Levels of Pb, Fe, Cd and Co in Soils of Automobile Workshop in Osun State, Nigeria

OLAYIWOLA OLAJUMOKE ABIDEMI

Osun State Polytechnic, Department of Applied Sciences,
P. M. B 301, Iree, Osun State, Nigeria
Tel: 08034991909
E-mail:perfectstars2001@yahoo.com

ABSTRACT: The disposal of waste of all kinds in auto-repair workshop areas in Nigeria is becoming alarming. The study looks into the contribution of different sections in auto-repair workshop to heavy metal pollution in soil .Thirty –two soil samples were collected at an auto-repair workshop in Osogbo, Ikirun, Iragbiji and Iree in Osun State for their cobalt, iron , lead and cadmium level at different sections namely: auto-mechanic unit, auto welding unit, auto electrician unit and auto painting unit using atomic absorption spectrophotometer.The highest cobalt concentration was obtained in Iree at the auto welding unit, (17.25± 1.10mg/kg), iron had its highest level in Ikirun at the auto-mechanic unit (43937± 35mg/kg) , lead had its highest concentration in Iree at the auto welding unit (2460±16 mg/kg) and cadmium with the highest in Iree at the auto welding unit as well (2.02 ±1.01 mg/kg).Sites studied had higher levels of heavy metals compared to control areas. The general trend of dispersion of metal contamination within the soil profile is iron>> lead>> cobalt>cadmium. Statistical analysis reveals correlation between lead/iron (r = 0.636) at p<0.01. This work reveals the individual contribution of various allied artisans to soil pollution in automobile workshop. The research serves as an important contribution to the database on the baseline qualities of Nigerian soil. @JASEM

Automotive service and repair shops are the largest small quantity generators of hazardous waste. Autorepair shops create many different types of waste during their daily operations. These include used oil and fluids, dirty shop rags, used parts, asbestors from brake pads and waste from solvents used for cleaning parts. All of which are expensive to dispose of and sometimes hazardous. The most dangerous waste commonly created in autorepair shops is from the solvents used to clean parts. Many of the chemicals that make up the solvents are extremely dangerous to human and the environment (Imevbore and Adeyemi, 1981). If not handled properly these chemicals can find their way into the air we breathe, the water we drink, our soil, lakes and streams.(Adeniyi and Afolabi,2002).Many parts cleaners and solvent are dangerous to workers health. "Used oil may contain components such as lead, cadmium, barium and other potentially toxic metals (Edebiri and Nwanokwale,1981;USEPA, 2001;Vazyuez-Duhalt and Bartha, 1989;).'' Heavy metals are of considered environmental concern due to their toxicity and accumulative behavior (Dahmani-Muller et al., 2000; Omgbu and Kokogbo, 1993). Advancement in technology had led to high level of industrialization leading to discharge of heavy metals into our environment. ''Graft (1984) noted that various activities by man in recent years have increased the quantity of distribution of heavy metals in the atmosphere, land and water bodiesO.'' The worldwide demand for lubricating oil for processes, passenger and heavy goods vehicles stands at about 3.5 million tons (Szranka, 1995).

In almost all the towns in Osun state, automobile workshops are found scattered all over the city , waste are indiscriminately dumped on every available space and all categorize of waste ranging from lubricating oil, junked cars, tyres, spare parts are always been found to litter all parts of the workshop. Waste from automobile workshop activities can be categorized into maintenance and materials handling wastes. Heavy metals in soil are toxic and some of the soluble metals may find their way to soil, rivers, lakes and streams resulting into pollution.

Different studies in auto repair workshops have been carried out by many authors (Ipeaiyeda et al., 2007; Teresa et al., 2005).But none of them studied the individual contributions of heavy metal contamination in soil by these various allied artisans in these pollution saga. This study looks into levels of lead, iron, cadmium, and cobalt in soil because of activities operating at the automechanic unit, auto welding unit, auto electrician unit and auto painting unit.

