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Investigation of the Effects of Age, Season and Quaility of Leachate (Contamianant) Transport in Bulumkutu Open Dumpsite, Maiduguri

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Abstract: *The disposal of solid wastes at Bulumkutu dump site over the years is an issue of great concerns more so with it attendants leachates emanating from the site causing a lot of untold odors' and discomfort to the people around it apart from the various medical conditions that might be caused by the leachate presence from the dumpsite. Generally, Municipal solid waste is disposed in low lying area without proper precautions or operational controls. Therefore municipal solid wastes management (MSWM) is one of major environmental problems in Borno. Municipal solid waste management encompasses planning, engineering, organizations, administrations, financials and legal aspects of activities associated with generation, storage, collections, transport, processing and disposal in an environmentally compatible manner adopting principles of economy activities and energy conservations. The research investigated the effects of the leachate and its variations over time as a result of age, season and quality of the leachate.*

Keywords: *Leachate, dumpsite, variations and municipal solid waste (MSW).*

INTRODUCTION

Maiduguri metropolis in Borno state is currently facing a municipal solid waste dilemma, for which all the elements in the society are responsible .The community sensitization and public awareness is low. There is no system of segregation of organic, inorganic and recyclable waste at household's level, besides the inadequacy of effective legal framework to address municipal solid waste management in the state. Management of municipal solid waste MSW is an issue of great concern to all and remains one of the most neglected areas of urban development in the state .With the rapid industrialization and population growths, the state of our environment are degrading day by day. Municipal solid waste generation has direct correlations with economic growth. Due to the rapid industrial growth and migration of people from the villages to the metropolises as a result of insurgency, the urban populations are increasing rapidly.

The disposal of solid wastes at Bulukutu dump site over the years is an issue of great concerns more so with it attendants leachates emanating from the site causing a lot of untold odors' and discomfort to the people around it apart from the various medical conditions that might be effected by the leachate presence from the dumpsite. Generally, Municipal solid waste is disposed in low lying area without proper precautions or operational controls. Therefore municipal solid wastes management (MSWM) is one of major environmental problems in Borno. Municipal solid waste management encompasses planning, engineering, organizations, administrations, financials and legal aspects of activities associated with generation, storage, collections, transport, processing and disposal in an environmentally compatible manner adopting principles of economy activities and energy conservations. The management of municipal solid waste is going through a critical phase due to the unavailability of suitable facilities to treat and dispose of the larger amount of municipal solid waste daily in the metropolises.

The management of municipal solid waste MSW requires proper infrastructure, maintenance and upgrade for all activities. The difficulties in providing the desired level of public service in the urban areas are often due to poor financials status of the municipal corporations such as the Borno environmental protection agency.

Insufficient management of disposal of municipal solid waste is an obvious cause for degradation of environment, ecological impacts such as land degradation, water and air pollutions are related with improper management of municipal solid waste. Most of the municipal solid waste is dumped on Land or in more or less uncontrolled manners. Lack of sufficient awareness at the grassroots level of the waste generation add to the problem of littering. As a result, there is serious threat to public health due to the environmental pollutions. Unscientific disposal causes an adverse impact on all components of the environment and human health.

One of the major pollutions problems caused by municipal solid waste at dumpsite is the leachate which is generated as a consequences of precipitation, surface runoff and infiltration or intrusions of ground water percolating through a dump site ,biochemical processes and the inherent water content of waste themselves. Leachate is the aqueous effluent generated as consequences of rainwater percolation through wastes and the inherent water content of waste themselves. Its quality is the result of biological, chemical and physical process .Rainfalls is the main contributor to the generation of leachate .The precipitation percolates through the waste and gains dissolved and suspended components from the biodegrading waste through several physical and chemicals reactions

