CONTRIBUTIONS OF METAL WELDING WORKSHOPS TO ENVIRONMENTAL POLLUTION IN AKURE METROPOLIS, ONDO STATE, NIGERIA

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ABSTRACT

The concentrations of eight metals - Zinc (Zn), Chromium (Cr), Iron (Fe), Manganese (Mn), Lead (Pb), Cadmium (Cd), Copper (Cu), and Cobalt (Co) in soil samples of selected gas and electric welding workshops in Akure of Ondo State in Nigeria were determined. This was aimed at assessing the contribution of welding activities to environmental pollution. Soil samples were collected from five gas and five electric welding workshops. A control sample collected for each of the welding workshops was about 100meters away from the study samples. The study samples and the control samples were pretreated digested and analyzed using atomic absorption spectrometer. The differences between the study samples and the control samples indicated that the welding activities are possible sources of environmental metal pollution. Foods of plant origin come from soil as such care should be taken to monitor the metal concentration of these metals in the soil as this is a channel through which metals can inadvertently enter the food chain.

Keywords: *Welding workshop, metal pollution, food chain.*

INTRODUCTION

Pollution of the environment may occur through industrial commercial activities of man. This happens when substances resulting from human activities enter the environment. The environment is said to be polluted when the concentration of these substances attain levels which may cause discomfort and/or harm to man, fauna and flora of his environment. The pollution of the environment has been found to result from man's determination to match desire with production through establishment of various industries with potentials to pollute the environment. Industry, big or small, is a source of pollution of water, soil and air (Udosen, Edoessien and Ibok, 1990).

The world is undergoing a silent epidemic of heavy metal poisoning due to ever increasing amount of metals being introduced into the biosphere (Odukoya, Bamigbose and Arowolo, 2000). In Nigeria and many third world countries, many industrial workshops such as welding workshop, mechanical and electrical workshops are located by the roadsides in residential areas where their customers could easily have access to them. The wastes produced in these workshops are potential environmental pollutants that need to be given a serious attention. Welding is a process in which two or more pieces of metal are joined together by the application of heat, pressure or a combination of both (Disc, 1981). With the development of new techniques arising in the first half of the 20th century, welding replaced bolting and riveting in the construction of many types of structures, including bridges and building.

It is also a basic process in the motor and aircraft industries and in the manufacture of food machinery. Along with soldering and brazing, it is essential in the production of virtually every manufactured product involving metals (Disc, 1981; Odukoya, Bamigbose and Arowolo, 2000). As we approach the end of the first decade of the 21st century, establishment of welding workshops within the city of Akure is on the increase. The welding processes most commonly employed today are gas and electric welding. The impact of these processes on the environment must be given attention. Contamination of the environment by metals can cause interference with plant metabolism and consequently the food chain. This is because the conversion of nitrate is inhibited so that the supply of the nitrogen available to the plant is reduced (Cook, 1976).

As a result of the literacy, poverty level and inadequate planning of most developing countries, many human activities co-exist with one another. For instance, it is in these countries that one will find welding workshop, mechanical workshop, restaurants and refuse dump sited close to one another or even in a residential area without considering the health implications on the people. This is not so in developed countries of the world. In the U.S.A for example, United State Environmental Protection Agency (USEPA) is responsible for the provision of information on environmental pollutants. Such detailed information is scanty in developing countries even though there has been an appreciable level of urbanization. A study conducted by Hindy in 1991 showed that top soil content was greatly affected by metals released from industrial activities.

The metals released into the environment through industrial/human activities may leach into the soil from where they can be taken up by plants as food thereby entering the food chain (Harrison and Chargawi, 1989; Odukoya, Bamigbose and Arowolo, 2000). It can also lead to contamination of underground water (Fuleker and Dave, 1992). Moreover, rain water can wash these metals into streams and rivers thereby posing a threat to the aquatic ecosystem. Since these metals can accumulate in aquatic organisms - plants and animals, including fish, they are a possible source of food poisoning (Waldron, 1980). This study is aimed at assessing the concentration of some metals in the top soil of these welding workshops and compare with concentrations in uncontaminated soil samples so as to determine the contribution of the welding workshop to metal pollution of the environment.