MATERIALS AND METHODS

Study area: The study was carried out in Osogbo, Ikirun, Iragbiji and Iree town, Osun state , Nigeria. Osogbo (Latitude 7°46.110'N, Longtitude 4°32.379'E), Ikirun (Latitude 7°55.899'N, Longtitude 4°39.929'E) , Iragbiji (Latitude 7°53.652'N , Longtitude 4°37.813'E) and Iree (7°56.878'N, Longtitude 4°44.052'E) are located on altitude of 288.5m, 396.4 m, 382.1m and 454.0 m respectively.

Sample collection and preparation: Soil samples for the study were collected in an automechanic workshop in four towns in Osun State, Nigeria. Soil

Levels of Pb, Fe, Cd and Co in.....

samples were collected at different units of the automobile workshop which comprise the automechanic unit ,auto welding unit, auto electrician unit and auto painting unit. Thirty -two soil samples were collected from the four different units in the four towns at 1 cm depth with a plastic spoon to avoid cross contamination and labeled. The samples were sundried and sieved. Samples for analysis were kept in a labeled polythene bag and then used for heavy metals determination. The control samples collected were also sundried, sieved, and labeled. The codes used for each town and each unit are as shown in Table 1 and 2 respectively.

The codes used for each town and each unit are as follows: For Osogbo, sample codes for towns and control sites are HVO and CHVO respectively, for Ikirun, HVK and CHVK for sample and control respectively. For samples at Iragbiji, HVG and CHVG for sample and control. For Iree, HVR and CHVR for sample and control respectively. The labeling codes used for locations where samples were collected at each unit of autorepair workshop are as follows: 1,2 for auto-mechanic unit, 3,4 for auto-welding unit, 5,6 for auto- electrician unit and 7,8 for auto-painting unit.

Digestion of the sample: 2g of each sample was accurately weighed into a washed and dried kjeldhal flask. 10ml of nitric/ perchloric acid was added to each sample and the tubes were placed in a digestor for about 10 minutes at 100-150 ^{o}C, the temperature of the digester was then increased to 230°C. The samples were then brought out and allowed to cool. 5ml of deionized water was added to each sample and then transferred into volumetric flask and excess deionized water was added to make it up to 100ml mark. The digest was then used for heavy metal (Co, Fe, Pb, and Cd) determination using atomic absorption spectrophotometer of model Buck 210 GVP.

RESULTS AND DISCUSSION

The levels of Co, Fe, Pb, and Cd found in soil samples and control samples are as shown in Tables 1-4. The levels of heavy metals obtained in Osogbo are as shown in Table 1. Cobalt had its highest concentration in HVO_8 (11.0±5.00 mg/kg) with the least concentration in HVO_6 (4.00±0.10 mg/kg) in the auto-electrician unit. This might be due to the fact that electrical materials used here contribute low cobalt content which get leached into the soil. The auto-painting unit however had the highest cobalt level in Osogbo. The information on cobalt content of soil in auto-mechanic workshop is sparse in literature. The range of iron concentration obtained in Osogbo was 32938±12- 11125±28 mg/kg. The highest was obtained in HVO_1 (32938±12 mg/kg) at the auto-mechanic unit. This result was however higher than the result obtained by Adewole and Uchegbu (2010) (1564-1238 mg/kg). The increase in iron content of the soil might be as a result of waste generated in this unit which includes solvent, hydraulic fluid, spent lubricants most of which are dumped into the soil directly. The range of level of lead in table 1 was 703±25- 16.0 ±12.0 mg/kg). The highest lead concentration obtained in HVO_2 was (703±25 mg/kg) , this could be as a result of lead containing compounds being used by auto-mechanics. The result obtained shows a higher soil lead level as compared to what was obtained by Osu and Okereke (2010). The level of heavy metals in soil of auto-mechanic workshop depends again on how long the workshop was established. The site used in Osogbo had being in existence since 1999. No cadmium was detected in all samples analysed in Osogbo. The levels of these metals in the control site(CHVO) were lower to values obtained in Osogbo. This difference in values suggested soil contamination.

