International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 5, Issue 04, April-2019

EFFECTS OF LEACHATE ON GROUND WATER DUE TO MUNICIPAL SOLID WASTE LANDFILL OF DADDU MAJRA, CHANDIGARH

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ABSTRACT : ***Municipal Solid Waste Management is an issue of major concern throughout the world. In developing countries such as India with a rapid increase in population, industrialization and urbanization, management of solid waste is a challenging task. Lack of budget, untrained manpower, inefficient collection, transportation and storage systems are the major area of concern. Among all the waste disposal methods landfilling is the simplest, cheapest and most cost-effective method of disposing of waste in both developed and developing nations of the world. Leaching of toxic chemicals with high BOD, COD, heavy metals such as chromium, lead, zinc, cadmium, copper, nickel and organic & inorganic compounds like sodium, magnesium, calcium, ammonium, sulphates, chlorides has an adverse effect on the ground water various physicochemical parameters and microbiological examinations besides heavy metals and ground water samples was conducted. In this study landfill site of Chandigarh which is a non-engineered landfill and located at Daddu Majra is examined for leachate characteristics and effect of the leachate on ground water. Leachate samples are collected from Daddu Majra landfill site and ground water samples are collected from the nearby available sources. The result of this study shows that the samples at shallower depth and near to landfill have traces of pollutants and as we go further deep and far from the landfill site the quality of water is improving. Thus, implies of pollution is due to leachates from the landfill site.***

INTRODUCTION

Ground water is a major source of potable water throughout the globe. Since last few decades the quality of ground water keeps on degrading, it has many causes such as application of pesticides, insecticides and fertilizers in the agricultural field. Untreated waste from underground septic tanks, toxic chemicals from underground storage tank and leachates from landfills are direct cause of pollution in ground water. The longer a landfill remains full of waste, the more the toxins from that waste seeps into the soil below and around the landfill. This leads to ground water contamination almost immediately when the landfills are very large, the amount of ground water polluted by them is significant. Contaminated ground water may cause water borne diseases. In areas where septic systems have not been installed or kept up correctly ground water may become infected with hepatitis due to human waste present in the water. Hepatitis is a very serious condition that causes irreversible damage to the liver. Dysentery can also be caused by ground water where septic waste is present.

In a study conducted by *Adeyemi et. al.* on effects of leachate on the blood of rats. The body weight of the animals placed on simulated leachate was the least among the test groups. Generally, the body weight of the rats as observed in this study was found to be better when the distance of groundwater was about 1.5km from the landfill than when was is about 1km from the landfill. This clearly indicates the effects of contaminated ground water due to leachate. Concentration of BOD, COD, ammoniacal nitrogen and pH in leachates provide the information regarding the biodegradability of waste as well as stages of leachate (*Bhatt et. al*.).

STUDY AREA

Chandigarh is first planned the city and a Union territory n India with a population of 1,05,5450 as of 2011 India census (*Chandigarh population census data, Census2011*). It serves the capital of two states i.e. Punjab and Haryana. Chandigarh covers an area of approximately 114 km ^{2} is bordered by Punjab from north, west and south side and by Haryana state from the east side. It is located near the foothills of the Shivalik range of the Himalayas in northwest India. The cartographic coordinates of Chandigarh are 30.74°N 76.79°E. It has an average elevation of 321 meters (1053 ft). Chandigarh has one of the highest per capita incomes in India. Chandigarh's gross state domestic product for 2014-15 is estimated at □0.29 lakh crore (US$4.3 billion) at current prices. Solid waste in Chandigarh is dumped at Daddu Majra landfill site and leachate percolation through soil to the ground is a problem as the site is non-engineered. Solid waste in Chandigarh is managed by Municipal Corporation of Chandigarh. The Office of the Medical Officer of Health is responsible for sanitation and health in the city. Chandigarh Municipal Corporation is responsible for collection, transportation and disposal from 58 sectors and 9 villages till 2018. For the management of the solid waste of Chandigarh area a Refuse Derived Fuel (RDF) plant is in operation since 2008 to convert 500 tonnes of solid waste to RDF.

MATERIALS AND METHODS

Waste Characteristics of City

Solid waste characteristic decides the quality of leachates. Chandigarh is generating 472 tonnes per day (TPD) of waste from households, commercial establishments, parks and markets.

