Environmental Research Journal 2 (3): 111-114, 2008
ISSN: 1994-5396

Characterization of Leachates Compositions from a Solid Waste Landfill in Port Harcourt, Nigeria

[1]Oyoh, K.B. and [2]B.O. Evbuomwan
[1]Department of Chemical Engineering, Federal University of Technology, Owerri, Nigeria
[2]Department of Chemical Engineering, University of Port Harcourt, Port Harcourt, Nigeria

Abstract: Characterization of leachates composition from solid waste dumpsite in Port Harcourt, has been studied. Integrated samples of leachate were collected during wet and dry seasons and analyzed for pH, suspended solid, biochemical oxygen demand, chemical oxygen demand ammonia, nitrate, sulphate and trace metals. Leachates were alkaline and amber in appearance. Analyses of sample revealed variation during wet and dry periods, respectively in turbidity (80 and 140 FTU), (211.6 and 140 mg L^{-1}), BOD (1990 and 677.0 mg L^{-1}). Mean concentrations of SS (177.9 mg L^{-1}), BOD (795.0 mg L^{-1}). Nitrate (0.50 mg L^{-1}) and sulphate (84.0 mg L^{-1}) meet acceptable limits recommended by regulatory bodies in Nigeria. Iron predominates and total metals concentration (175.8 mg L^{-1}) regulatory lime of 3 mg L^{-1}. The ratio of BOD/COD ranged from 0.11-0.40. Therefore, physiochemical and / or biological method are required to treat leachates before they are discharged into environment at the dumpsite to either eliminate, or drastically reduce short and long term detrimental effects on ecology, public health and the environment.

Key words: Environmental pollution, leahcate characteristics, solid wastes, landfill, dumpsite

INTRODUCTION

The post independences era in Nigeria has witnessed a series of political and socio-economic developments. Today, the nation states and a federal capital territory in comparison with the initial 4 regions at independence in 1960. Over the years, there is considerable growth in the awareness of environmental pollution problems and it has become a major national and international issues. Port Harcourt, one of cities in sub-Saharan tropical Africa is experiencing the problem of waste management, primarily as a result of unplanned development, rural-urban migration and natural increase within the city. This remarkable growth rate has been matched by improvement in the quality of urban environment. Instead, the demog and increased industrial and commercial activities have caused an astronomical increase in the volume and diversity of solid waste in Nigeria (Aluko, 2001).

Although, solid waste is an asset when properly managed, its volume has continued to increase in recent times in result of socio-economic development including wage increases. In Nigeria, much has been and is being invested on municipal management in cities. But little progress has been made because of severe financial, technological and institutional constraints and the private sectors apart from erratic growth of housing units in the inner core of urban cities.

Despite the best attempts of waste avoidance, reduction, reuse and recovery (recycling, composting and energy recovery), land disposal sites are still the principal focus for ultimate disposal of residual wastes and incineration residues world-wide (Charlotte, 1995). The placement and compaction of municipal wastes in landfills facilitates the development of facultative and anaerobic control and promotes biological decomposition of landfill waste. Hence, leachates of diverse composition are produced, depending on site and operational practices, age of the landfill method, climatic and hydrogeological conditions and surface water ingression (Campell, 1993). Leachates therefore migrate vertically and laterally into the environment by direct discharge into the adjacent serving about 16 communities around the landfill.

The realization of the pollution effects of landfill leachates on the environment has prompted a number of studies. These includes domestic waste leachate quality (Akuko *et al*., 2000), as well as underground water quality Loizidou, 1993).

At the study site, leachates are discharged into the environmental media treatment. This has resulted in low farm production, abnoxious gasses into the environment, contamination of the domestic water sources (Tairu, 1998). For treatment however, new chemical treatment, gravel filtration, waste stabilization and constructed wetlands, among other strategies can be investigated, develop a

Corresponding Author: K.B. Oyoh, Department of Chemical Engineering, Federal University of Technology, Owerri, Nigeria

cost effective and sustainable method of treatment for leachates at the landfill site.

This study therefore, aims to identified compositions of the landfill, with a view to estimating its polluting effects and to designing a sustainable, cost effective and environmental friendly method of treatment.

MATERIALS AND METHODS

Study location: Port Harcourt, founded in 1976 has an estimated population of between 2.0 million. The city is situated at an average height of 150 m drained by 4 river basins and surrounded by secondary rainforest as well as a savannah. It experiences a mainly tropical climate with an estimated annual rainfall of about 1200 mm. The landfill has dumpsite since 1990, incorporating drainage pipes and lines with clay and gravel, even though in reality, the site was predominantly a containment landfill that was upgraded and commissioned in 1999. The state-owned landfill sites are managed since the operational practices as the site do not follow the standard, normal practices. The landfill covers about 9 ha solid wastes having being deposited to an estimated depth of about 2.5 m. It has been used for municipal solid waste disposal for years. It receives domestic industrial and institutional wastes by public and private waste management operators (Aluko, 2001).

