International Journal of Environment, Agriculture and Biotechnology
Vol-7, Issue-2; Mar-Apr, 2022

Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Peer Reviewed

Metallic Percolations and Environmental Impacts of Spent Lubesat Local Auto-Mechanic Workshops

Oladejo. Duduyemi[*1], A. Moronkolaa[1], S.A. Adebanjo[1], K.A. Adedeji[2], A.O. Adefuye[2]

[1]Lagos State University, Faculty of Engineering Department of Chemical and Polymer Engineering, Nigeria
[2]Lagos State University, Faculty of Engineering Department of Mechanical Engineering, Nigeria
[*]Corresponding author e-mail:engrduduyemi@yahoo.com

Received: 27 Mar 2022; Received in revised form: 15 Apr 2022; Accepted: 20 Apr 2022; Available online: 24 Apr 2022

Abstract— *The illusion of herbs and grasses atmost mechanic workshops was given the concern to know the effects of mechanic activities on the environment using the Epe Central mechanic village as a case study. Soil and water samples from the environment were analysed for Copper (Cu) and Lead (Pb) with the view to investigating the extent of percolations and the consequential effects of the heavy metals from spent lube on the surrounding water and soils. The concentrations of Lead (Pb) and Copper Cu recorded at the soil surface were 2049.64 ppm and 153.22 ppm respectively. At depths between 7.8 to 30.1 meters (25 to 100 ft), the concentrations profile estimated for Copper metals reduced drastically to 59.98 ppm in a linear relationship defined with the depths as $Y_{(x)}=-1.03064*x+175.758$ while Lead concentration reduced to 342.35 ppm. The concentrations of Copperwere0.63ppm in well water and 0.36ppm in the borehole water sources. Likewise, the Lead evaluated was 0.13 ppm in well water and 0.04 ppm in the bore-hole water sources respectively.These values were however higher than evaluated values at distant locations. Mechanic activities at the location are believed to be responsible for biotic degradations. It is anticipated that the heavy metals in the spent oil percolate into the soil as leachates and runoff which may prime the pollution of underground water in a long run.*

***Keywords*— *Spent oil, Leachates, Concentration, Bio-toxic, Heavy metal, Hazardous, Percolation*1.0**

I. INTRODUCTION

Soils are the major sink for heavy metals and organic contaminants released into the environment either in the short run or at a distant time in life. Organic components may get degraded by microbial actions into compounds of lesser molecular weights thereby remediating the soil.Soils may become contaminated by the accumulation of heavy metals and metalloidswhich may be obtained through emissions from the rapidly expanding industrial wastes and bye products, mine tailings, disposal of high metal wastes, leaded gasoline and paints (Khan et al., 2008; Raymond and Felix 2011).The presence of a pollutant within any medium of interest has a consequential effect on the biotic system. In addition to physical transport process effects, complex biological and chemical transformations could take place. The types and mechanisms of transformation that a pollutant will undergo in deciding its ultimate fate rest on a combination of factors (Ewing and Lin 1991; Fang and Hong 1999). These vary from the medium of discharge and environmental conditions, nature of the soil and quantities ofthe pollutants. Therefore, the absorption of heavy metals in soils has been an issue of great interest in the past few years not only to ecologists, environmentalists and farmers but tobiologists as well (Grzebisz and Ciesla 2001).

Assessment of the environmental risk due to soil pollution is also of importance to both agricultural and non-agricultural sectors as heavy metals are potentially harmful to plants and human health in the secondary linkage. The presence of pollutants in soils for a very long time enters the food chain in significantly elevated amounts (Lacatusu, 1998). Some heavy metals are useful as micro-elements which are essential to plant metabolic activities in trace amounts, their non-biodegradability leads to their accumulation and persistence in soils at levels that may be harmful to the environment and public health (Fang & Hong, 1999; Lenntech, 2002; Hakan, 2006). It is not only when the heavy metals are present in bioavailable forms and at excessive levels that they have the potential to become toxic to plants, essential nutrients may also be shielded from being available.The consequence is the evasive nature of the locations where the heavy metals abound as plants cease to thrive or exist after a long time(Nagajyoti et al., 2010)