Table 1. Concentration of Co, Fe, Pb and Cd in Osogbo (mg/kg)

Sample	Cobalt	Iron	Lead	Cadmium
HVO_1	6.25±3.50	32938±12	61.0±16.9	nd
HVO_2	6.50±4.00	30625±15	703±25	nd
HVO_3	8.00±3.00	17500±21	26.3±2.3	nd
HVO_4	5.00±0.50	13063±16	17.3±14.0	nd
HVO_5	4.00±2.10	12125±22	26.5±11.3	nd
HVO_6	4.00±0.10	14250±19	16.0±12.0	nd
HVO_7	5.00±0.90	11125±28	68.0±10.0	nd
HVO_8	11.0±5.00	15563±30	91.0±29	nd
CHVO	1.02±0.85	262±9	10.1±2.5	nd

nd = not detected

Levels of Pb, Fe, Cd and Co in…..

Table 2 reveals the result in all the units studied in Ikirun. The soil cobalt content in Ikirun had highest value in HVK_2 (13.75±3.00 mg/kg). This might be due presence of cobalt in the materials being used by the automechanics.As these materials are used , some of it get leached into the soil and contaminate it. The auto-electrician unit had some cobalt in its soil (9.50±0.90 mg/kg) and the least cobalt level. Runoff water during rain or wind can wash or disperse soil particles from one place to the other and contaminate the soil. The soil in the auto-welding unit also had cobalt content of 12.75±6.20 mg/kg next to the auto-mechanic unit here. The range of cobalt concentration was 13.75±3.00-9.50±0.90 mg/kg. The higest level of iron was obtained in the automechanic unit (43937±35 mg/kg) and very high compared to what was obtained by Adewole and Ucheagbu (2010). Iron is a plant micronutrient, which is needed

for physiological plant growth in small amount but has been grossly increased due to improper disposal of spent engine oil. Fossil fuel products are used leading to excess accumulation of heavy pollution (Aiyesanmi, 2005). The auto-mechanic workshop within Ikirun and disposal of waste into open vacant plots and water body which pose an environmental risk. Soil lead level here was highest in HVK_5 (325±10 mg/kg) at the auto-electrician unit and least level obtained in HVK_6 (69.8±9.9 mg/kg). The levels of lead obtained was higher than the values obtained by Ano (1994) and Nwoko and Egunjobi (2002). The values obtained were above the permissible level for soil as recommended by USEPA (1986) and this is a serious environmental concern which needs urgent attention. Cadmium was not detected in all soil samples analysed in Ikirun too.

Table 2. Concentration of Co,Fe, Pb and Cd in Ikirun (mg/kg)

Sample	Cobalt	Iron	Lead	Cadmium
HVK_1	12.00±1.00	43937±35	160±15	nd
HVK_2	13.75±3.00	1685±20	294±20	nd
HVK_3	12.75±6.20	1358±17	128±11	nd
HVK_4	11.00±0.90	1213±28	173±28	nd
HVK_5	11.75±1.50	1458±50	325±10	nd
HVK_6	9.50±0.90	1313±18	69.8±9.9	nd
HVK_7	11.5±10.0	895±71	234±32	nd
HVK_8	nd	1357±27	134±10	nd
CHVK	0.81±0.60	401±9	20.9±1.3	nd

nd = not detected

Table 3 illustrates the levels of these heavy metals in Iragbiji. No cobalt was detected in HVG_1 here.HVG_2 however had a concentration 10.00±0.61 mg/kg of cobalt. This discrepancy could be attributed to the fact that the auto-mechanic carry out most of their work in HVG_2 as compared to HVG_1 where they only hang their clothes. HVG_3 (8.00±0.90 mg/kg) had cobalt level next to HVG_2. Cobalt was not detected in HVG_6. The auto-painting unit had the least cobalt content as shown in table 3.The range of level of iron obtained was 20250 ±20 – 10563±41 mg/kg which

happens to be the auto electrician unit . Wastes from these workshops are indiscriminately dumped in every available space thus contaminating the soil causing substancial alteration in the chemical composition and pH of the soil and will have a major effect on plant growth, microbial population and human. The highest level of lead was obtained in HVG_5 (1068±10 mg/kg) at the auto[electrician unit and least lead content in HVG_8 at the auto-painting unit. Cadmium was not detected in soil analysed in Iragbiji.

