Arabian Journal of Chemical and Environmental Researches

Vol. 02 Issue 1 (2015) 22–28

The Study of Mobility of Pb and Zn From New and Used Lubricant Engine Oil in Soil Using PVC Columns.

S. Jodeh[1]*, R. Odeh[1], M. Sawalha[1], O. Hamed[1], R. Salghi[2], S. Radi[3], I. Warad[1]

[1]*Department of Chemistry, AN-Najah National University, P. O. Box 7, Nablus, State of Palestine.*
[2]*Equipe de Génie de l'Environnement et de Biotechnologie, ENSA, Université Ibn Zohr, BP 1136, Agadir Morocco*
[3]*Laboratoire de Chimie Appliquée et Environnement (LCAE), Faculté des Sciences, Université Mohamed I, 60 000 Oujda, Morocco*

Received 5 Jan 2015, Revised 26 Mar 2015, Accepted 27 Mar 2015

Abstract

Today interest of public regarding environmental pollution has raised concerns of adverse impacts on various parts of environment such as soil, plants, drinking water, air pollution and aquatic life. In this study different plastic columns were filled with agricultural soil and an amount of used and new lubricant engine oil was added to the column to understand the metals distribution in soil. Every five days affixed volume of the lubricant oil was added and then the leachate of oil was collected and analyzed. The amount of used oil added was calculated depends on the amount of annual rain falls in Palestine and the diameter and length of the plastic columns. The results indicated that more than 70% of lubricant oil adsorbed by the soil.

Keywords: soil, column, heavy metals, adsorption, used oil, ground water, leachate.

*Corresponding author.
E-mail address: sjodeh@najah.edu

1. Introduction

Heavy-metal pollution has raised serious environmental concerns worldwide because bio-accumulation of these elements beyond the tolerance thresholds of living organisms poses long term risk to the earth's ecosystem [1-4]. Industrial, urban, and farming activities are the main sources of heavy metals in the environment. Precise identification of the actual sources of heavy metal contamination of soil and water resources is urgent, due to the acute, severe, and persistent impacts of these pollutants on human health and on the sustainability of ecosystems.

Most of the reports on the effects of petroleum products on plants have focused on crude oil, diesel and gasoline [5-6] which get to the environment through accidental spillage. However, through the activities of automobile, generator, other machines, and servicing engineers (mechanics) spent oil is discharged to the environment indiscriminately. Spent oil is a mixture of different chemicals [7] including petroleum hydrocarbons, chlorinated biphenyls, chlorodibenzofurans, lubricative additives, decomposition products and heavy metals that come from engine parts as they wear away. Spent oil contains polycyclic aromatic hydrocarbons (PAHs) and chemicaladditives like lead, zinc, sulphur, phosphorus, magnesium, iron, vanadium, aluminum, nickel, calcium, barium, phenols, amines and benzenes [8]. The concentration of PAHs in spent oil increases with time of usage [9].

Toxicity characteristic leaching procedure (TCLP) was used to measure heavy metals contained in oil and sludge samples from auto mechanic workshops. Some result indicated that concentration of Pb in oil and sludge samples are considered toxic, also high concentrations of other heavy metals such as barium and chromium were measured in that test [10]. In other results showed increase in bulk density, water porosity, organic carbon and organic matter and decrease in soil capillarity, aeration, nitrogen, phosphorous, sodium, manganese and potassium content [11]. In this study two samples of used and new lubricant engine oil will be taken and added to the top soil layer in PVC column and amount of distilled water will be added for five days to the column to see how the metals in oil will be distributed and leached out through the soil inside the columns. Both the leachate and the soil samples will be analyzed for zinc and lead using flame atomic absorption (FAAS).

2. Materials and methodology

2.1. Chemicals

All chemicals used in this study were analytical grade with very high purity. Some chemicals were purchased from the local market while others were from chemistry labs in the university. The new and used engine oil (SAE 15 W- 40) were purchased from Shell oil company in Nablus, Palestine.

2.2. Instrumentation

Flame Atomic Absorption Spectrophotometer modelZicE-3000SERIES deigned in UK AA Spectrometer, PH& Conductivity meter Jenway model 3540, Shaker model LSBO-15S, Centrifuge HermelZ200A, Balance 301S, hydrometer ASTM152-h, JLabTech furnace modleLOD-060E all were available at the department of chemistry.