Spent Engine Oil used oil that had lost its properties due to abrasion, temperature,and denaturation and cannot be used as such in machinery unless reclaimed. Copper is the third most used metal in the world as they are used as alloys with other metalloids [Martinez and Motto].Most commonly found at contaminated sites are lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni) [Adriano, 2003; VCI, 2011] Though Copper is an essential micronutrient required in the growth of both plants and animals.as micro-element,Cu's interaction with the environment is complex (Raymond and Felix 2011)

Lead is a metal belonging to group IV with a high melting point 327.4°C, and a boiling point of 1725°C.It is a naturally occurring, bluish-gray metal usually found as a mineral combined with other elements, such as sulphur (i.e., PbS, $PbSO_4$), or oxygen ($PbCO_3$) and ranges from 10 to 30 mg kg^{-1} in the earth's crust [USDHHS]. The mean Pb concentration for surface soils worldwide averages 32 mg $kg-1$ and ranges from 10 to 67 mg $kg-1$ (Kabata and Pendians, 2001). The toxicities and environmental effects of organolead compounds are particularly noteworthy because of the former widespread use in metal alloys, distribution of tetraethyllead as a gasoline additive and incursion in automotive batteries.

A common practice in many artisan and mechanic workshops is the indiscriminate disposal of the spent engine oil into drains and in the open spaces around workshops. Spent lube has dark brown to a black colour looks and it is harmful to the soil environment. This is anticipated as it contains a mixture of different chemicals including low to high molecular weight (C15-C21) compounds, lubricants, additives and decomposition products and heavy metals which are harmful to the soil and human health (Duffus, 2002). These characteristics may lead to Soils contaminated with used lubricant, more so as oil is capable of displacing air and water being non-miscible, it may lead to changing soil consistency and chemical aggregate compositions.

Lubricants or engine oil is used in automobiles which include motor vehicles, bikes, electric generators and heavy-duty turbines while the disposal of the spent oil is not yet under any regulations for appropriate disposal or recycling in Nigeria. This study aims at investigatingthe effects of contamination of heavy metals on the soil and water sources around the aged automobile workshops with due consideration to Copper and Lead metals accumulation.

II. MATERIALS AND METHODS

2.1 Sampling Map and Site

The investigation was conducted in a central Automobile workshop at Mechanic Village in Epe opposite the Federal Road Safety Commission Epe. Epe Local Government Lagos State, Nigeria. Epe is located in Lagos State, an African megacity which is located in southwestern Nigeria on the West Coast of Africa, within latitudes 518 6 o 23'N and 6o41'N and longitudes 2o42'E and 3o42'E. The sampling area Map is presented in Figure 1:

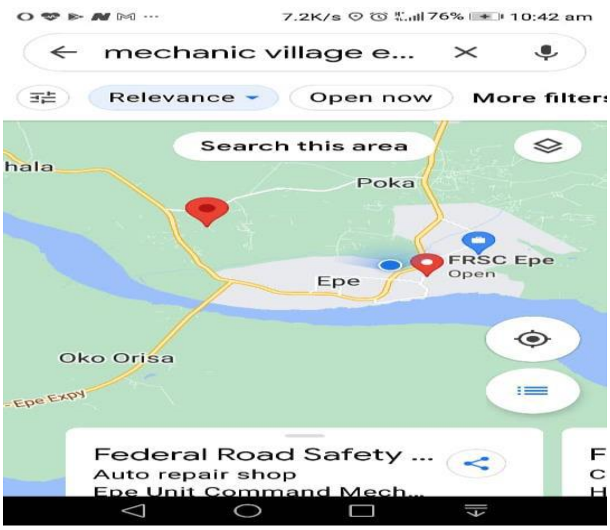

Fig.1: Sampling Map and site of Investigation.

Two metals of interest were lead (Pb) and copper (Cu) as contaminants from machine abrasion and lube constituents. They were investigated in the water and soil samples at the sites and the surroundings.

2.2 Sample Collection and analyses

Soil samples from the study site were collected into a pre-cleaned polythene bag using a stainless Van-ven grab, air-dried and then sieved with a 200 mm mesh screen. Soil samples at the top surface and at different depths of 25, 50, 75 and 100 cm of soil column were obtained to determine the extent of percolation of the heavy metals at the workshop site.