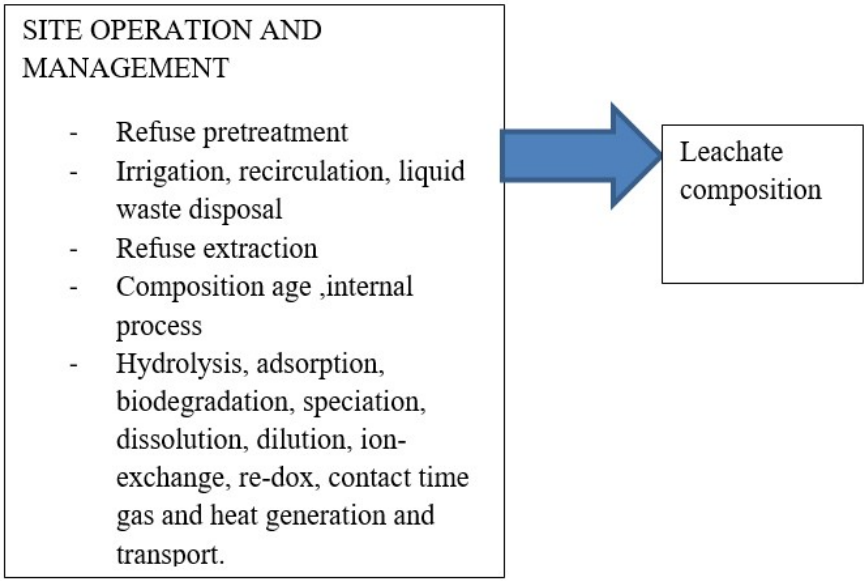
LITERATURE REVIEW

Municipal solid waste (MSW) represents major crises for both urban and rural communities because of lack of awareness of effects of dumping their waste in water canals and other unapproved places causing untold potentials hazard to both human and animals in the society. The storage of any waste material at Dumpsite or landfill poses a potentials problems. One of problem is the possible contamination on soil, ground water and surface water that may occur as leachate produced by water or liquid moving into or through and out of the dumpsite or landfill., migrating into adjacent area(Schroeder et

al.,1994).Leachate can be harmful and toxic o human and the environment (Umi Raihana et al.,2014.).Fatta et al (1994) determined that even traces of toxins in leachate can be harmful for the quality of surface and ground water and also for human health (.Guisboti, 2009).Other researcher (Al-Yagout and Homade .,2003,(Gworeck et al.,2016) classified leachate as one of major source of heavy metals transfer to the environment. Dumpsite leachate effluents are known to be characterized by high organic and inorganic pollutants concentration (Bodzek et al., 2006) and are extremely toxic to the environment. The significant impact of leachate could be entrophications of aquatic systems and toxic effects on fauna which are caused by a variety of contaminants (Lavrova and koumanova., 2010).Typical constituents concentration in Dumpsite leachate are 1000mg/lit BOD5,18000mg/lit COD,225mg/lit TN,30mg/lit TP,1000mg/lit Ca,250mg/lit Mg,500mg/lit Na ,500mg/lit K,60mg/lit Fe,500mg/lit Cl, and 300mg/SO4(Tchobanoglous and kreith,1998).Due to its high toxicity ,leachate is a major threat for aquifers and surface water health status(Bulc,2006).

The major problem in Dumpsite leachate treatments is the extremely high concentrations of ammonia and organic nitrogen.(Bulc,2006),Lavrova and koumanova (2010). Municipal solid waste (MSW) is an inevitable byproduct of human activities. MSW management is highly influenced by the socio-economic and political driver of the society. Unscientific Management and adhoc approaches in municipal solid waste management have led to a generation of voluminous leachate in urban conglomerate with its attendant's consequences. The composition of Dumpsite leachate varies greatly depending on the age of the landfill or dumpsite .As the age of dumpsite increases, Organic concentrations (COD) in leachate decreases and increase of ammonia nitrogen Concentration. The existing relation between the age of the dumpsite and the organic matter compositions may provide useful criteria to choose a suited treatment process (Amalendu, 2004), Bagui (2004) has tabulated the range of concentration of different parameters in leachate of municipal waste which is shown in table 1 describe the lower limits and upper limits that can be expected from landfill or a dumpsite.