2.3. Soil characterization

2.3.1: Soil collection and preparation

A sample of soil was collected from area (500m2) located in the east of Tulkarm which is far from any source of engine oil contamination. The sample was sieved by 2mm sieve and analyzed for organic matter, pH and conductivity, moisture, texture and specific gravity.

2.3.2 Soil digestion

About 100g of the soil was dried at 1050C and then cooled. A 1.0 g of homogeneous sieved soil was placed in a 250 mL flask and 10 ml concentrated nitric acid was added and the mixture was heated until boiling using a magnetic stir bar. After cooling, 5 ml of concentrated HNO3 was added to the flask and refluxed for half hour. The mixture was heated and stirred for additional 10 minutes and cooled. After cooling 2 ml distilled water and 3 ml H2O2 were added to the mixture and cooled again. The solution appeared grey, diluted by distilled water to 100ml.The flask was closed by Para film and inverted several times, finally it was filtered using filter paper number 4 [12].

2.3.3 Engine oil digestion

Small amount of used oil (0.5g) and new oil (15W-40) was placed in two digestion flasks separately and 4 mL of concentrated H2SO4 added to each flask and column put at the top of each flask to remove acid vapor produced by refluxing for about 5 minutes at 4400C. A 10 mL of H2O2were added and refluxed for two minutes. When the tow solutions were cooled deionized H2O water was added to make the volume of each solution 100 ml [13]. The two mixtures were filtrated and become ready for measuring concentrations of Pb and Zn using flame atomic absorption spectrophotometer. Standard solutions were prepared for calibration curves with R2> 0.98 [14].

2.4. Soil-column Experiment

Three PVC plastic columns were prepared with 1.5 meter long and six inch diameter (15.25 cm). The soil was filled in the three columns and compressed. The first column was for used engine oil, the second for new engine oil, while the third column used as a control for distribution (lead and zinc) contained in the stock solution (500 mg/L) prepared particularly for this experiment. A 2 L of both types of used and new engine oil were added to the first and second columns respectively, and then one litter of distilled water was added to each column for five days gradually while the stock solution was added to the third column and distilled water also added to it at the same rate. The concentration of both Zn and Pb in used and new oil was measured before the addition and the concentrations were summarized in Table 3.

2.4.1 Distribution of metals in soil columns

After adding distilled water to the three columns for five days, the leachate from the three columns were collected and analyzed for metals. Each column was cut into six parts (0-20, 20-40, 40-60, 60-80, 80-100, and 100-120) cm. In each part the soil samples were analyzed by taking five grams at each depth were digested by Nitric acid and H_2O_2 as mentioned before and centrifuged and filtrated to be analyzed by flame atomic absorption spectrophotometer.

3. Results and discussion

Results of this work are represented in tabular and graphical forms .These results are devoted to understand the effect of used engine oil on the environment and comparing it with effect of new engine oil, these results based on experimental study of releasing heavy metals into soil and adsorption of zinc and lead onto soil using soil columns and analysing of soil samples by flame atomic absorption experiment.

3.1: Soil characteristics

Sample of soil was analyzed in Poison Control & Chemical /Biological Centre at Al- Najah National University and the results were shown in Table 1.

Table 1: Soil characteristics

SOIL PROPERTY	RESULT
Specificgravity	2.34
pH value	7.5
Conductivity	182*u*s
Organicmatter	6.4%
Moisture	9.56%

3.2: Heavy metal concentration in engine oil

As shown in the table 2 there are an obvious differences in the concentration of five metals Zn and Pb between used and unused engine oil (15W–40) according to three replicates of acid oil digestion by method mentioned in methodology and measuring concentration by flame atomic absorption spectrophotometry. These differences can be explained by contaminating of lubricating oil with dirt and metal parts worn out from engine surfaces during operation, and all metals measured are used in manufacturing various parts of the motor. Since engine components are composed from various alloys, increases in concentration of some metals may indicate a failure in specific component or resulting from wear of that component, for example increases in zinc concentration results from additives and galvanized piping wear. Lead in used oil may result from bearing cages alloyed with copper and Ti [15-16].

Table 2: Zinc and lead concentrations in used and new engine oil (15W-40)

Metal	Wavelength	Oil type	Concentration(mg/L)
Zn	213.9nm	Unused	8.89
		Used	25.22
Pb	217nm	Unused	3.42
		Used	8.56

3.3: Soil- column experiment

Concentration of both Zinc and lead at different depths of the three columns of soil (used, new and stock solution) were shown in Figs 1-2 and Table 3.