MATERIALS AND METHODS

Soil samples of ten different welding workshops (five gas and five electric workshops) were collected. Control samples were collected from a distance of about 100 meters from each of the welding workshops. The study samples and control samples were collected with plastic cups into polythene bags and were taken into the laboratory oven for drying at 103^0C for about 5 hours. The samples were then ground and sieved using a 0.5mm mesh sieve. The samples were then stored in cellophane bags until they were digested.

2g of each ground samples was weighed into a beaker using an analytical balance - Metler AE160. $50cm^3$ of concentrated Nitric acid (HNO_3) and $1cm^3$ Perclorin acid ($HCLO_4$) were added. The mixture was digested by boiling gently on a hot plate. After digestion, the sample was evaporated to dryness and the residue mixed with 0.1M HNO_3 and filtered into a 100ml flask using Whatman No.1 filter paper (Odukoya et al., 2000). Blank determination was also carried out. The metals were determined using atomic absorption spectrophotometer - Buck 20A model.

All the analyses were conducted in duplicates and expressed as mean data ± SD (standard deviation) (Duncan, 1955). Statistical analyses were performed using SAS of 2005 (version 9.1, SAS Institute Inc., Cary, NC).

RESULTS AND DISCUSSION

The results of the analysis of the surface soil samples are as shown on Tables 1 and 2. Table 1 contains the metal concentration of welding site soil samples and their respective control sites. Table 2 contains the accumulated factors of metals in each site. To fully discuss the results, the concentrations shown on both tables will be of importance.

Zinc (Zn) is an ubiquitous metal with usually high control site's concentration ranging from 52.04mg/100g to 70.25mg/100mg. The welders' workshops sites had concentration of Zinc ranging from 102.69mg/100g to 225.36mg/100g. The accumulation factor of Zinc in all these sites ranges from 42.02mg/100g to 173.32mg/100g. Sample 8 (Laco's house) had the least concentration of Zinc and consequently the least accumulation factor of 42.02mg/100g. The highest amount of accumulated Zinc was recorded on sample 2, which is Owena Garage 1 with active welding and auto mechanic maintenance activities going on.

Chromium (Cr) a ferro-magnetic metal was equally abundant on each site, though with lower control samples concentrations. The control samples concentration ranged from 0.85 to 3.22mg/00g. The real sample had a concentration between 167.00 and 806.50mg/100g. The accumulation factor of chromium ranged from 133.78mg/100g to 805.30mg/100g. The least accumulation factor of chromium of 133.78mg/100g was recorded for Ilesa Garage 1. On the other hand, the sample 3 (Majasan) had the highest concentration of chromium at 806.50mg/100g. This workshop has been in operation for nine years.

Iron (Fe), an equally ubiquitous metal in the soil, had a relatively lower control sample concentration ranging from 5.21mg/100g to 36.04mg/100g. The real sample had a relatively higher concentration from 505.00mg/100g to 1760mg/100g. The sample with the highest concentration happened to be sample 1 from Ilesa Garage 1. The accumulation factor for iron ranged between 449.79mg/100g and 1740.62mg/100g. The sample with least accumulated iron was sample with 449.79mg/100g from Laco's house. On the other hand, sample 1 of Ilesa garage 1 had the highest accumulated concentration of chromium at 1740. 62mg/100g.