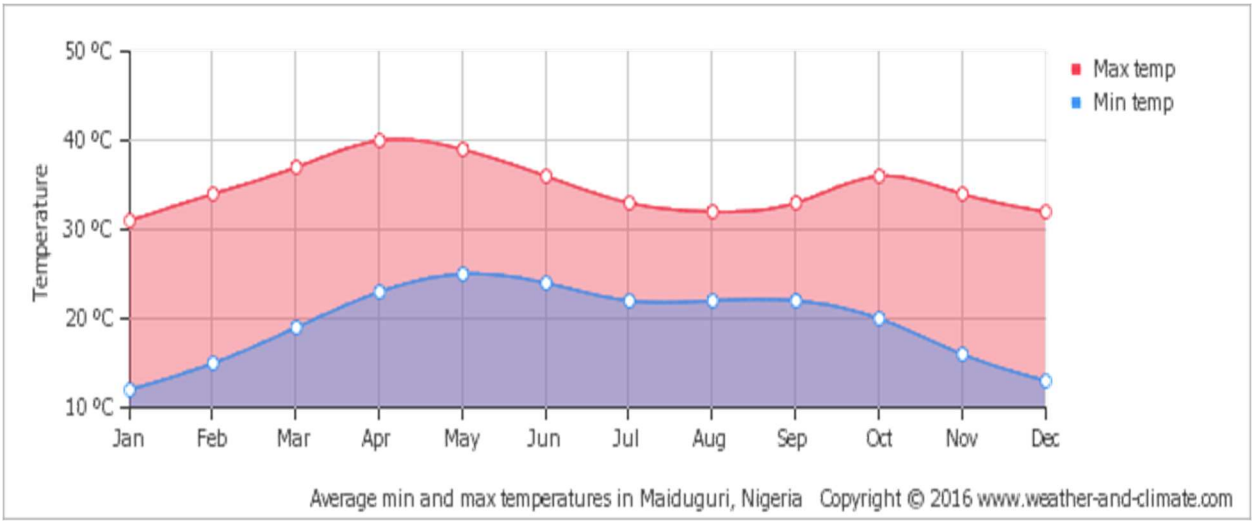
FACTORS INFLUENCING LEACHATE FORMATIONS IN AN OPEN DUMPSITE



ACTORS INFLUENCING LEACHATE COMPOSITION IN DUMPSITE

DIFFERENT CHARACTERISTICS OF LEACHATE GENERATION FROM DIFFERENT DUMPSITE OR LANDFILL

PHYSICAL	ORGANIC CONSTUTENTS	INORGANIC CONSTITUENTS	BIOLOGICAL
Appearance	Organic chemicals	Suspended solids(SS),Total solids (TS),volatile suspended solids (VSS),Volatile dissolved solids(VDS),chloride sulphate	Biochemical oxygen demand (BOD)
PH	Phenols	Phosphate	coliform
Oxidations –reduction potentials	Chemical oxidations demand(COD)	Alkalinity and acidity, N-nitrate, Ammonia -N	Bacterial
Conductivity	Total organic (TOC),Volatile acids, Tanins, lignins	Sodium, potassium, calcium, manganese, Hardness, Heavy metals such as Pb, Cd, Ni, Cr, Co, Zn, etc.	Total fecal streptococci
Turbidity	Oxygen –N,Ester soluble,Nil grease	Arsenic cyanide fluorite selenium	
Temperature	Methylene Blue, organic groups as required, chlorinated hydrocarbons		
Odor			



There are two (2) options for MSW dumping all over the world; one is the crude landfill (open Dumpsites) and the sanitary landfill. Sanitary landfill is one of the secured and safe facilities for the disposal of municipal solid waste (MSW).The most common pathway for leachate to the environment is from the bottom of dumpsite or landfill through the unsaturated soil layers to the hydraulic connections to surface water. However, pollution may also result from discharge of leachate through treatment plants or direct discharge of untreated or partially treated leachate. There are several factors that may influence the pollution potential of leachate according to many researchers. These include the concentrations and flux of the leachate, the Dumpsite sitting i.e. the hydrogeological setting and the degree of protection provided the basic quality, volume and sensitivity of the receiving groundwater and surface water.

Insufficient management and disposal of solid waste is an obvious cause for degradation of environment in the developing countries. Ecological impacts such s land degradation, water and air pollution are related with improper management of solid waste .In Asian countries and most African countries, most of the solid waste is dumped on land in more or less uncontrolled manners. Lack of sufficient awareness at the grassroots level of the waste generation added to the problem of littering. As a result, there is serious threat to public health due to environmental
and human health.

TABLE 2.1 PARAMETERS OF PRETREATED LEACHATE AND THE LIMITING VALUE ACCORDING TO WORLD HEALTH ORGANIZATION (WHO)

POLLUTANTS	AVERAGE	LIMITING VALUES ACCORDING TO WHO
PH	8.15	6.5-8.5
COD	10897mg/l	250mg/l
BOD	26mg/l	50mg/l
TDS	8906mg/l	1000mg/l
IRON	3.8mg/l	3mg/l
CADMUIM	4.3mg/l	0.003mg/l

STUDY LOCATION

Maiduguri metropolis is the largest town of Borno state has a population of slightly Five million inhabitants. It lies between latitude 10°48′00′′ and longitude 11°20′00′′ (Moyomi and Mohammed, 2014).The climatic condition of Maiduguri metropolis is hot characterized with high humidity and is semi-arid with a maximum mean temperature of up to 47°c and minimum mean temperature as low as 25°c .Total rainfall during the year is between 650-700mm with 85%of total rainfall occurring between July and September.