Sr. No.	Parameters	Composition (%)
01	Biodegradables	52.7
02	Paper	10.67
03	Plastic	8.42
04	Metal	1.4
05	Glass	1.38
05	Inert	25.43

Sampling of Leachate and Groundwater

Leachates are collected from Daddu Majra dumping ground, Chandigarh of two different periods from September – October 2018 and February – March 2019 As the dumping sites are open dumps so therefore no leachate collection facility is available at the dump sites, therefore, the samples of leachate were collected randomly in and around the waste piles and mixed thoroughly to get a representative sample. Five water samples are collected from nearby tube wells in the months of September, October, January and February 2018-2019. Samples were collected from different distances from the landfill and at variable depths to measure the impact of leachates in the ground water. Their physiochemical properties like pH, Chlorides, total hardness, alkalinity, BOD, COD, TDS and heavy metals like Pb, Ni, Cu, and Zn were determined. Experiments were conducted based on different methodologies and results of the leachate obtained from Daddu Majra landfill were obtained.

Groundwater Sampling Sites details:

Sr. No.	**Sample site**	**Location**	**Distance(m)**	**Depth(ft)**	**Source of Water Sample**
1	GW 1	Daddu majra	1000	60	Tube well
2	GW 2	Daddu majra colony	2000	120	Tube well
3	GW 3	Daddu majra	2500	70	Tube well
4	GW 4	Daddu majra	3000	100	Tube well
5	GW 5	Dhanas	4000	70	Tube well

Methodology used for testing:

Sr. No.	**Parameter**	**Method**
1	pH	Electrometric
2	Total Hardness	Titration
3	Chlorides	Titration
4	Total Dissolved Solids	Gravimetric Technique
5	Alkalinity	Titration
6	COD	COD Digestor
7	BOD	Winkler's Method
8	Lead	AAS
9	Copper	AAS
10	Zinc	AAS
11	nickel	AAS
12	EC	Electrical Conductivity Meter

RESULTS AND DISCUSSION

Leacahte characteristics of the Daddu Majra landfill in the months of November, December, January and February were measured on 19th date of each month in 2018-19, which are:

Leachate characteristics of Daddu Majra landfill:

Sr. No.	**Parameters**	**Sep 18**	**Oct 18**	**Jan 19**	**Feb 19**
1	pH	7.8	7.6	9.2	9.0
2	Total Hardness	1280	1250	1300	1485
3	Chlorides	2136	2145	2190	2230
4	Total Dissolved Solids	34900	35700	35947	35000
5	Alkalinity	5467	6478	5673	5800
6	COD	18990	18800	19930	19964
7	BOD	2440	2230	2290	2900

8	Lead	0.63	0.63	0.66	0.64
9	Copper	3.72	3.74	3.72	3.80
10	Zinc	10.41	10.40	10.45	10.60
11	nickel	0.98	0.98	0.96	0.94

Results show that leachate obtained from unsecured Daddu Majra landfill is basic in nature. Literature mentions that the pH generates from the leachates ranges from 4.5-9.0 depends upon the age of landfill. Younger landfill has an acidic pH up to 6.5 and mature landfill has a pH of greater than 7.5. This is primarily because in the initial stages of the landfill the leachate generated has an increased concentration of Volatile Fatty Acids (VFA) resulting lower pH values of about <6.5 while in older landfill sites these VFA are converted to methane and carbon dioxide thereby resulting in a more alkaline nature of the leachate characteristics (pH > 7.5).

Total hardness is due to increased levels of calcium and sulphates in the landfill waste. High chloride values indicate the presence of soluble wastes in the landfill. It reflects that there is a large quantity of agricultural, sewage and another animal waste which is deposited in the landfill site. High value of TDS in the leachate reflects the presence of a large quantity of dissolved inorganic and organic substance in the solution. This demonstrates the mineral contents and degree of salinity of the leachate. The high alkalinity value in leachate denotes the intensity of biodegradation process happening within the landfill site. Due to biodegradation processes of organic content, a remarkable amount of bicarbonates is produced, which represents dissolved carbon-dioxide.

Heavy metals include lead, zinc, copper and nickel. Presence of these heavy metals found in the leachate is due to presence of solid waste like electronic products, batteries, ceramics, paint chips, light bulbs, lead foils etc. in the landfill. Same parameters were computed for six ground water samples on same date on which leachate samples' characteristics were measured near the landfill; compared with IS 10500:2012 and analysed that are they within desirable limits or not.

