IMPACTS OF INDISCRIMINATE DISPOSAL OF SPENT LUBES, EPE AUTOMOBILE WORKSHOPS

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Abstract

The non-existence of herbs and grasses in affected areas of the mechanic workshop due to spent lubricating oil contamination was investigated. Soil and water samples from the environment were analysed for the presence of Copper (Cu) and Lead (Pb) with the view to investigate the extent of percolations and consequential effects on the surrounding water bodies. Soil samples from affected patches were also analysed to ascertain their sources in comparison with virgin oil samples content. The concentrations of Copper Cu and lead (Pb) recorded at the topsoil was 2049.64 ppm and 153.22 ppm respectively both were however higher than recorded values in virgin lube oil. The concentration of Copper was 0.63mg/l in well water and 0.36mg/l in the borehole. Lead evaluated was 0.13mg/l in well water and 0.04mg/l in the bore hole. However, at depths from 25 to 100 feet into the soil the concentrations profile of the Copper metals reduced drastically to 59.98ppm and for Lead, to 342.35mg/l. The rate of metallic distribution on contaminated soils depends on the metal species and its reactive status, gradient of percolations of Lead (Pb) and Copper (Cu) differs such that Copper reduction was consistently reducing with while a sharp decline with Square (R^2) regression of 0.9377 and a linear relationship with the depths are of the form $f(x)=-1.03064*x + 175.758$. On the other hand, the concentration profile of Copper was quadratic and with high concentration at the soil surface which reduced sharply to a basal value characteristic of the soil generic composition. It is anticipated that the heavy metals in the spent oil percolate into the soil as leachates and may get to the underground water may which leads to pollution of underground water in the environment mainly by runoff rather than by percolation which may take years.

keywords: Spent oil, Leachates, Concentration, Bio-toxic, Heavy metal, Hazardous, Percolation

The majority of solution on the contamination of soil with heavy metals comes down to the determination of their content in a few soil samples without considering the specificity of their random and systematic variation.

Some heavy metals have bio-importance as trace elements but, the bio-toxic effects of many of them in human biochemistry are of great concern. Hence, there is need for proper understanding of the conditions, such as the concentrations and oxidation states, which makes them harmful, and how their bio-toxicity occurs. It is important to know their sources, leaching process, chemical conversions and their mode of deposition to know their relevance to the environment.

Most heavy metals have density greater than 5gcm-3. The low level of their content in soils and plants as well as the biological role of most of them makes them microelements (Lacatusu, 1998). At low concentrations some of these metals are essential for the proper growth of plants and human metabolism. Deficiencies in these essential elements or micronutrients can lead to diseases and even death of the plant or animal (Asaah & Suh, 2005). However, their non-biodegradability leads to their accumulation and persistence in soils at levels that are harmful to the environment and public health (Lenntech, 2009; Abrahams, 2002; Schroeder et al., 2003,2004; Fang & Hong, 1999; Hakan, 2006).

MATERIALS AND METHODS

The study was conducted between May - October, 2010 at Nuclear Chemistry and Environmental Research Centre, Ghana atomic Energy Commission.

Soil and water samples were taken from an automobile workshop in Epe to test for the presence of Copper and Lead as a result of disposal of spent oil, and to show that there is leaching /percolation of heavy metal in the soil. Table 4.1 shows the concentration of copper and lead in the water and soil samples.

The experiment carried out on the soil samples shows that the concentration of Copper Cu and lead (Pb) decrease in the soil as the distance/depth increases from top soil to the other layers with distance with 25 centimeters between each layers of soil. This is shown in fig. 4.6a and fig.4.6b.

The United State environmental Protection Agency (USEPA) sets the maximum contamination level for copper and Lead in water are 1.3(mg/l or ppm) and 0.01(mg/l or ppm) respectively. After the test carried out on the well water and bore hole within the automobile workshop the concentration of copper and lead are as follows.

Copper is 0.63mg/l in well water and 0.36mg/l in bore hole. Lead is 0.13mg/l in well water and 0.04mg/l in bore hole. The well and borehole have depth of 25feet and 70feet respectively.

It is observed that as the depth increases, the concentration of the metals decreases. This implies that if the depth of the well and the borehole are increased, the concentration of the heavy metals will reduce far below their threshold. Such that the water will be safe for consumption. This is shown in table 4.8a and b.

Introduction

The concentration of heavy metals in soils has been an issue of great interest in the past few years not only to ecologist, biologists and farmers but also an environmentalist. The ultimate fate of any pollutant within a medium of interest is the effects on the biotic system, physical transport process effects, complex biological and the chemical transformations take place. The types and mechanisms of transformation that a pollutant will undergo in deciding its ultimate fate rest on a combination of factors. These range from the medium of discharge and environmental conditions to the nature and quantity of pollutant (Ahlrichs and Ossner 1987; Birke and Rauch (1994).

Assessment of the environmental risk due to soil pollution is of importance to both agricultural and non-agricultural sectors. Heavy metals are potentially harmful to both plants and human health. Its persistence in soils for a very long time enters the food chain in significantly elevated amounts (Fang, and Hong 1999; Hakan, 2006). Their non-biodegradability even though some of them are useful micro-elements leads to their accumulation and persistence in soils at levels that may be harmful to the environment and public health (Lenntech, 2009; Fang and Hong, 1999; Hakan, 2006; Lacastus 1998).