Leachate samples for the research work will was collected from Bulumkutu open Dumpsite .It was observed that there is no any cover of any description placed over the spread to inhibit the ingress of surface water or to minimize litter of surface water or to minimize litter below and odors or to reduce the presence of vermin and insects. Rags pickers regularly set fire to waste to separate non-combustible materials for recovery since there is no specific arrangements to prevent flow of water into and out of the Dumpsite, the diffusions of contaminants released during degradation of dumpsite waste may proceed without uninhibited .No proper compaction is done to compress the waste into the site

MAP OF NIGERIA SHOWING MAIDUGURI

MATERIALS AND METHODOLOGY

SAMPLING PROCEDURE

The quality of leachate was determined after taking integrated samples at different locations of the dumpsite. The sites were the sampling would be undertaken is an open dumpsite, a non-engineered site where there is no any liner nor leachate collector or treatment system, The leachate samples are collected from the base of solids waste heaps where the leachate is being drained due to gravitational forces. The leachate sampling was undertaken on three different point in time so as to ascertain the effects of the rainfall on the leachate quality. Leachate samples are collected from the same locations to determine

the effects of age and seasonal variation on the leachate characteristics of Bulumkutu open dumpsite municipal solid waste.

LABORATORY INVESTIGATIONS

The various physic-chemical parameters such as PH value, Total solids(TS),suspended solids(SS),Total dissolved solids (TDS),Turbidity, Hardness, Biological oxygen demand(BOD),chemical oxygen demand(COD),Chloride(cl),Nitrate(NO),Total phosphorous(TP), sulphate (SO4) and possibly other anticipated heavy metals such as Iron(Fe),Lead (Pb),Chromium(Cr),Cadmium(Cd),Copper(Cu),zinc(zn) and nickel(Ni).
Arsenic (AS) was analyzed to determine the pollution potentials of the leachate discharge from the Bulumkutu municipal solid waste (MSW) dumpsite.

Standard methods for examinations of waste and wastewater as specified by American public health associations (APHA, standard methods for the examinations of water and wastewater, 21st editions) while PH values are measured using electronic PH meter (4500-H .B .of standard methods) while the total solid (TS) was determined by properly shaken unfiltered sample and estimated using gravimetric methods (254.B of standard methods)

Table: 2.2 CHEMICAL COMPOSITION OF LEACHATE FROM MUNICIPAL SOLID WASTE (MSW)

Parameter	Concentration Range Mg/l	Bulumkutu
Alkalinity (As CoCo3	0-20,850	(16,200)
Aluminum	0.5-850	(900)
Antinomy	0.-3.19	(2.18)
Arsenic	0.-70.2	(60.5)
Barium	0-12.5	(7.0)
Beryllium	0-0.36	(0.5)
BOD 5	0.195,000	(15,000)
Barium	0.413	(0.215)
Cadmium	0.1.16	(9.5)
Calcium	5-4,0 80	(3500)
Chloride	11,375	(12,375)
Chloromium	0-22.5	(20)
COD^2	0-89,520	(72,000)
Conductivity umho/cm	480-72,500	-
Copper	0-9.9	(8.0)
Cyanide	0-6	-
Fluoride	0.1-1.3	(1.5)
Hardness (as Caco3)	0.1-225,000	(230,000)
Iron	0-42,000	(38,000)
Lead	0-14.2	(16.0)
Manganese	0-115,600	(120,000)
Manganese	0.05-1,400	(900)
Organic Holiday	0.320-3.5	(4.0)
Benzene	0.1-0.6	(0.5)

Ethyl benzene	0.-4.9	(0.2)
Nitrogen (Ammonia)	0-1250	(1000)
Nitrogen (Nitrate)	0-9.8	(8.5)
Nitrogen (Organic)	0-1,000	(900)
Nitrogen (Kyeldahl)	0-3, 320	(2800)
Nickel	0.-7.5	(0.95)

Phenol	0.17-6.6	(5.5)
Phosphorous (total)	0-234	(200)
Phosphate	0.01-154	(150)
PH	1.5-9.5	(8.00)
Potassium	0.16-3,370	(4.00)
Selenium	0-1.85	(2.3)
Silver	0-1.90	(2.2)
Sodium	0-8,000	(7800)
Thallium	0-032	(0.5)
Tin	0-016	(0.18)
TDS[3]	584-55,000	
TSS[4]	140,900	
TOC [3]	335,000	
TVA[6] (as Acetic Acid)	0-19,000	

TABLE 2.3 LEACHATE CONCENTRATION CHANGES WITH DUMPSITE AGE (LANDFILL)