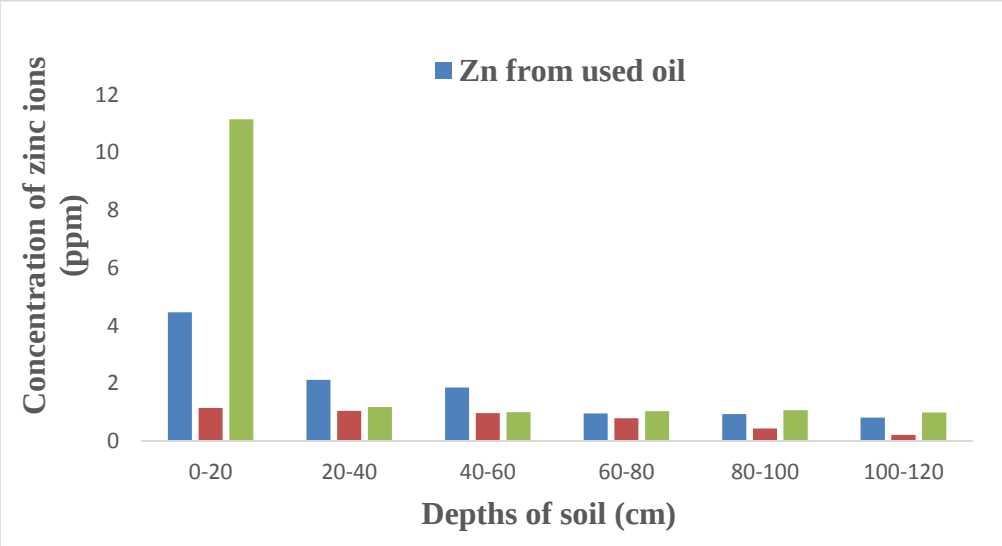

Figure 1: Zinc concentration at various depths of soil from used engine oil, new engine oil and 50 ppm stock solution

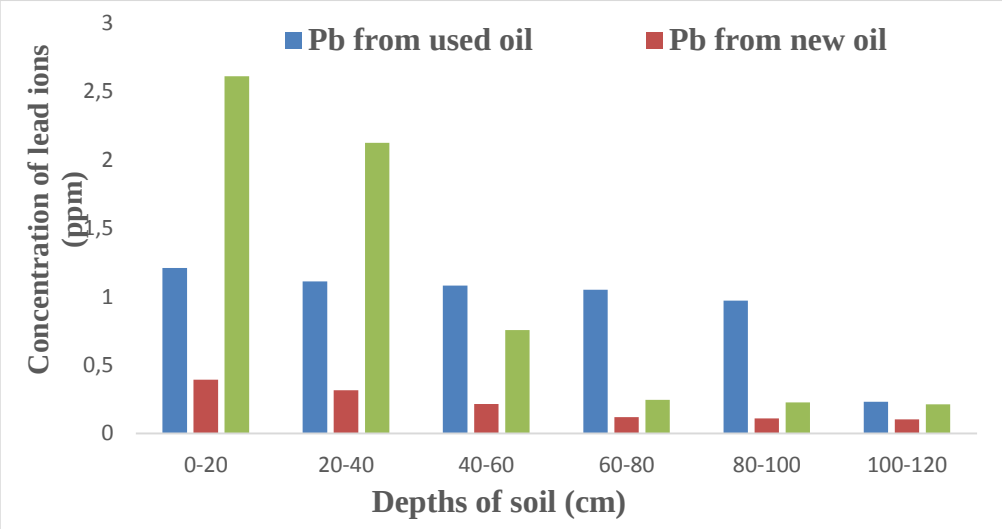

Figure 2: Lead ions concentration at various depths of soil from used engine oil, new engine oil, and 50 ppm stock solution.

Table 3. Summary of the columns experiment results.

