ELEMENTAL ANALYSIS OF LEACHATES FROM OPEN- DUMP-SOLID WASTES IN ONDO STATE, NIGERIA: IMPLICATION ON UNDERGROUND WATER AND SURFACE WATER SAFETY

[1]Sabejeje, A. J., [2]Oketayo O.O., [3]Bello, I.J and [4]Sabejeje, T. A

[1,3] Integrated Science Department, Adeyemi College of Education, Ondo.
*[*2] Department of Physics, Federal University Oye-Ekiti, Ekiti State. Nigeria.*
[4] Biology Department, Adeyemi College of Education, Ondo.
[*]**Corresponding** author's address: Department of Physics, Federal University Oye-Ekiti, Ekiti State, Nigeria. E-mail: oketayodele@gmail.com

Abstract

For many developing cities across the world, waste management is always a major problem. The concentrations of some selected heavy metals in landfill leachates from Ondo State, Nigeria were determined using Flame Atomic Absorption Spectrophotometer (FAAS) to ascertain the susceptibility of refuse dump solid wastes to leaching of contaminants in Ondo State, Nigeria. The result indicated that Cu, Fe, Ni and Pb were in the range 0.01 - 0.02, 7.00 - 8.00, 0.60 - 0.70 and 0.80 - 0.90 mg/L respectively. These levels (except Cu) have been found higher than the maximum permissible limits recommended by WHO (2009) threshold values and other literatures (in most cases). This implies that leachates from these landfills could be a contributing factor to level of these heavy metals in groundwater, especially where the dumpsites are close to the drinking water sources. Elemental analysis of drinking waters within this vicinity is needed for safety.

Keywords: Elemental analysis, leachates, waste dump and FAAS.

{**Citation:** Sabejeje, A. J., Oketayo O.O., Bello, I.J and Sabejeje, T. A. Elemental analysis of leachates from open-dump-solid wastes in Ondo State, Nigeria: Implication on underground water and surface water safety. American Journal of Research Communication, 2014, 2(10): 287-296} www.usa-journals.com, ISSN: 2325-4076.

INRODUCTION

Large numbers of human activities today produce wastes which may become harmful to the body if allowed to be stored. As a result of agricultural and industrial revolution, industries are found of producing wastes which may not be recycled again. Hence, there is need for disposal. Recent statistics reveal that industries produce twice the wastes generated by residential and commercial sources per year and 35 times more waste than is generated by sewage treatment plants (Martins and Johnson, 1987). For many developing cities across the world, waste management is always a major challenge.

From Nigeria context, wastes are littered with mountains of illegal dumping sites. Local rivers have also become avenue for dumping refuse and sewage. Such dumping sites do not only serve as the breeding ground for flies, rodents and mosquitoes but also threaten human health and environment with adverse effect on the quality of life.

During raining season, the rain water washes away the heavy metals from the wastes into the soil and the nearby lake, river, sea, or pond. From this, the living organisms obtain water for their proper growth and development and as this occurs, they take heavy metals along with the water they obtain. Human beings are not left out of this hazard. Since every living soul depends on water and vegetation for their survival. Human beings are prone to consume these heavy metals as they consume the contaminated water and vegetation.

Moreover, with respect to the increasing awareness of the impending danger of hazardous wastes to the environment, large numbers of countries especially the U. S. A. now make large funds available for research into toxic wastes disposal methods that would produce minimum risk to the environment and human health (Rowen and Abel-Magid, 1995). Environmental protection agency services are established to formulate policies and regulations on the generation, transportation, treatment, storage and disposal of wastes.

The World Health Organization (WHO) and the North Atlantic Treaty Organization (WHO-NATO, 2011) committee on the challenges of modern society have active industrial wastes management guideline programme. England and Germany have industrial and hazardous wastes cleaning houses where wastes from one industry can be directed to another for use as that industry's feedstock. In Canada, the Environmental protection service (EPS) plays an indirect and shared role with provincial government in the areas of health, agriculture and the environment. The early programme of Canada for the land disposal of sludge include physiochemical and biochemical characterization of base metals and milling sludge reclamation of acid sludge from waste oil reclamation and leachability of radioactive products from uranium mine tailings (Rowen and Abel-Magid, 1995).

Hence, there is an increasing global awareness of the toxic effect of the wastes which most human beings ignorantly consume from surrounding water and food (vegetation). In order to reduce this effect, there is need for environmental deterioration in leachates from economic, agricultural and technological advancement and most especially from open dump solid wastes.

Human exposure to heavy metals has risen dramatically in the last 60 years (Martins and Coughtery, 1982). However, as a result of an exponential increase in the use of heavy metals in industrial processes and products, chronic exposure comes from mercury amalgam, dental fillings, lead in paints and tap water, chemical residues in processed foods and personal care products such as cosmetics, shampoo and other hair products, mouth wash, toothpaste, soap especially the medicated ones, e. t. c. In today's industrial society, there is no escaping route to toxic chemicals and metals. In addition to the hazards at home which include inhalation of air pollutants, consumption of contaminated water and food and outdoors, many occupations involve daily heavy metals exposure. Over 50 professions entail exposure to mercury alone. These include physicians, pharmaceutical workers, dentists, laboratory workers, hairdressers, painters, welders, metal workers, cosmetic workers, battery makers, photographers, visual artists, potters to mention a few (Gary, 2001).