Parameter	Landfill/Open Dumpsite Age (YEARS)				
Mg/L	0.5	5-10	10-20	(Bulumkutu)	> ≥0
BOD	10,000-25,000	1,000-4,000	50-1,000	(800)	<50
COD	15,000-40,000	10,000-20,000	1,000-5,000	(2300)	<1,000
Nitrogen (Kyle/Daw)	1,000-300	400-600	75-300	(300)	<50
Nitrogen (Ammonia)	500-1,500	300-500	50-200	(170)	<30
TDS	10,000-25,000	5,000-10,000	2,000-5,000	(300)	<300
PH	3-6	6-7	7-7.5	(7.5)	7.5
Calcium	2,000-4,000	500-2,000	300-500	(200)	<300
Sodium & Potassium	2,000-4,000	500-1,500	100-500	(600)	<100
Magnesium & Iron	500-1,500	500-1,000	100-500	(750)	<100
Zinc & Aluminum	100-200	50-100	10-50	(90)	<100
Chloride	1,000-3000	500-2,000	100-500	(200)	<100

Sulphate	500-2,000	200-1,000	50-100	(200)	<10
Phosphorous	100-300	10-100	50-100	(250)	<10

EFFECTS OF DISTANCE OF DUMPSITE ON GROUNDWATER CONTAMIANTION

The extent of contamination level of groundwater quality due to leachate percolation depends upon a number of factors like chemical composition of the leachate ,rainfall ,depth and distance of the well from the pollution source (the dumpsite).Groundwater sample of different depths and distance from dumpsite are to be analyze to understand the level of contaminations (USEPA,2004). Concentration of contaminants were found to be high in the sampling sites which are near to the landfill/dumpsite as reported by Abbas (2014) and Su shi (2015).Interestingly, the groundwater contamination drops fast with increase in the sampling sites from the landfill/dumpsite .The leachate was further found to be gentler as the distance from the landfill/dumpsites is increased.

TABLE 2.4 LEACHATE CHARACTERIZATIONS AND STABILIZATION AT VARIOUS DEPTHS AND ITS IMPACT ON GROUNDWATER QUAILITY

TOTAL SITE AREA	4ha
WASTE FILLED AREAS	3.5ha
DISPOSAL QUANTITY (MT/day)	APPROX 140
WASTE OWNERSHIP DSIPOSAL METHOD	BORNO STATE SANITATION BOARD AND OPEN DUMPING AND LEVELLING BY BULLDOZER
AVERAGE DEPTH OF WASTE DUMP	APPROX.1.5M
GROUND CONDITIONS	SILTY –CLAY SOIL
HYDROLOGY	WATER TABLE AT 3-5M
AGE	26YEARS

Studies undertaken by several researchers indicates that the physico- chemical characteristics ,ionic pollutants concentration ,Nitrogenous pollutants concentrations ,carbonaceous pollutants concentrations and heavy metals concentration at variable depths tends to improves as the distance increase away from the dumpsites .Accordingly, it shows that the quality of groundwater in the area near the dumpsites is greatly affected by leachate contaminations as again those that are far away from the dumpsites .The quality of groundwater was found to significantly improve with increase in depth and distance of the wells from the dumpsites .If it is unavoidable ,deeper drilling and frequent analysis of water samples are desirable in areas where there is dumpsites even if it is decommissioned dumpsites with few years (Mor et al.2006).

The quality of ground water in areas where there are dumpsites are reported to be distorted and presence of heavy metals of various pathogenic microorganism which are attributed to the leachate contaminations and most dumpsites/landfill are not isolated enough as required by regulatory bodies .Reported cases drinking groundwater polluted by heavy metals such as manganese and other ascernic substances in leachate for a long time is reported to increase risks of cancer and infants deaths as well as induce motor and

cognitive disorder .More recent studies have revealed that emerging pollutants with genotoxicity ,reproductive toxicity among others.

Leachate from dumpsites are likely source of contamination of drinking water causing poisoning ,cancer ,heart disease and teratogenicity abnormalities' .Equally ,leachate was implicate d for bacteria contaminations of drinking water.

The research seeks to establish an in-depth studies concerning groundwater quality, establish a bench –mark information's on the extent .of pollutants brought about by the dumpsites. The evaluation of the dumpsite leachate quality and quantities is to be established for use in environmental impact assessment as well as the factors that influences the leachate production processes which varies with time and space ,hence the need for in-depth evaluation .The conventional contaminant are known as reported in several research work ,but the exact composition of dumpsite leachate composition is yet to be established and obviously their potentials impacts on the environment in this part of the world is relatively unexplored.