2.2.1 Soil Analysis: Nitric-peroxide acid digestion was carried out using 5ml of 65% nitric acid and 5 ml of 30%

hydrogen peroxide added to 1g each of sample in a 100ml conical flask placed on a hot plate for about forty-five minutes until the solid dissolved and the volume of contents was reduced to about 5 ml. The content of the flask was then filtered through a 0.45 µMillipore membrane filter paper, transferred quantitatively to a 50 ml volumetric flask by adding distilled water to make up to mark and analyzed for copper and Lead heavy metals using Atomic Absorption Spectrophotometer (AAS) model Buck Scientific 210 GVP (Mester and Sturgeon, 2003).

2.2.2 Water Analysis:

Samples of water from different wells and boreholes of water sources in locations around the mechanic village water samples were collected into plastic specimen bottles and labelled. 5 ml of concentrated nitric acid was added to 100 ml of water sample and evaporated to 25 ml. The concentrate was transferred to a 50 ml flask and diluted to the required volume with distilled water. Metal contents were determined using Atomic Absorption Spectrophotometer to determine the presence of copper, and Lead in the samples (Olowu et al., 2019). The assays were repeated for the respective samples and the average values were recorded.

III. RESULTS AND DISCUSSIONS

The physical appraisal of the environment gave distinct effects of the usage and impacts of the spent engine oil disposed of indiscriminately. This observation was registered at different sites of mechanic workshops and this is evident as patches around the respective site as shown in Plate1:

Fig 2: Environmental effects of used lubricating oil on soil patches.

At designated places of maintenance ladened with automobile repair and used engines, the places are devoid of plant growth and appeared as dark spots. Obscuration of biomes at the indicated points is inferential of the pollutants.

The water sources around the Mechanic village mainly wells and boreholes have depthsin the range of 5 and 30 mdepth respectively. The concentrations of copper and lead in the water samples were found to be in the range of 0.63 ±0.05 (ppm) of Copper from the well water sources and 0.13 ±0.03 (ppm) of Lead. The United State Environmental Protection Agency (USEPA) sets the maximum contamination level for copper and lead in water to be 1.3(mg/l or ppm) and 0.01(mg/l or ppm) respectively.

The presence of these heavy metals at the different depths showed that there are possibilities of leaching /percolation of the heavy metals into the soil by different mechanisms or it may be characteristics of the soil origin. The heavy metals at all the depths dug decreased gradually as the depths increasedfrom topsoil toother subsurface layers and aretrapped within a range of 0-25 cm inthe soil.

The analysis revealed that the soil samples contaminated with the lead (Pb)andCopper (Cu)were pronounced at the soil surfacesevident from the pictorial feature of the environment as shown in Fig 1. This may be responsible for the clear absence of plants in some areas. All the contaminated areas were devoid of biomass and shrubs. However, the concentration decreased in the soil as the distance/depth of the soilcolumn increased. Lead concentrations distribution as the different depths of the soil profile is shown in Fig. 2:

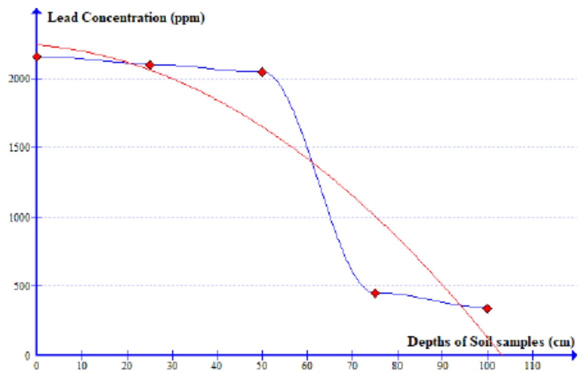

Fig.3: Concentration distribution of Lead in an oil-polluted mechanic workshop

The regression R^2 obtained was 0.8527, the pattern of the concentration distribution was quadratic and was of the form described in equation 2:

$$Y_{(x)}=-0.186192*x^2-2.46816*x+2238.93 \quad \ldots 2$$

The major part of the metallic content was engaged at the topsoil but may be admissible to further relocation by run-offs especially into the neighbouring water bodiesand soil when rainfall which may lead to increased concentration. The degree of metallic distribution in the soils environment depends on the metal species and its reactive status. gradient of percolations of Lead (Pb) and Copper