Leachate sampling and analysis: Leachate drains were strategically constructed to collect effluents from the waste mass into a pond by gravity. No precipitation for the week preceding sampling for dry period samples, while wet season leachates were collected during a rainy period. To determine the leachates, integrated samples were collected from randomly selected leachate drains at the site (APHA, 1998, 1060A3).

Analytical methods were according to "Standard methods for examination of water and wastewater" unless otherwise stated all Suspended solids and turbidity were determined using a portable data logging spectro-photometer, dialing (650 and 580) in the programmes and results were expressed, respectively in mg L^{-1} and FTU. Colour was determined by Lovibond colour comparator determined by glass electrode method with a standard calibrated pH. Dissolved solids, temperature and conductivity were determined. Atomic absorption spectro-photometer was used for metals analyze were digested, using concentrated trioxonitate volume made to 50 mL with deionized water. Dissolved Oxygen (DO) was determined by Azide modification of Wrinkler's method utilizing potassium tertaoxochromate (VI) in boiling concentration tetraxosulphate (VI) solution used to determine COD while Nesller's method was used to determine ammonia. Nitrate was determined by phenoldisulphonic (Taras, 1950) while phosphate was analysed by colorimetry using olybdovanadate method.

RESULTS AND DISCUSSION

The characteristics of leachates are shown in Table 1-4. High concentrations of pollutants prevailed in leachate, nitrate, sulphate and phosphate. This corroborated the findings of Tairu (1998), where a high incidence of mortality was reported domestic animals, low farm produce and contaminated domestic water sources were placed and attributed to direct discharge leachates into nearby environment at the landfill site. There is no thermal pollution in the stream since leachates have temperature of 26°C. Leachate were amber, coloured and alkaline with pH range of 8.03-8.28. This is typical of samples from and such wastewater requires high coagulant to ensure sweep coagulation of pollutants if chemical treatment is desired Cooper (1996). Leachates produced during wet season were more alkaline as compared to those produced during dry period. Leachates collected showed higher concentrations pollutants

Table 1: Physiochemical characteristics of wet, dry and combined leachate samples

Parameters	Wet season Mean±SD, n = 05	Dry season Mean±SD, n = 07	Combined samples Mean±SD, n = 12	FEPA's standards
Temperature (°C)	25.66±0.75	25.76±098	25.66±084	< 40
pH	8.28±0.38	8.03±0.36	8.17±037	6-7
Colour (HU)	423.60±101.20	434.71±35.20	426.0±68.96	7
Turdicity (FTU)	80±37.35	140.0±33.03	114.25±42.46	-
Conductivity(μS cm^{-1})	5562±2565.90	4807±1738.37	5155.75±2.61.38	-
Total Solids (mg L^{-1})	4819.6±133.36	488.43±1995.80	4270±1751.07	-
SS (mg L^{-1})	211.60±99.54	140.71±51.48	176.92±7791	30
TDS (mg L^{-1})	4606±367.25	4735±1981.42	4093.75±1743.28	2000
Alkalinity (mg L^{-1})	208.40±1547.25	1421.43±838.54	1731.75±1206.84	-
Chloride (mg L^{-1})	1606±765.44	1271.29±882.65	1450.08±802.49	600
Sulphate (mg L^{-1})	111.18±44.66	65.33±32.53	84.86±42.76	500
DO (mg L^{-1})	2.09±0.12	1.87±0.26	1.94±0.24	-
BOD (mg L^{-1})	990±626.47	677.0±82.42	795.83±419.56	50
COD (mg L^{-1})	2066.6±1538.46	2802.14±531.50	2914.50±1016.85	-

Table 2: Nitrogen and phosphate changes of wet and combined leachate samples

Parameters	Wet season Mean±SD, n = 05	Dry season Mean±SD, n = 07	Combined samples Mean±SD, n = 12	FEPA's standards
Ammonia (mg L^{-1})	62.26±178.65	1316.72±1299.95	855.13±1299.95	-
Nitrate (mg L^{-1})	0.50±0.18	0.58±0.37	0.58±0.29	20
Phosphate (mg L^{-1})	2.31±1.28	2.07±1.87	2.2±1.56	05