Metal	Wavelength	Oil type	Amountused (mg/L)	Columns(mg/L)	Leachate (mg/L)	Difference (mg/L)
Zn	213.9nm	Unused	10.89	7.28	2.64	0.97
		Used	25.22	13.15	10.53	1.54
Pb	217nm	Unused	3.42	2.17	0.32	0.93
		Used	8.56	6.52	1.57	0.47
Stock solution		Zn	20.00	16.22	2.34	1.44
		Pb	8.00	6.32	1.12	0.56

Results indicated that there is a possibility of leaching these metals since measurable concentrations are noticed after more than 120 cm depth of the soil. Also it's obvious that lead is more adsorable to the soil used in this experiment since its concentration is higher in the upper part of the column. The difference in concentrations indicated in Table 3 is due to the total errors came from the instrument and measurements and some of the metals adsorbed on the walls of the PVC tubes.

Conclusion

The study above showed that the spent lubricant oil has an important contribution to environment pollution. This pollution can be in soil as the results showed and from the leachate of heavy metals to ground water. Those two properties will effect on human being via agriculture and drinking water.

Conflict of Interest-The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

[1] A. Voegelin, K. Barmettler, R. Kretzschmar, Heavy Metal Release from Contaminated Soils, J. *Environ. Qual.* 32, 865-875 (2003)

[2] A. J. Whittle, A. J. Dyson, The fate of heavy metals in green waste composting, The fate of heavy metals in green waste composting, *The Environmentalist*, 22, 13-21 (2002)

[3] F. X. Han, A. Banin, G. B. Triplett, Redistribution of heavy metals in arid-zone soils under a wetting-drying cycle soil moisture regime, *Soil Science*, 166(1), 19-28 (2001)

[4] D. P. Oliver, M. J. McLaughlin, R. Naidu, Smith, E. J. Maynard, I. C. Calder., Measuring Pb Bioavailability from Household Dusts Using an in Vitro Model**,** *Environ. Sci. Technol.* 33(24), 4434-4439 (1999)

[5] S. Siddiqui, W. A. Adams, The Fate of Diesel Hydrocarbons in Soils and their Effects on Germination of Perennial Ryegrass, *Environ. Toxicol.* 17(1), 49-62 (2003)

[6] O. E. Inoni, D. G. Omotor, F. N. Adun, The Effect Of Oil Spillage On Crop Yield And Farm Income In Delta State, Nigeria, *J. Centr. Eur. Agric.* 7(1), 41-49 (2006).

[7] J. Wang, C. R. Jia, C. K. Wong, P. K. Wong, Characterization of Polycyclic Aromatic Hydrocarbons Created in Lubricating Oils, *Water, Air Soil Poll.* 120, 381-396 (2000)

[8] F. O. Cotton,M. L. Whisman,S. W. Gowtzinger,J. W. Reynolds, Analysis of 30 used motor Oils, *Hydrocarbon Processing*, 15, 131-140 (1977)

[9] U. Obini, C. O. Okafor, J. N. Afiukwa, Determination of levels of polycyclic aromatic hydrocarbons in soil contaminated with spent motor Engine oil in Abakaliki Auto-Mechanic Village, *J. Appl. Sci. Environ. Manage*, 17, 169-175 (2013)

[10] T. Raukytea, D. J. Hargreavesb,Z. Pawlaka. Determination of heavy metals and volatile aromatic compounds in used engine oils and sludges, *Fuel*, 3(2), 481-485 (2006)

[11] J. Kayode, A. Oyedeji, O. Olowoyo, Evaluation of the Effects of Pollution with Spent Lubricating Oil on the Physical and Chemical Properties of Soil, *Journal of Science and Technology*,10, 1-5 (2009)

[12] L. Welson. Acid Digestion of Sediments, Sludges, and soils. BPT, *Environmental Analytical Lab*, page 2 (1993)

[13] E. D. Rosado, J. Pichtel, Chemical characterization of fresh, used and weathered motor oil via GC/MS, NMR and FTIR techniques, *Proc of the Indi Acad of Sci*, 112(2)**,** 109-116 (2003)

[14] D. E. Anderew.S. C. Lenore,E. G. Arnold. Standard methods for the examination of water and wastewater , 19th edition (1995).

[15] T. Mckenzie, Atomic Absorption Spectrophotometry for the analysis of wear metals in oil samples. *Mulgrave, Victoria, Australia. Varian* AA-10, Pages 1-9 (1981)

[16] S. Jodeh, R. Odeh, M. Sawalha, A. Abu Obaid, R. Salghi, B. Hammouti, S. Radi, I. Warad. Adsorption of lead and zinc from used lubricant oil using agricultural soil: equilibrium, kinetic and thermodynamic studies *J. Mater. Environ. Sci*, 6,580-591(2015)