Spent lubricating oil sometimes referred to as waste engine oil from automobile mechanic shops, mechanical or electrical engine repairers' shops from servicing of vehicles' engines, generating set and other types of engines. It has dark brown to a black colour and it is harmful to the soil environment. This is because 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 (Komisarek, 1997; Udedi, 2003)). Soils contaminated with used lubricant were devoid of plants growth as oil is capable of displacing air and water, leading to anaerobic conditions. This observation is shown in Figure 1:

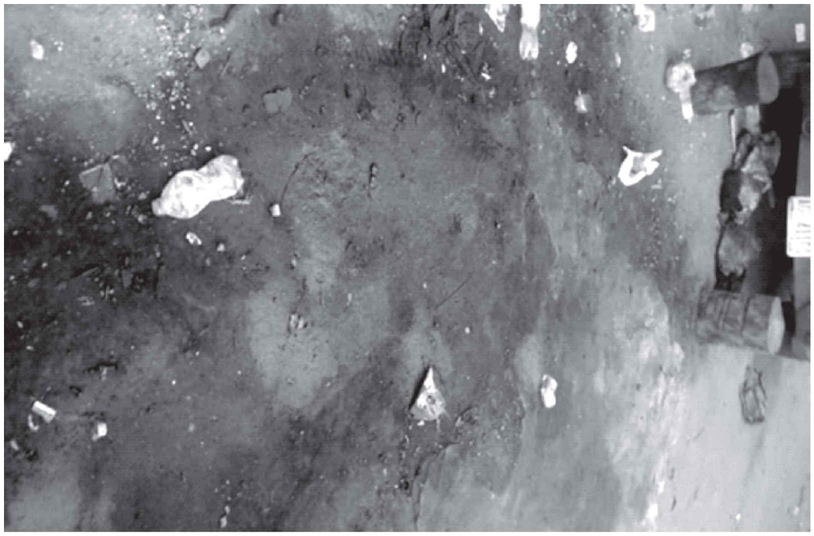

Fig 1: Environmental effects of used lubricating oil on soil patches

Spent lubricant oil in the soil increases bulk density, decreases 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 leaching of the elements which may depend on the soil characteristics such as soil porosity and soil type. 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, boreholes streams is another means of contaminations which can affect the sustainable use of soil rsources (Lacatusu, 1998). Heavy metals can also be emitted both in elemental and compound (organic and inorganic) forms. Anthropogenic sources of emission include the various industrial point sources of former and present mining sites, foundries and smelters, combustion by-products and traffics. All these terminate in the water bodies, absorption by plants and could end up in the human system (Peplow 1999; Ogwuegbu and Ijioma, (2003).

Different kinds of pollutants, each with its toxic effects, have been natures reward for their participation in man's discovery of himself by technological innovations, Copper distribution and other heavy metals (Grzebisz and Diatta, 2001; Kabata-Pendias and Pendias 1999). The majority of contaminants of soil with heavy metals comes down to the determination of their content in a few soil samples without considering the specificity of their random and systematic variation. This study aims at investigating the effects of contamination of heavy metal on the soil and water sources around an aged automobile workshop.

Materials and Methods

The investigation was conducted in Epe Mechanic Village in Epe. Epe local government Lagos State, Nigeria. Two types of metals which are major contaminants from machine abrasion and lube constituents next to iron were investigated in the water and soil samples of the sites.

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 depth of 25, 50, 75 and 100 cm dug were obtained to determine the extent of percolation of the heavy metals at the workshop site.

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 (Olowu et al., 2019).

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 mark with distilled water. Metal contents were determined using Atomic Absorption Spectrophotometer to determine the presence of copper, and Lead in the samples, the assays were repeated three times and the average values were recorded.

Results And Discussions

The water sources around the Mechanic village mainly wells and boreholes have depths in the average of 25 ft and 70 ft 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) Lead. The United State Environmental Protection Agency (USEPA) sets the maximum contamination level for copper and lead in water are 1.3(mg/l or ppm) and 0.01(mg/l or ppm) respectively.

The analysis of the soil samples indicated presence and contamination with different concentrations of Copper Cu and lead (Pb) in the profile. The presence of these heavy metals at the different depths showed that there is leaching /percolation of the heavy metal into the soil by different mechanisms. The heavy metals at all the depth dug decreased at different levels as the depths increased from topsoil to other subsurface layers. At depths of 25 centimetres between each layer of soil profile the distribution obtained for Lead (Pb) concentrations is described in Figure. 2:

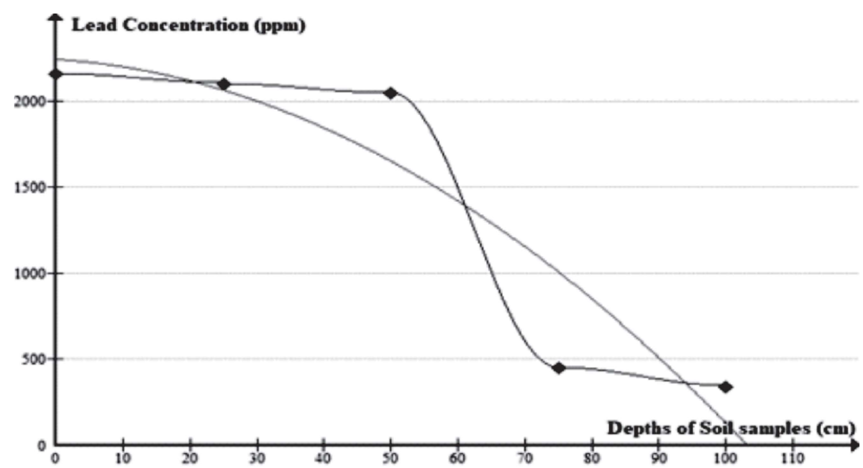

Fig. 2: Concentration gradients of Lead in oil-polluted mechanic workshop soil.

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:

f(x)=-0.186192*x^2 -2.46816*x + 2238.93 ...2

The major part of the content was retained at the topsoil as they are not admissible to percolation but may be subject to disposal into the run-offs especially into the neighbouring water bodies when rainfalls.

The heavy metal concentrations found to be prevalent at the topmost part of the contaminated soil is evident from the pictorial feature of the environment as shown in Fig 1, the concentrations in the soil was presumed to be responsible for the clear absence of plants at some sites. All the contaminated areas were devoid of biomass and shrubs. Lead concentration substantially decreased with increasing soil depth as the concentration changed drastically from 2040.57 ± 0.5 ppm at 30 cm to 475.40 ± 0.5 ppm at about 75 cm. Hence the nature of oil infested soil is such that the contaminant is retained on the topsoil, more so that they could be bonded further and trapped within the soil in the observed range of 0 to 25 cm. 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 of the spillages 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 ppm in water obtained from a borehole which was in the average depths of 25 ft and 70 ft for the well and borehole sources respectively.

In similar experiment, the concentrations of copper as the soil depth increased is found to follow a decreasing trend displayed at the automobile workshop is shown in Figure 3:

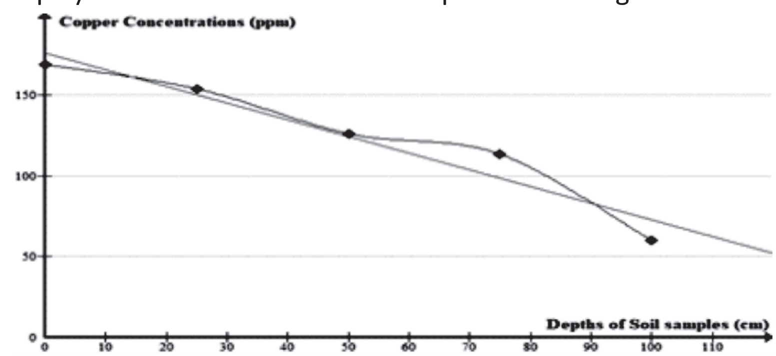

Figure 3: Concentration gradient of copper as the depth of soil decreased

The trend of degradation displayed a high Regression Square (R^2) of 0.9377, showing a linear relationship and it was clearly described in Equation (2):

$f(x)=-1.03064*x+175.758$ 2

This implied a progressive decrease in concentration of copper as the depth of soil is increased. The experiment carried out on the soil samples shows that the concentration of Copper Cu decrease in the soil as the distance/depth increases from topsoil to other layers of the soil.

The Copper concentration in the water sample from wells was determined to be 0.63mg/l and 0.36mg/l in water sourced from borehole around the mechanic workshop relatively at about 70±5 ft depth. 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. Evaluated concentrations of Copper is 0.63 mg/l in well water and 0.36 mg/l in the borehole while for lead 0.13mg/l in well water and 0.04mg/l in borehole. Therefore, the concentrations of lead and copper from two sources of water did not display any fright above their respective threshold values. It is observed that as the depth increases, the concentrations of the heavy metal decreases indicating that there were indications percolations. Therefore, increased depths of the wells and boreholes will reduce far below their threshold values of the heavy metals concentrations so that the water will be safer for consumption.

Conclusions:

Spent oil-contaminated soil aggregated and form black patches in the environment when indiscriminately discharged. 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 components. It is also a medium of transport of contaminant to other parts of soil and water bodies. Underground water in the environment may get polluted at a longer time by percolation but readily by run-off from surface topsoil.

The analysis revealed that the heavy metal concentrations were higher at the topsoil and reduced drastically as the depth of the soil increased. In both cases, the values are lesser than the United State Environmental Protection Agency (USEPA) sets the point of maximum contamination level of 1.3(mg/l or ppm) for copper and 0.01(mg/l or ppm) for Lead. 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 is fit and safe for human consumption as the depth is enhanced. To avoid exposure of heavy metals to water sources, the well/ borehole water sources should be covered appropriately and be dug at distances over 100 meters to the automobile workshop and for a recommended depth of 90 feet and above.

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