(Cu) differs such that Copper was consistently reducing while a sharp decline having with Square (R^2) regression of 0.9377

A substantial decrease with increasing soil depth was observed as the concentration changed drastically from 2040.57 ± 0.5 ppm at 30 cm to 475.40 ± 0.5 ppm at about 75 cm depth. This may however depend on the type of soil and its consistency. The level of heavy metal pollution in areas where there are automobile workshops is higher than in those that do not have automobile impacts.

The effects on the environment water sources as investigated by the analysis of the metals showed that the concentration of Lead was 0.13 ± 0.01 ppm in the well water and 0.04 ± 0.01 ppmin water obtained from a borehole which was in the average depthsof 25ft and 70 ft for the well and borehole sources respectively.

After the test carried out on the well water and borehole within the automobile workshop the concentrations of copper as the soil depth increased is found to follow a decreasing trend displayed in Figure 3:

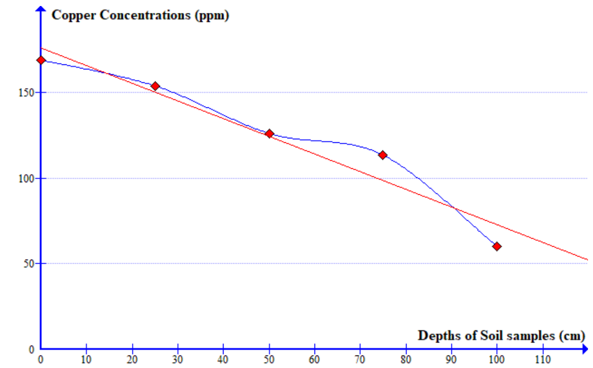

Fig.4: Concentration gradient of copper as the depth of soil decreased

The trend of degradation was close to linearity and was clearly described in Equation (2) with a Regression Square (R^2) of 0.9377.

$$Y(x)=-1.03064*x+175.758 \qquad ....3$$

This implied a progressive decrease in concentration as the depth of soil increased. The Copper concentration in the well water sample was determined to be 0.63mg/l and 0.36mg/l in borehole water sourced around the mechanic workshop location relatively at about 70±5 ftdepth. There was a sharp decrease and the two sources did not show any alarm above their threshold values. It is observed that as the depth increases, the concentrations of the metal decrease. This implies that if the depth of the well and the borehole are increased, the concentration of the heavy metals may reduce far below their threshold and safer for consumption. The United State Environmental Protection Agency (USEPA) sets the maximum contamination level for copper and lead in water to be 1.3(mg/l or ppm) and 0.01(mg/l or ppm) respectively.

The experiment carried out on the soil samples shows that Copper is 0.63mg/l in well water and 0.36mg/l in the borehole. Lead is 0.13mg/l in well water and 0.04mg/l in borehole. The well and borehole have a depth of 5 and30 meters respectively.It is noteworthy that concentrations of the metals in all the samples analyzed are lower than the permissible limits set by WHO and FEPA which implies that the water sources are fit and safe for human consumption as the depth is enhanced irrespective of the super facial disruption.

IV. CONCLUSIONS

Heavy metals in the spent oil percolate into the soil at different degrees as leachates which depends on the solubility of the metal species and its interactions with other chemical species in the soil.Spent oil-contaminated soil aggregates to form black patches in the environment. Underground water in the environment presently was revealed to have Cu and Pb as heavy metals sampled below the WHO and FEPA thresholds and so are safe at radial distances over30 meters to the automobile workshop and witha recommended depth of30 meters. The Spent lubricant and greases in the soil increased soil bulk density and consequently decreased the water holding capacity and aeration propensity. The medium of communication of heavy metals toxicity with the bio component of the environment could be traced to the leaching of the elements which may depend on the soil characteristics such as soil porosity and soil types. Direct transport of the elements from the highly concentrated regions of the workshops especially during heavy rainfalls and the consequential runoff to the water bodies such as wells, and boreholes streams is another means of communication and contamination.