Table 3: Trace metals compositions of wet dry and combined leachates

Parameters	Wet Season Mean±SD, n = 05	Dry season Mean±SD, n = 07	Combined samples Mean±SD, n = 12	FEPA's standards
Lead (mg L^{-1})	1.693±0.64	1.34±089	1.490±0.738	< 1
Nickel (mg L^{-1})	0.659±0.48	0.952±0.29	0.815±0.379	< 1
Cadmium (mg L^{-1})	0.103±0.07	0389±0.37	0.330±0.340	< 1
Iron (mg L^{-1})	189.485±74.12	120.392±76.01	148.53±76.352	20.0
Manganese (mg L^{-1})	23.623±12.87	24.854±9.90	22.634±10.645	05.0
Zinc (mg L^{-1})	2.257±1.33	1.423±0.51	1.955±1.073	< 1

particularly for conductivity. SS, dissolved solids, BOD, COD, phosphate, lead except on colour, turbidity, dissolved oxygen, ammonia, nikel, cadmium and manganese (Table 1-3). This could be surface water ingress into the landfill that promotes solubilisation of pollutants from actively decomposing waste mass into each leachate from the landfill site (Campbell, 1993).

The suspended solids (177.9 mg L^{-1}) and turbidity (114.3 FTU) values indicated presence of organic and inorganic solids that act as adsorptive sites for certain chemicals and biological agents. The dissolved oxygen (1.94 mg L^{-1}) was quite low and cannot support desire aerobic organisms downstream. This may upset the encourage development of septic conditions and lead to proliferation of anaerobic biota that may produce anaerobic conditions. The ammonia value (855.1 mg L^{-1}) provides evidence of its release from decomposition of nitrogenous substances in refuse. The standard for ammonia in wastewater aimed for discharged into surface waters in Nigeria even though it is highly toxic even at low concentrations. Conversely, nitrate and phosphate values were within permissible limits (Ogban, 2000); Iron (48.5 mg L^{-1}), manganese (22.6 mg L^{-1}) and zinc (12.0 mg L^{-1}) concentrations were high. The concentrations of lead (1.5 mg L^{-1}), cadmium (0.3 mg L^{-1}) and nikel (0.8 mg L^{-1}) were permissible for disposal on land according to the national regulatory standards (Table 3). Total metals concentrations exceeded the national threshold value (Table 4). This may be hazardous to the ecosystem and public health since metals are cumulative toxicants that pose danger near the top of the food chain. It could also lead to bioacculmation and bioconcentration of these metals in the food chain.

The characteristics of leachates made it mandatory for an appropriate and wise selection of a treatment method that can meet any given discharge standard. Experiments should be conducted at laboratory scale on possible treatment methods. It would be easy if leachate treatment methods were transferable directly from one location to another. This is because leachates vary greatly in composition form site to site and after a while, the treatment process initially selected may be inappropriate as the landfill ages.

Table 4: Characteristics of leachates and national regulatory standards in Nigeria

Parameters	Leachates	FEPA's standards (recommended values)
Colour (HU)	426.1	7.0
Turdicity (FTU)	114.3	5.0
SS (mg L^{-1})	176.9	30.0
BOD (mg L^{-1})	795.8	50.0
Phosphate (mg L^{-1})	2.2	5.0
Sulphate (mg L^{-1})	84.0	500.0
Iron (mg L^{-1})	148.5	20.0
Total metals (mg L^{-1})	175.8	3.0

CONCLUSION

Solid water management has been a very serious problem in urban centres. Waste taken to a dumpsite for disposal cause serious problems through contaminating the land and water resources nearby. Developing countries like Nigeria have to address these problems due to high costs involved. Thus, of the various solutions to this problem which are available, an aquatic Forsk is found to reduce various organic and toxic pollutants to the desired levels. This phytoremediation technique can also be used in combination with other plant is indigenous, tolerant to waste and toxic chemicals. This physiochemical methods and economic in keeping the environment safe.

REFERENCES

Aluko, O.O., 2001. Characterization and Treatment of leachates from a Municipal solid waste landfill safe in Ibadan. MPH Dissel University of Ibadan, Ibadan, Nigeria, pp: 83-84.

Aluko, O.O., M.K.C. Sridhar and P.A. Oluwande, 2000. Treatment of leachate from Municipal Solid wastes using Constructed Nigerian Experience. International Conference on Constructed Wetlands for Wastewater Treatment in Tropical and sub-tropical, pp: 30.

APHA, 1998. Standard Methods for Examination of Water and wastewater. 19th Edn. American Public Health Association.

Campbell, D.J.V., 1993. Environmental Management of Landfill sites. J.I.W.EM, 7: 170-173.

Charlotte, Y., 1998. Applying COSHH Principles to Waste Management. Environ. Health J., 106: 289.

Ogban, F.K., 2000. Trace Elements, a Glowing Appreciation of their effect on man. Science, pp: 181.

Tairu, A.N., 1998. Water Quality surveillance and Treatment. National Water Bulletin, pp: 2.

Taras, O.M., 1950. J. Analytical Spetroscopy, 120: 1243-1246.

Loizidou, B.F., 1993. Environmental effects of landfills. Total Environ., 100: 414-428.