Drinking water limits as per IS 10500:2012

Sr. No.	**Parameters**	**IS 10500:2012**
1	pH	6.5-8.5
2	Colour	Clear
3	Total Hardness	200 mg/l
4	Chlorides	250 mg/l
5	TDS	500 mg/l
6	Alkalinity	200 mg/l
7	COD	Nil
8	BOD	Nil
9	Lead	0.01 mg/l
10	Copper	0.05 mg/l
11	Zinc	5 mg/l
12	Nickel	0.02 mg/l
13	EC	300

Characteristics of ground water samples

pH	**GW1**	**GW2**	**GW3**	**GW4**	**GW5**
September	7.6	7.2	7.2	7.0	6.5
October	7.4	7.3	7.2	7.1	6.8
January	8.9	8.2	8.0	7.9	7.4
February	8.9	8.1	8.0	7.8	7.5

Total Hardness	**GW1**	**GW2**	**GW3**	**GW4**	**GW5**
September	270	240	235	210	200
October	300	285	260	245	220
January	350	330	300	280	225
February	390	400	300	270	245

Chlorides	**GW1**	**GW2**	**GW3**	**GW4**	**GW5**
September	86.1	84.9	83.2	81.7	80.9
October	93.2	90.9	90	88.7	86.9
January	114.2	107	98.9	96.4	93.6
February	115.3	107.4	99	96.4	94

TDS	GW1	GW2	GW3	GW4	GW5
September	644	1010	680.4	608.6	482.6
October	648.7	1123.7	745.9	600.2	519.3
January	687.8	1130.6	790	647.2	534.2
February	689.3	1145.9	810.5	663.4	555

Alkalinity	GW1	GW2	GW3	GW4	GW5
September	485	474	380	386	389
October	498	490	485	467	400
January	521	513	489	478	414
February	534	527	515	490	428

BOD	GW1	GW2	GW3	GW4	GW5
September	530	410	320	305	180
October	590	420	330	320	270
January	600	480	330	350	300
February	600	490	320	360	350

Lead	GW1	GW2	GW3	GW4	GW5
September	0.02	0.01	0.001	ND	ND
October	0.02	ND	ND	ND	ND
January	ND	ND	ND	ND	ND
February	0.01	ND	ND	ND	ND

Copper	GW1	GW2	GW3	GW4	GW5
September	0.15	ND	ND	ND	ND
October	0.15	ND	ND	ND	ND
January	0.13	ND	ND	ND	ND
February	0.01	ND	ND	ND	ND

Lead	GW1	GW2	GW3	GW4	GW5
September	0.02	0.01	0.001	ND	ND
October	0.02	ND	ND	ND	ND
January	ND	ND	ND	ND	ND
February	0.01	ND	ND	ND	ND

Nickel	GW1	GW2	GW3	GW4	GW5
September	ND	ND	ND	ND	ND
October	ND	ND	ND	ND	ND
January	ND	ND	ND	ND	ND
February	ND	ND	ND	ND	ND

Zinc	GW1	GW2	GW3	GW4	GW5
September	0.18	0.22	ND	ND	ND
October	0.16	0.14	ND	ND	ND
January	0.12	0.11	ND	ND	ND
February	0.17	ND	ND	ND	ND

EC (µS/cm)	GW1	GW2	GW3	GW4	GW5
September	1034	1000	945	930	910
October	1053	1065	1045	1021	976
January	1030	1078	1223	1026	1021
February	1124	1146	1139	1098	1023

These tables offer the summary of the outcomes obtained from groundwater samples in the proximity of the Daddu Majra landfill. Comparing the results of groundwater quality parameters with desirable limits specified by IS 10500:2012, The groundwaterof the region studied is predominantly used for irrigation purposes as well as domestic purposes. Hence it is necessary to find appropriateness of groundwater for irrigation purposes as well as domestic purposes. The groundwater of the region is generally clear and fresh except those places which are close to landfill site. Samples taken from the places near to the landfill site were found highly contaminated. However, contamination of groundwater reduces fast with the distance of groundwater sources from the landfill. The pH values indicate that groundwater of the region is basic in nature to some extent. The high TDS value in groundwater indicates high concentration of dissolved solids which cause gastro-intestinal problems in human. The heavy metals Pb, Ni, Cu and Zn are considered as toxic ones for drinking water. A number of factors are responsible for the degree of contamination of groundwater due to landfill leachate like distance and depth of the groundwater source from the landfill, rainfall, chemical composition of leachate etc. Although few parameters' concentrations did not exceed IS standard for drinking water of the region even then the quality of groundwater show a notable risk to human health.

CONCLUSIONS

The present study reveals the extent to which open dumping of MSW has led to the contamination of the nearby ground water due to percolation of the leachate. The leachate generated affects the ground water quality in the adjacent areas through percolation in the sub-soil. The ground water quality of nearby sites of municipal solid waste landfill sites are of poor quality since they are contaminated due to leachate. The ground water quality improves with the increase in distance from the source of pollution. Although few parameters' concentrations did not exceed IS standard for drinking water still the quality of groundwater show are remarkable risk to human health. Because of this risk to their health, people of the region should stop the consumption of groundwater from the untreated groundwater sources close to the landfill site. The WQI indicated the majority of the ground water samples belong to poor quality of water in Chandigarh. In the future, it is recommended to have an engineered landfill sites for each of the three cities which can control the impact of leachate on the ground water.

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