REFERENCES

[1] VCI, Copper history/Future, Van Commodities Inc., 2011, http://trademetalfutures.com/copperhistory.html.

[2] Martínez C. E. and Motto H. L., 2000 "Solubility of lead, zinc and copper added to mineral soils," *Environmental Pollution*, vol. 107, no. 1, pp. 153–158.

[3] Adriano D. C., 2003. *Trace Elements in Terrestrial Environments: Biogeochemistry, Bioavailability and Risks of Metals*, Springer, New York, NY, USA, 2nd edition,.

[4] EPA (2009).Waste-non-hazardous waste. USA: EPA. http://www.epa.gov/epawaste/nonhaz/deFne/index (http://www.epa.gov/epawaste/nonhaz/deFne/index). Retrieved May 18, 2009.

[5] Ewing, R.E., and Lin, T. (1991) Class of parameter estimation techniques for fluid flow in porous media, Advances in water resources, 24:, No . 2, p89-97

[6] Fang, T. H. & Hong, E. (1999). Mechanisms influencing the spacial distribution of trace metals in surFcial sediments off the south- western Taiwan. Marine Bulletin, 38, 1026-1037.

[7] Grzebisz, W., Ciesla, Diatta, J.B. (2001). Spartial distribution of copper in available soils and in non-consumable crops(Flax, oil-seed rape)cultivated near a copper smelter. polish J. of environment studies ,10,145,269,.

[8] Hakan, P. (2006). The distribution and sources of heavy metals in Izmit Bay surface sediment affected by polluted stream. Marine Pollution Bulletin.

[9] Lacatusu, R. (1998). Appraising levels of soil contamination and pollution with heavy metals: Developments for planning and sustainable use of land resources. European Soil Bureau joint research center, 393-402

[10] Lenntech, l. (2009).Heavy metals: www.lenntech.com/processes/heavy/heavy-metal (http://www.lenntech.com/processes/heavy/heavy- metal). Retrieved March 12, 2011.

[11] Kabata-PendiasA.and H. Pendias, Trace Metals in Soils and Plants, CRC Press, Boca Raton, Fla, USA, 2nd edition, 2001.

[12] Olowu Rasaq A., Osundiya Medinat O., Jimoh Abayomi A., Adeosun Festus I., Quadri Elizabeth O., Alegbe M.J.(2019). Comparative assessment of potential toxic metals concentrations in water, sediment and fish (Clariasgariepinus) in Epe Lagoon, earthen and concrete ponds in Epe Area of Lagos State. Global Science Research Journals, ISSN: 2408-5464 Vol. 7 (3), pp. 516-526.

[13] Nagajyoti P. C., Lee K. D. & . SreekanthT. V. M (2010) Heavy metals, occurrence and toxicity for plants: a review, Environmental Chemistry Letters volume 8, pages199–216

[14] Khan S., Q. Cao, Y. M. Zheng, Y. Z. Huang, and Y. G. Zhu, "Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China," *Environmental Pollution*, vol. 152, no. 3, pp. 686–692, 2008.

[15] RaymondA.W. and Felix E. O. (2011). Heavy Metals in Contaminated Soils: A Review of Sources, Chemistry, Risks and Best Available Strategies for Remediation. International Scholarly ResearchNoticeshttps://doi.org/10.5402/2011/402647.

[16] USDHHS, *Toxicological profile for lead*, United States Department of Health and Human Services, Atlanta, Ga, USA, 1999.

[17] Ogwuegbu, M.O., and Ijioma, M.A. (2003) Effects of Heavy Certain Metals in the Population due to Mineral Exploitation

[18] Udedi, S.S. (2003) From Guinea Worm scourge to Metal Toxicity in Ebonyi State, Chemistry in Nigeria as the New Millennium Unfolds

[19] United Nation Environmental Protection/Global Program of Action (2004). Why the marine environmental needs protection from Heavy Metals, Heavy Metals 2004.