 ml with same color and dusty material obtained on previous day. From 11th day onwards the color was somewhat faint yellow and amount of leachate was increased, the leachate collected on 11th day was 250 ml. From 12th day onwards an average of 400 ml leachate was collected from the leachate model. After 47th days onwards, the color of the leachate obtained started to change towards clear and after 74 days the clear leachate was obtained without any color. This might be due to the solid waste released all its organic and inorganic constituents in to the leachate. The material left behind was only the residue. It might be possible that some of the inorganic material which cannot be dissolved in the water might leave behind in the solid waste. Thus the leachate was collected and used for further study.

III. b) Analysis of Leachate: The analysis of leachate collected from the laboratory model was carried out for the parameters like pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Chloride (Cl), Total Alkalinity (TA), Sulphate (SO₄), Phosphate (PO₄), Nitrate (NO₃), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Heavy Metals (Iron (Fe), Zinc (Zn), Cadmium (Cd), Chromium (Cr) and E Coli as per the standard methods (APHA, 1985). The results obtained after analysis of leachate are presented in Table 1.

Table1: Showing Characteristics of Leachate obtained from the solid waste through Experimental model designed at Laboratory.

S.N.	Parameter	Concentration		S.N.	Parameter	Concentration
1	pH	6.8		12	DO	0.67
2	EC (µmhos cm ⁻¹)	5662		13	BOD	2944
3	TDS	4606		14	COD	7366
4	Alkalinity	2208		15	Sodium	462
5	Hardness	854		16	Potassium	90
6	Calcium	547		17	Cadmium	0.103
7	Magnesium	183		18	Iron	148.5
8	Chloride	1606		19	Chromium	31.08
9	Sulphate	111.8		20	Zinc	12.257
10	Phosphate	76		21	E coli/ 100 ml	39.56
11	Nitrate	91				

*All values are in ppm except pH and otherwise stated

IV. RESULT AND DISCUSSION

It is seen from Table 1 that, pH of leachate is 6.8 which is somewhat acidic. This reflects the presence of acids and bicarbonate ions in the leachate. According to Slomczynska and Slomczynski(2004) with time, the leachates become neutral or weakly alkaline (pH 7.0-7.6). The high values of EC (5662) and TDS (4606) in the leachate indicate presence of inorganic constituents in the sample. High conductivity value was recorded due to leaching of the inorganic constituents in the leachate. Calcium and Magnesium are the two major ions in the evaluation of buffering capacity of the leachates during the waste degradation. Significant higher concentrations of Calcium (547 mg/l) and Magnesium (183 mg/l) was observed in the leachate. Chloride is considered to be a very conservative anion that is only attenuated during dilution. In solid waste leachate, the chloride ion concentration was found 1606 mg/l. Sulphate concentration was found 111.8 mg/l in the leachate. Sulphate content of leachate mainly depends on the decomposition of organic matter present in solid wastes (Shivakumaret al., 2004) and it is expected to decrease with refuse age. This decrease is caused by the reduction of sulphate to sulphide coincident with the initiation of anaerobic conditions in the landfill. Thus, the sulphate concentration in leachate can also be used as an indicator of waste stabilization within landfill. During anaerobic refuse decomposition, sulphate is reduced to sulphide that forms insoluble precipitates with most metals (Christensen et al., 2000). Concentration of phosphate is very low, which is 76 mg/l. The major form of phosphorous existing in leachate is orthophosphate. Low phosphorous concentration is indicative of anaerobic condition in the solid waste. The concentration of nitrate is 91 mg/L. It can be explained as, in the solid waste, it is expected that eventually a small amount of ammonium will be nitrified during the leachate passage through waste bed. Sodium and potassium ions leached from the solid waste were 462 mg/L and 90 mg/L respectively. The rate of sodium ion leaching was high as compare to the potassium ion. Potassium is immobilized in the easily degradable organic matter, but it becomes soluble

due to the decomposition processes. Potassium ion has the least complex forming ability and gets associated to the other ions that can be leach out at first from the waste bed (Brady and Weil, 1999).

Leachate has high BOD, which is related to the high COD showing a high organic load. The BOD and COD values are 2944 mg/L and 7366 mg/L respectively. The leachate takes with it high organic load which is added due to the decomposition of the solid waste. The DO value does not have any meaning to the leachate because there is aerobic as well as anaerobic decomposition of the waste and there is no chance of addition of dissolved oxygen. The DO was found 0.67 mg/L. However, DO of the water infiltrated through solid waste may be utilized by the bacteria for the decomposition of waste in the solid waste dump.

The concentrations of the metals such as Cd, Fe, Cr and Zn were recorded which are 0.103, 148.5, 31.08 and 12.257 mg/L respectively. The high level of Fe (148.5 mg/L) in the leachate sample indicates that Fe and steel scrap are also dumped in the landfill. The presence of Zn in the leachate shows that the landfill receives waste from batteries and fluorescent lamps (Moret.al, 2006). The review of literature on the concentration of heavy metals in leachate of different landfills of Norway and USA were studied by Slomczynska and Slomczynski in 2004 found that the landfill leachates in Norway contain Fe, Zn Cr and Cd in the range of 11.5 mg/l to 68.9 mg/l, 0.055 mg/l to 0.12 mg/l, 0.002 mg/l to 0.035 and 0.0001 mg/l to 0.0008 mg/l respectively.

Heavy metal leaching ability from the waste mainly depends on complex formation and sorption. The major mechanism like precipitation and cation exchange capacity accounts for maximum heavy metal content in leachate. With the aging of the landfills the processes of the biological degradation of organic substances slow down and the susceptibility of leachates to biological degradation declines.

The E Coli was measured 39.56/100 ml indicating the fecal load of the solid waste discharged from Sangamner city. It is the most important aspects in the water quality near the dumping site. The most common and widespread health risks associated with drinking water are the bacterial contamination caused either directly or indirectly by waste (Thitame, 2010).

V.CONCLUSION

It is concluded that the leachate shows high organic and inorganic chemical load along with heavy metal. When enter in environment it will not only contaminate surface and ground water but also disturb the soil microbiology. The contamination of water may be unsuitable for the consumption to local residence and agriculture as well.

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