Current studies indicate that every minute, level of toxic elements have negative health consequences. (Gary, 2001). However, these vary from person to person. Nutritional status, metabolic rate, the integrity of detoxification pathway (ability to detoxify toxic substance) and the mode or degree of heavy metal exposure also affect how an individual responds. Children and the elderly, whose immune system are either underdeveloped or age-compromised, are more vulnerable to toxicity (Gary, 2001). Metals are particularly toxic to the rapidly developing systems of the foetus, infants and young children (Gary, 2001). Such metals, for example lead or mercury, can easily cross the placenta and damage the foetal brain (ASTDR, 1999).

Sample Collection

Fifty leachate samples were obtained from the dumpsites in ten different locations in Ondo State during raining season. The dumpsites were located in Ondo state and lies in climate region between latitude and longitude North 7^0 13′ and East 4^0 52′.

The physical characteristics which formed the criteria for sampling were dark colour and about eighty years (80 yrs) of existence from their appearance. Relatively, distilled water was used as the control sample with threshold value. Plate 1 shows one of the sites studied.

Plate 1: Aigo River-One of the sites studied.

Digestion Procedure

Wet ashing method was employed in this research work. Fifty millimeter (50 mL) of leachate sample was obtained using a measuring cylinder into a 25 mL beaker. Five millimeter (5 mL) of HNO_3 was measured using syringe and added to the sample. The mixture was heated until it boiled and evaporated up to 20 mL. It was then removed from the hot plate. Upon cooling, 5 mL of HNO_3 was added to the remaining 20 mL of the mixture sample and heated. A light coloured clear solution was observed indicating complete digestion of the sample. Two millimeters (2 mL) of HNO_3 was further added and heated to dissolve the precipitate present in it. The solution was transferred to 50 mL standard volumetric flask and a clean wash bottle was used to make the solution up to 50 mL. This now served as the sample which was used for elemental analysis. Wet ashing was employed to avoid interference of organic matters that may be present in the leachates which can interfere with the results of the analysis thereby leaving behind the inorganic component of the samples for the analysis. Each sample was analyzed thrice for Copper (Cu), Iron (Fe), Nickel (Ni) and Lead (Pb) using Flame Atomic Absorption Spectrophotometer (Buck Scientific, VGP 210 model) at Obafemi Awolowo University, Ile-Ife Nigeria Central Science Laboratory and the result is presented in Table 2.

RESULTS AND DISCUSSION

Table 1 shows the detection limits of the elements for the equipment used for analysis (indicating the sensitivity of the equipment in determining the elements considered while Table 2 shows the levels of these metals in the leachate samples collected.

Table 1: Detection limits of metals

METALS	DETECTION LIMITS (mg/L)	WHO (2009) Recomended Limits
Lead (Pb)	0.02	0.01
Iron (Fe)	0.005	
Nickel (Ni)	0.002	
Copper (Cu)	0.0005	0.005

Table 2: Heavy Metal Content of the Leachates (mg/L)

Metals	Leachate sample (mg/L) Range	Mean ± SD	Threshold value (mg/L) (WHO, 2009)
Copper (Cu)	0.01 - 0.02	0.02 ± 0.01	1.00
Iron (Fe)	7.00 - 8.00	0.75 ± 0.05	0.30
Lead (Pb)	0.80 - 0.90	0.85 ± 0.03	0.05
Nickel (Ni)	0.60 - 0.70	0.65 ± 0.05	0.10

The result indicated that the concentrations of the four heavy metals detected in the leachate samples were greater than their threshold values except copper with concentration lower than its maximum permissible limit by WHO (2009). The levels of these metals were compared with the results obtained in similar works within and outside Nigeria (Table 3).

Table 3: Levels of Heavy Metals in Leachates compared with Literatures

Metals	In this study	Aiyesanmi and Imoisi (2011)	Huan-Jung *et al* (2005)	Mapanda *et al* (2007)
Cu	0.01- 0.02	0.40-0.61	ND	ND
Fe	7.00-8.00	1.96 ± 3.19	ND	ND
Ni	0.60-0.70	0.05 ± 0.07	0.01-0.07	2.90-3.70
Pb	0.80-0.90	0.05- 0.12	0.10	ND

ND=Not determined

The concentrations of Fe, Ni and Pb (except Cu) in leachate samples used for this study were higher than the levels observed in leachates from Benin City (Aiyesanmi and Imosi, 2011). This could be as a result of wastes deposition from the nearby mechanical and artisanal workshops. Also, the concentrations of Ni were higher in the samples studied than those reported by Huan-Jung *et al* (2005) for leachates in Tiwan but less than the values reported for Harare leachate samples in Zimbabwe (Manpanda *et al.*, 2007) as reported by Aiyesanmi and Imoisi (2011). Higher concentrations of Pb were also recorded in this study than leahates (0.10 mg/L) in Taiwan as reported by Huan-Jung *et al* (2005). It is possible to have a significant increase in Pb content of groundwaters and farmlands in this area. The concentration of Cu and Pb were lower in samples in this study than the values (0.02 ± 0.01 and 8.81± 0.06 respectively) reported by Ogundiran *et al* (2012) in samples from Ibadan (One of the largest cities in Nigeria).

CONCLUSION

Fifty leachate samples were collected at ten different locations. Samples were digested using wet ashing method and the elemental analysis was carried out using Flame Atomic Absorption Spectrophotometer (FAAS). The analysis revealed the presence of these heavy metals at a concentration greater than their threshold values (except copper) as recommended by WHO (2009) for the maximum permissible limit of heavy metals in leachates. This suggested the possibility that wastes from these areas are susceptible to leaching of these heavy metals into ground water and the adjoining surface at a level that may be hazardous to human health. As a result, it is suggested that water samples from such environment should always be properly and adequately treated with chelating agents. The government at various levels (Federal, State, and

Local) should ensure that the water is supplied to the public (most especially, for those who reside in these areas) by construction of bore hole.

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