Manganese (Mn) occurred at relatively lower concentration compared to other metals discussed already. The control sample concentration was between 0.92mg/100g and 6.89mg/100g. The real samples concentrations were much higher at a range of 64.56mg/100g to 199.52mg/100g. The highest concentration of manganese was recorded for sample 1 (Ilesa Garage 1). The accumulation factor of manganese over the control amounted to 63.64mg/100g and 131.92mg/100g. The sample 1 from Ilesa Garage I happened to accumulate the highest concentration of this metal at 131.92mg/100g. Similar observation had been made for this sample with respect to iron concentration.

Lead (Pb), a poisonous metal, was present in both control and real samples. The control samples contained between 0.91mg/100g and 4.23mg/100g of lead. The real samples contained lead ion concentration between 35.05mg/100g and 169.84mg/100g. The accumulation factors ranged between 34.02 and 167.61mg/100g. Maximum concentration of 167.61mg/100g was encountered in sample 1 (Ilesa Garage 1) while the minimum accumulation lead of 34.02mg/100g was recorded for sample 6, (Ilesa Garage 2). Cadmium (Cd), an equally poisonous metal was present in all samples. Control samples had concentration ranging between 0.65mg/100g and 2.30mg/100g. The welder's site sample had recorded concentration of cadmium ranging between 12.57mg/100g and 47.46mg/100g. When corrected with control value, the accumulation factor of this metal was between 10.54mg/100g and 46.17mg/100g. The most concentrated sample was sample 4 (Y junction) while the minimum of 12.57mg./100g was recorded for sample 5 (Orita Obele 1).

Copper (Cu) occurred in all samples and the control samples concentration was between 0.78mg/100g and 4.32mg/100g. The real samples had concentration ranging from 54.04mg/100g to 253.30mg/100g. The accumulation of copper in these samples sites amounted to 53.17mg/100g to 248.98mg/100g. A maximum accumulated level of copper of 248.98mg/100g was recorded for sample 6 (Ilesa Garage 2). The least accumulation was recorded at Pakusa (sample 9). Cobalt (Co) was also detected in measurable quantities in both real and control samples. The control samples had concentration ranging from 0.56mg/100g to 3.26mg/100g. The real samples had recorded concentration of 24.52mg/100g to 153.96mg/100g. This translated to accumulation factor ranging from 23.48gm/100g to 153.46mg/100g, the maximum of which was recorded for sample 8 (Laco's house). The minimum of 23.48mg/100g was recorded for sample 6 (Ilesa Garage 2). Comparative evaluation of the concentration of metals from the welding sites with those of the corresponding control sites clearly shows that the metals were contributed by the welding activities. The concentrations of the metals vary from site to site and these depend most probably on the age of the site, type and nature of the metal being frequently used for welding activities. For instance, zinc and cadmium are used for coating iron and steel while stainless steel - an alloy of iron, chromium and nickel may contain manganese and phosphorus as impurities (Judith et al., 1993; Ojo and Ajayi, 2005). Although these welding workshops are not located near streams or rivers, run-off from them during rain may flow into these water sources thereby causing pollution. There is high tendency that these metals could leach to pollute both surface and underground water.

Pollution implication of these metals should be given utmost attention especially in relation to human health. For example, Zn induces vomiting, dehydration, electrolyte imbalance, abdominal pain, lethargy, dizziness and lack of muscular co-ordination in man when taken in excess. Also, Pb pollution can cause dysfunction in kidney, reproductive system, liver, brain and central nervous system. Contamination of the marine environment could lead to gradual build up of these metals in aquatic organisms including fish, crab and water plants (Vasquez, Delgado and De la Huerta, 1993; W.H.O., 1984; Goldsmith and Hildyard , 1988). These metals can be taken up by plants and they can thus gain entry into the food chain. Because this uptake is mostly irreversible, the metals should not be introduced indiscriminately into the environment in the interest of the health of the inhabitants.