GOVERNING EQUATIONS

There are various governing equations which are essential for the utilization of all the outlined steps. The partial differential equations describing the groundwater flow, velocity and contaminants transports can be expressed as follows according to Harbaugh (2016) and Zheng and Wang (2014):

For the ground water flow model,

$$\frac{d}{dx}\left[kx(\psi)\frac{d\psi}{dx}\right]+\frac{d}{dy}\left[ky(\psi)\frac{d\psi}{dy}\right]+\frac{d}{dz}[kz(\psi)\frac{d\psi}{dz}=\ [\frac{\theta}{nSs}+c(\psi)\frac{d\psi}{dt}]+-Q\ \ldots.1$$

For the contaminant transport Model:

$$\frac{d}{dx}\left(\theta Dxx\frac{d}{dx}+\theta Dxy\frac{dc}{dy}+\theta Dxz\frac{dc}{dz}\right)+\frac{d}{dy}\left(\theta Dyx\frac{dc}{dx}+\theta Dyy\frac{dc}{dy}+\theta Dyz\frac{dc}{dz}\right)$$
$$+\frac{d}{dz}\left(\theta Dxx\frac{dc}{dx}+\theta Dzy\frac{dc}{dy}+\theta Dzz\frac{dc}{dz}\right)-[\frac{d}{dx}(V\times C)+\frac{d}{dy}(VyC+\frac{d}{dz}(VzC)$$
$$=\frac{d}{dt}(\theta C)+\rho b\frac{ds}{dt}+Km\theta C-1+-R$$

Where X,Y Z are the Cartesian coordinates axis ., t is the time .,Kx, Ky ,Kz are the hydraulic conductivity along the respective Cartesian plane ,X,Y,Z coordinates axis ,ψ is the pressure head ,ɵ is the moisture content .,n is the effective porosity of the porous media Ss is the specific storage of the porous media .C(ψ) is the specific moisture capacity ,Q is a volumetric flux per unit volume representing sources and sinks of water.,Dij(I,j=x,y,z) is the hydrodynamic dispersion coefficient .,C is the concentration of contaminants dissolved in groundwater.,Vx,Vy,Vz are groundwater velocities in x,y,z directions and Vx=-Kxδh/δx, and Vy=-Kyδh/δy, while Vz=-Kzδh/δz, h=′z+ψ is the total head., ρb is the bulk density of the porous media,S is the weight absorbed water per unit area of porous media .,Km is the decay coefficient .,m is the m-th order of chemical /biological decay .R is the retardation coefficient which is defined as

R=1+ ρb/n kd

Where Kd is the partition coefficient .The component of the hydrodynamic dispersion coefficient are also calculated by equation below

$$Dxx=\acute{\alpha} L V^2x/|v|+\acute{\alpha}TH V^2y/|v|+\acute{\alpha} TV v^2z/|v|+D^*$$

$$Dyy=\acute{\alpha} L v^2y/|v|+\acute{\alpha} T H v^2x/|v|+\acute{\alpha} T V v^2z/|v|+D^*$$

Where ά L is the longitudinal dispersiivity ,ά T H is the horizontal transverse dispersitivity and ά T V is the vertical transverse dispersitivity and D* is the molecular diffusion coefficient , $|V|=\sqrt{v^2x+v^2y+v^2z}$ is the magnitude of the velocity vector.

When the velocity vector is aligned with same coordinates axis, all the cross items becomes zero.

These governing equations cannot be solved analytically; therefore they have to be solving using numerical methods. The finite difference method is used in MODFLOW and MT3DMS Package for deriving the solution to the governing equation.

Although, some of the models have been applied in the prediction of contaminants sorption and transport in developed countries, not much has been done in Nigeria .One of the six (6) guidelines and standards defining environmental policy includes the management of solid and hazardous wastes ,notwithstanding there are numerous issues that hinder its successful execution (Eneh and Agbaue,2011).It is observed that most of the work in contamination of groundwater due to landfilling and open land dumping is described qualitatively ,without much emphasis to quantitative measurement and prediction

CONCLUSION

The release of leachate to the environment is one of the major environmental impacts related to disposal of waste .Disposed waste in Open Dumpsites undergoes a series of phases where the waste is decomposed .During the decomposition, leachate is generated by excess rainwater infiltrating the waste .The leachate contains several groups of pollutant namely Dissolved organic matter, inorganic macro components, heavy metals and xenobiotic organic compounds.

Existing literatures shows that the compositions of leachate is highly dependent on the degradation stage of the waste.

Leachate generation is an inevitable consequence of the practice of waste disposals .Many environmental factors and operational practices influence landfill process resulting in temporal and spatial variations in the quantity and quality of land fill leachate. Leachate sampling methods and sample handling routine may also influence the leachate quality.

Several studies have also indicated seasonal variations in leachate compositions and concentrations have been reported.

Mathematical models have been developed over the years to simulate these variations as well as leachate generations and transport process.

Several reviews of selected flow and transport model have been reported in literature's ,many of which have been applied to simulate the migration of leachate contaminants

plumes away from sanitary landfill and similar concepts have also been adopted to develop mathematical models or use existing models to simulate leachate occurrences and behavior with a landfill.