Table 3. Concentration of Co,Fe, Pb and Cd in Iragbiji (mg/kg)

Sample	Cobalt	Iron	Lead	Cadmium
HVG_1	nd	10563±41	144±30	nd
HVG_2	10.00±0.61	11125±23	109±5	nd
HVG_3	8.00±0.90	15000±10	145±10	nd
HVG_4	5.50±0.50	13625±15	160±11	nd
HVG_5	6.50±1.10	20250±20	1068±10	nd
HVG_6	nd	19562±16	753±5	nd
HVG_7	1.75±1.20	12250±13	38.3±11.0	nd
HVG_8	3.75±0.80	11375±35	36.8±0.9	nd
CHVG	0.72±0.30	728±15	12.5±4.9	nd

nd = not detected

Levels of Pb, Fe, Cd and Co in…..

Table 4 reveals the highest cobalt level in HVR_3 (17.3±1.10 mg/kg) at the auto-welding unit. It was not however detected in HVR_1 here in Iree. The range of iron content was 38125±30 -4500±10 mg/kg. The level of iron spread all over the units here and could be as a result of the population in this town with few auto-mechanic workshops and so they litter and spread most of this used engine oil and spent fluid all over. The highest iron content was obtained in HVR_8 (38125±30 mg/kg). The highest level of lead was obtained in HVR_4 (2460±16 mg/kg) at the auto-welding units followed by HVR_5 (1685± 15 mg/kg) at the auto-electrician unit. This result reveals how these arlied artisans spread their waste indiscriminately, which calls for urgent attention and awareness. Cadmium was however detected in Iree in this study at HVR_2 and HVR_3 (0.70±0.90 mg/kg and 2.02±1.01 mg/kg respectively). The result however was found to fall between the values obtained by Osu and Okereke(2010) (50.03±0.26- 0.22±0.003 mg/kg). The high concentration of iron in these sites might be attributed to metal construction works, welding of metals, iron bending which is common practice. Virtually in every auto repair workshop there are various sections that deal with other filling of metals, welding of these metals and paveling of vehicle bodies. Iron fillings from metal works, oil spillage of gasoline, diesel, engine oil and lubricating oil coupled with rusting results in high iron concentration .The high value of iron obtained agrees with what was obtained by Shinggu et al., 2007.

Table 4. Concentration of Co,Fe, Pb and Cd in Iree (mg/kg)

Sample	Cobalt	Iron	Lead	Cadmium
HVR_1	6.25±0.60	21750±52	873±11	nd
HVR_2	12.3±0.9	34937±35	995±16	0.70±0.90
HVR_3	17.3±1.10	30125±19	268±8	2.02±1.01
HVR_4	8.75±1.30	36250±25	2460±16	nd
HVR_5	6.50±0.90	25062±17	1685±15	nd
HVR_6	6.75±0.60	24938±16	750±3	nd
HVR_7	nd	4500±10	18.0±12.0	nd
HVR_8	2.00±1.30	38125±30	12.0±0.6	nd
CHVR	0.75±0.18	809±21	6.9±5.1	nd

nd = not detected

The contribution of these units in auto repair workshop to iron contamination of the soil is in the other auto mechanic unit >> auto welding unit > auto electrician unit> auto painting unit. The levels of heavy metals in all these units are however low compared to the levels obtained for the control samples. This invariably indicates a level of pollution in the study area. The levels of heavy metals can affect human, plant s and animal health (Ewers and Schlikopter, 1991; McGrath et al., 1995). Presence of high lead level can result into brain damage, brain disorder and can cause stunded growth in plants (Somer, 1995). Excessive level of iron can seriously affect flora and fauna in water bodies. To much cadmium can cause disfunctioning of the kidney.