CONCLUSION AND RECOMMENDATIONS

A glance at the concentrations of the metals analyzed in the soil samples from the welding sites reveals pollutional trends compared with the samples from the control sites. Metal pollution of soil is very hazardous and of no use to biological processes such as photosynthesis (Goldsmith and Hildyard, 1988; Goyer, 1991). For example, the presence of lead can cause lead poisoning while iron overload in the body leads to liver dysfunction and cardiovascular effect. It also causes deposition of iron in the lungs, heart and pancreas (Corne and Lawcer, 1977; Goyer, 1991).

Although most of these welding workshops are not located near streams or rivers, however, run - off from them during rainfall may flow into these water sources and thus resulting in their pollution. These metals could leach into the soil to pollute the underground water. Through irreversible up-taking, these metals can enter the food chain. Also, there is danger of bio accumulation in aquatic organisms thereby posing a health hazard to the organisms concerned and the consumers.

It is evident that welding activities constitute a source of metal pollution. Therefore, indiscriminate location of welding workshops should be discouraged. Welding workshops should be selectively located away from food plants and water sources. Furthermore, regular monitoring of the welding sites for metal pollution is necessary by agencies responsible for environmental protection. This would safeguard the health of the populace. Also, welding workshops should be concrete floored all round. This is obtainable in most developed economies that are health conscious. This method will reduce significantly the rate at which the metals pollute the soil.

Table 1: Concentration of metals in welding sites soil and control sites (mg/kg). Values in parenthesis represent the control sites