REFERENCES

Abbas .A.A.,Jungsong.G.Ping.L.Z.,Ya Pan,Y., Winston., Al-Rekabi (2009).Review on Landfill leachate treatments .American journal of applied science,6(4).,pp672-684,2009.

Ahmed S. khanbilvardi R.M, fillos and gleason P.A, two dimensional model for estimating leachate for water management, conf.proc, ASCE,forth horth Texas, April 17-21, 738-148

Ahmed S. khanbilvardi R.M, fillos J and gleason P. tho dimensional leachate estimation through land live. J.Hydrengineering ASCE 118:, 306-323

A.Kansel, Solid waste management strategies for India, Indian journal of environmental protections, 22(4), 2002, 444-448.

A .khajuria, Y.Yamamodo and T.Morikoa, Solid waste Management in Asian countries, Problems and issues. Proceeding of 4th international conference on waste management and environment, June2-4, 109, 2008 643-653

Al-shifi, R. predicting the generation and transport of pollutants by water shed hydrologic system model proc.inter.emf, April Lisbon, Portugal, 888-895 management and environment, June2-4, 109, 2008 643-653

Al-shifi, R. predicting the generation and transport of pollutants by water shed hydrologic system model proc.inter.emf, April Lisbon, Portugal, 888-895

A.H.Robinson, Landfill Leachate Treatment, Journal of membrane Technology, 2005, 5-12

Akessin N.P Nilsson seasonal change and pattern of leacheate fluid in municipal solid waste land fill journal environment 123,892-900 ( )

Amalendu, B. (2004).Design of landfill and integrated solid waste management, 3rd Editions, John Wiley & Sons, Inc. Hoboken. New jersey, Canada

APHA, Standard methods for examination of water and waste water (19th edition).

Augustine D.J Pacey, modeling land fill methane generation conference proceedings 3rd international land fill symposium, sardine Italy vol,1;115-148

Bendz, D.C Dengisson,L evaporation from an active uncovered landfill, journal of hydrology, 182:143-155,1996

Beven, K,P. german waterflow in soil micropores.11A combined flow model, journal of soil science, 32:15-29( )

Blakey W.C infiltration and absorption of water by domestic aste in landfills, research carried out by WRC harwell landfill leachate symp, oxon .UK. (1986)

Brooks, R.H.A.T. covey properties of porous media affection fluid flow, Proc: AM.soci. Civ Eng.g 92,61-87, 1989

C.Visvanathan and J.Tranker, Municipal solid Management in Asia. A comparative analysis workshop on sustainable landfill management 3-5 December, Chennai, India, 2003, 3-5

Catfrey,R.P,R.K ham, the role of evaporation in determining leachate production from milled refuse landfill compost sci. march-April: 11-15 (1986)

Campbell D.J.V understanding water balance in landfill sites waste management ,75:594-600 (1998)

Clozying of leachate collection systems used in harzardous waste disposal identifying white paper, prepared for USEPA research triangle park, north Corolina.

Chen C.R.J wagnet, simulation of water and chemicals in micropores soils, part 1representation of the equivalent macrospore influence and it effects on soil water flow J>Hydro, 130:105-126 (1999)

Christerisen, T.H and Kyeldsen P, (1989) basic biochemical process in landfill.in: T.H Christensen R> cassu and R. stegman (editors) landfilling press technology and environmental impact academic press London PP. 29-49

Demetamorphous A.C Kortifictis G.P, Bourodinas E.I and navy E.G moisture transport in a solid waste land fill model and sensivity analysis water resource , bullet 22, 601-609 ( )

El-fadd M,nomical modeling of gas and heat generation in sanitary landfill Ph.D dissertation standford university

Enviro nmental Protection Agency (EPA Ghana) Manual for the preparation of District waste management in Ghana. Best practice .Environmental Guidance. Series NO 3, EPA, Accra. (200)

Ehrig H.S quality and quantity of sanitary landfill leachate waste management Res 1:53-68(2000)

Ettala, M., infiltration and hydraulic caudation at a sanitary lawful. Aqua finically, 2; 231-237,71006.

Erdogan H prediction models for sanitary land fill in Eng, conf. prece ASCE boulder, Co July 6-8, 540- 547

Farguhar G.J leachate production and characterization. Com journal civil Eng.g 16 317-325 ( )

Fenn D.G Harley K.J Deg. T.V ( ) used of waste balance method for cincinati predicting leachate generation at waste disposal site EPA 530/5w-168 USEPA ohio.

Foo, K.Y., Hammed B.H. (2009). An overview of landfill leachate treatment via activated carbon absorption Process. Journal of hazardous materials (171)

Fred Lee. G, Anne Jones-Lee (1994). A groundwaterprotection strategy for lined landfills. Enviromental. Science and technology.