Statistical analysis: One-way analysis of variance (ANOVA) was used to test if significance differences exist between mean concentrations of heavy metals. The result showed that there were no significant statistical differences at $p<0.05$ for Pb (F= 0.849, p= 0.494), Fe (F=0.898, p=0.470), Co (F=1.475, p=0.271), and Cd (F=0.794, p=0.521). A positive correlation was obtained between lead/iron (r = 0.636), lead/cadmium (r = 0.666) at $p<0.01$ and also between iron /cadmium (r = 0.520) at $p< 0.05$, suggesting a linear relationship.

Conclusion: The investigation in this study revealed that the soil in the auto repair workshop comprising auto-mechanic units and other allied artisans is grossly polluted with iron and lead. Phytoremediation is however recommended so as to remove these metals from the contaminated soil.

REFERENCES

Adeniyi, A.A. and Afolabi, J.A. (2002) Determination of total petroleum hydrocarbons and heavy metals in soils within the vicinity of facilities handling refined petroleum products in Lagos metropolis. Environment International, 28 (1-2), 79—82.

Adewole, M.B. and Uchegbu L.U. (2010) Properties of soils and plants uptake within the vicinity of selected automobile workshops in Ile-Ife Southwestern Nigeria. Ethiopian Journal of Environmental Studies and Management 3 (3) 31-35.

Levels of Pb, Fe, Cd and Co in…..

Aiyesanmi, A.F. (2005) Assessment of heavy metals contamination of Robertkiri oil field soil. Science. 15, 42-46.

Ano, A.O. (1994) Trace metal studies on soils of the Nigerian coastal plain sands.Status of Cu, Zn, Pb, Fe and Mn. J. Soils and Crops. 4 (1) 1-5.

Dahmari-Muller, H. Van O.F., Gelie B., Balabane, M. (2000) Environ.Pollut. 109, 231-238.

Edebiri, R.A.O. and Nwanokwale, E. (1981) Contorl of pollution from international combustion engine used lubricants. Proc. Int. Seminar petroleum industry and Nigeria environment. 9-12

Ewers, U. and Schlikopter, H.W. (1991) Metals and their compounds in the environment occurrence, analysis and biological relevance.   New York 971-1014

Imevbore, A.A.A. and Adeyemi, S.A. (1981) Environmental monitoring in relation to pollution and control of oil pollution . Inc. Proc. Seminar on the petroleum industry and the Nigerian environment 6, 135-142.

McGrath, S., Chaudri, A.M., Griller, K.E. (1995). Long term effects of metals in sewage sludge soils, microorganisms and plants. J. Ind. Microbiol. 14, 94-104.

Nwoko, C.O. and Egunjobi,J.K. (2002) Lead contamination of soil and vegetation in an abandoned battery factory site in Ibadan, Nigeria. J.Sustain. Agric. Environmental. 4(1) 91-96.

Osu, C.I. and Okereke, V.C. (2010) Heavy metals contamination in relation to microbial counts in soils of automobile mechanic workshops, Port Harcourt Metropolis, Rivers States, Nigeria. Journal of American Science 6 (9) 236-241.

Shinggu, D.Y. , Ogungbuaja, V.O., Barminas, J.T. and Toma , I. (2002) Analysis of street dust for heavy metal pollutants in Mubi, Adamawa State, Nigeria. International Journal of Physical Sciences, 2(11) 290-293.

Somer, E. (1994) The toxic potential of trace metal in foods. A review . J.food science 39, 215-217.

Teresa, R., Douglas, J.H. and Zenon P. (2005) Determination of heavy metals and volatile aromatic compounds in used engine oils and sludges, Fuel, 85(4) 481-485.

United States Environmental Protection Agency (1986) Test methods of evaluation of soil waste. UEPA Washington, D.E. USEPA S/W, 846.

United States Evironmental Protection Agency(2001) An analysis of compositing an environmental remediation technology. USEPA solid waste and emergency response (5305W). EPA 530-R-98-008, 2-38.

Vazquez-Duhalt R, Bartha, R. (1989) Biodegradation of petropleum in soil environment. Can. J. microbiol., 20, 1985-1988.