Welding Site	Age (years)	Zn	Cr	Fe	Mn	Pb	Cd	Cu	Co
Ilesa garage 1	15	176.39 ± 1.10 (65.33 ± 0.37)	167.00 ± 1.03 (3.22 ± 0.01)	1760.00 ± 2.23 (19.38 ± 0.68)	137.75 ± 1.53 (5.83 ± 0.14)	169.84 ± 1.60 (1.23 ± 0.01)	41.67 ± 0.47 (1.25 ± 0.31)	228.50 ± 3.26 (3.26 ± 0.02)	43.92 ± 0.06 (2.68 ± 0.22)
Owena garage 1	15	225.36 ± 0.91 (52.04 ± 0.65)	421.64 ± 2.04 (2.25 ± 0.01)	531.23 ± 1.45 (12.35 ± 0.24)	111.05 ± 2.21 (6.89 ± 0.15)	101.01 ± 1.56 (2.01 ± 0.02)	36.01 ± 0.23 (2.30 ± 0.60)	157.57 ± 0.52 (0.78 ± 0.02)	55.45 ± 1.07 (1.05 ± 0.03)
Majasan along Ondo road	9	181.80 ± 1.701 (56.32 ± 0.45)	806.50 ± 2.40 (1.20 ± 0.02)	888.65 ± 3.67 (21.04 ± 0.42)	83.07 ± 0.67 (2.38 ± 0.14)	85.41 ± 1.12 (1.22 ± 0.02)	27.64 ± 0.50 (0.81 ± 0.02)	141.39 ± 0.87 (1.35 ± 0.04)	119.20 ± 0.83 (0.75 ± 0.03)
Y junction Ondo road	10	183.16 ± 1.36 (67.25 ± 0.51)	519.72 ± 0.69 (1.00 ± 0.01)	839.46 ± 2.05 (24.26 ± 0.33)	(129.55 ± 1.51 (1.53 ± 0.13)	93.16 ± 1.20 (2.03 ± 0.2)	47.46 ± 0.76 (1.29 ± 0.42)	164.63 ± 0.60 (2.31 ± 0.21)	124.60 ± 0.57 (1.35 ± 0.03)
Orita Obele 1	14	195.65 ± 1.50 (70.25 ± 0.71)	630.26 ± 0.69 (1.04 ± 0.04)	710.84 ± 3.64 (36.04 ± 1.00)	199.52 ± 3.79 (4.01 ± 0.20)	106.85 ± 1.20 (4.23 ± 0.35)	12.57 ± 0.36 (2.03 ± 0.03)	83.26 ± 1.05 (2.87 ± 0.30)	90.68 ± 0.67 (3.26 ± 0.27)
Ilesa garage 2	7	152.50 ± 0.54 (60.10 ± 0.48)	291.04 ± 1.01 (1.90 ± 0.05)	1033.67 ± 3.05 (23.60 ± 0.70)	199.10 ± 1.56 (8.32 ± 0.06)	35.05 ± 0.30 (1.03 ± 0.03)	28.36 ± 0.92 (1.16 ± 0.03)	253.30 ± 1.30 (4.32 ± 0.35)	24.52 ± 0.10 (1.04 ± 0.03)
Owena garage 2	15	192.00 ± 2.83 (50.23 ± 0.40)	635.43 ± 0.60 (2.02 ± 0.23)	534.23 ± 2.79 (31.63 ± 0.31)	84.82 ± 0.88 (2.18 ± 0.11)	114.00 ± 0.97 (0.91 ± 0.01)	15.32 ± 0.30 (0.87 ± 0.32)	67.98 ± 0.83 (3.06 ± 0.20)	116.70 ± 0.70 (1.01 ± 0.03)
Laco's house	15	102.69 ± 2.14 (55.67 ± 0.58)	538.22 ± 0.33 (3.02 ± 0.09)	505.00 ± 2.07 (5.21 ± 0.30)	64.56 ± 0.91 (0.92 ± 0.02)	91.59 ± 1.03 (1.05 ± 0.02)	17.95 ± 0.36 (0.65 ± 0.01)	105.50 ± 0.84 (0.88 ± 0.03)	153.96 ± 0.43 (0.60 ± 0.01)
Pakusa along Ondo road	14	167.83 ± 0.25 (69.00 ± 0.22)	307.35 ± 0.49 (2.06 ± 0.32)	534.23 ± 2.79 (15.65 ± 0.20)	104.59 ± 2.00 (4.25 ± 0.13)	85.51 ± 0.26 (1.24 ± 0.04)	40.38 ± 0.06 (1.25 ± 0.04)	54.04 ± 0.23 (0.87 ± 0.02)	99.58 ± 0.95 (0.56 ± 0.02)
Orita Obele 2	12	136.04 ± 0.65 (69.54 ± 0.22)	576.51 ± 0.58 (0.85 ± 0.02)	646.68 ± 2.15 (7.53 ± 0.61)	132.51 ± 2.26 (3.20 ± 0.41)	75.56 ± 0.55 (3.20 ± 0.03)	14.23 ± 0.53 (1.89 ± 0.03)	105.50 ± 0.58 (3.30 ± 0.34)	105.54 ± 0.75 (2.84 ± 0.34)

Source: Experimentation, 2010

Table 2: Accumulation factors of metals (mg/kg).

	Zn	Cr	Fe	Mn	Pb	Cd	Cu	Co
Ilesa garage 1	111.06	133.78	1740.62	131.92	167.61	40.42	224.34	41.24
Owena garage 1	173.32	419.39	518.88	104.16	99.00	33.71	156.79	53.60
Majasan along Ondo road	1254.48	805.30	867.61	80.09	84.19	26.83	149.04	118.45
Y junction Ondo road	115.91	518.78	815.20	128.02	91.13	46.17	162.32	123.25
Orita Obele 1	125.40	629.72	674.80	195.51	102.62	10.54	80.54	87.42
Ilesa garage 2	92.40	289.14	1010.07	190.78	34.02	27.20	248.98	23.48
Owena garage 2	141.77	633.41	522.41	82.64	113.09	14.45	64.92	115.69
Laco's house	42.02	535.20	499.79	63.64	90.64	17.40	104.62	153.46
Pakusa along Ondo road	98.83	305.29	518.58	100.34	89.27	39.12	53.17	99.02
Orita Obele 2	66.50	575.66	639.15	129.31	72.36	12.55	102.20	102.70

Source: Experimentation, 2010

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