Fuller W.H Ford A.A and carter G.E predicting movement of selected metals in soils, application of the disposal 5th Ann. Symp. Orlando florida March 26-28 EPA 600- 9-29-023ac

G.Tchobanoglous, H.Thesen and S.A. Vigil integrated solid waste management Engineering Principles and Management issues (1st Editions) New York McGraw Hill, 1993

Gee, J.R; the prediction of leachate generation in lawfill a new method; 6th annual malison conference of applied research and practice on municipal and industrial west , pp. 201-224,2009.

Gerke, H.H. M.T; van genuchten a dual proposity model for simulating the preferential movement of water and solutes in structured porous media, water resource res.29:305-319, 2011

Ibrahim A. Mirsal (2008). Soi l Pol lution-Or igin, Monitoring & Remediation Second edition, Springer.

IS 2720- Part 5 (1970). Method of Test for Soils: Determination of liquid and plastic limits. Bureau of Indian Standards, New Delhi.

IS 2720- Part 30 (1980). Method of Test for Soils: Laboratory vane shear test. Bureau of

Indian Standards, New Delhi.IS 2720- Part 3 (1980). Method of Test for Soils: Determination of specific gravity. Bureau of India Standards, New Delhi.

IS 2720- Part 5 (1970). Method of Test for Soils: Determination of liquid and plastic limits. Bureau of Indian Standards, New Delhi.

Kortiatis G.P Modelling the moisture transport through solid waste landfill Ph.D dissertation, Rutgers university ( )

Lee, J.Y jung LH Lee W.B and Kim J.O, computer and experimental simulation of the production of methane from municipal solid waste. Water sci tech .27. 225-234

Lee J.L ; shin H.S. and clung H ; simulation of leachate quality using laboratory hyalite proc. Thro Int. landfills syrup. Sandinia , Italy, 865-875 ( )

Noble J.J nasir G.m, heestan J.F and Arnold A.E experimental an mathematical modeling of moisture flow in land filltech centre env.mgt, turf university.

Rao S.K; prediction of settlement in landfills for foundation design purpose Ph.D dissertation .West Virginia university ( )

Reddy. K.R, Hiroshan Hett iarachchi, Janardhanan Gangathulasi, Jean Bogner, and Thomas Lagier (2009).

Reddy. K.R., Hiroshan Hettiarachchi, Naveen Parakalla, Janardhanan Gangathulasi, Jean Bogner, and Thoma Lagier (2009

Rowe R.K and broker J.R; pollutants migration through liner undertrain by fractured sill J. Geotech Englg Asiel , 127 1902-1919 ( )

.Roa ,T.Rao .V.V.S.G .,RANGSAVSIN,K ,Surinda .L Mahesh,j.(2011) Assessments of groundwater contamination from a hazardous dumpsite in Ram fit ,india .Hydrogeology journal Vol 150.pp465-469

S.Renou, J.G. Giaduran, S.Poulain, F. dirassouyan and P.Moulin.Landfill leachate treatment. Review and opportunity, journal of Hazardous materials, 150, 2008 468-493

Singh V.P kinematic wave modeling in water resource environmental hydrology john wisely and sons New York 2010

Straub W.A and lynch D.R., models of lawfill leaching organic strength. J. environs. Engg, AIP ASCE, 180,251-268 ( )

Stegman R.H J ehrig leachate production and quality-result of land fill process and operation conference proceeding gs. An international landfill symposium. Sardinia Italy XXVIII:1-16, 2012

Thoma, S.G, D.P Gallegos D.M smith, Impact of fracture coating on fracture/matrix flow interaction unsaturated porous media water resource; 28:1357-1367,1998

Tsana Y.W, C.F Tsana, channel model of flow through fractured media, water resource 23:467-479.(2000)

USEPA (2011) Municipal solid waste landfill criteria technical manual, subpart-D ,Design criteria ,united state environmental protection Agency .,http//www.epa.gov

USEPA (1989). Requirements for Hazardous waste landfill design, continuation and closure. Engla/625/4-89-022, USEPA Washington DC,USA,57P.

YAING C.W Nummon, T.J jacniki , M.P cogley, D.R and capine, S.V.( )

Zeiess, C.W major moisture flow through municipal solid waste pattern and characteristic .J. environment systems 22.211-231 ( )

Zheng , C(2009) Recent Development and pure direction for MT3DMS and related transports codes ,Ground water vol.7 pp 620-625

Zheng ,C.and Bernett,G.C.(1995). Applied contaminant transport modeling, van Nostrand Reinhodo ,A Divison of international Thompson publishing inc.New York pp440