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ASSESSMENT OF THE HEAVY METAL POLLUTION OF THE SOIL OF AJAOKUTA STEEL COMPANY, AJAOKUTA, KOGI STATE NIGERIA

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ABSTRACT

Soil samples from different sections of Ajaokuta Steel Complex, Ajaokuta were collected randomly for the analysis of the concentration of selected heavy metals caused by the activities of the iron and steel complex. The results obtained were compared with WHO, NAFDAC and SON standards; and the parameters assessed fall within the permissible limits. The low concentration could be attributed to the fact that the Ajaokuta Steel Company has not been in operation for more than five years. The analysis was done using pH meter and atomic absorption spectrometric technique. The pH of the soil S_1 (7.50), S_2 (7.60), S_3 (7.10) and S_5 (7.20) were slightly basic and S_4 (6.10) and S_6 (6.90) were slightly acidic and the concentration of the heavy metals in ppm were within the permissible range except for Fe which is in a high concentration, which was found to range between 97.4to116.5 mg/Kg. Heavy metal pollutants in the environment are of immense concern globally, so there is need to study and enlighten the habitants of such environments where this giant company is situated as clarified in this study.

Keywords: soil, heavy metals, pH

INTRODUCTION

A pollutant is any substance in the environment, which causes objectionable effects, impairing the welfare of the environment, reducing the quality of the life and may eventually cause death. Such a substance has to be present in the environment beyond a set or tolerance limit, which could be either a desirable or acceptable limit. (Duruibe, *et al.*, 2007). Hence, environmental pollution is the presence of a pollutant in the environment; air, water and soil, which may be poisonous or toxic and will cause harm to living things in the polluted environment.

Pollution is the introduction of contaminants into an environment that causes instability, disorder, harm or discomfort to the ecosystem i.e., physical systems or living organisms (Petraitis, 2007). Pollution can take the form of chemical substances, or energy, such as noise, heat, or light. Environmental pollutants from many different sources contaminate water, air and land, putting humans and ecosystems at risk and often pitting people against industry. The term pollution of the environment herein refers to an increase of trace elements beyond the tolerable limits of the environment (Fifield and Haines, 1995). The term "heavy metals" refers to any metallic element that has a relatively high density and is toxic or poisonous even at low concentration. Heavy metals are natural constituents of the Earth's crust, but human activities have drastically altered their geochemical balance (Adefemi, *et al., 2007).* Heavy metals include lead (pb), Cadmium (Cd), Zinc (Zn), Mercury (Hg), Arsenic (As), Silver (Ag), Chromium (Cr), Copper (Cu), Iron (Fe), and the platinum group elements. Environment is defined as the totality of surrounding of an organism or group of organisms especially, the combination of external physical conditions that affect and influence the growth, development and survival of organisms (Cullaj, *et al.*, 2000). [6] It consists of the flora, fauna and a biotic, and includes the aquatic, among various sources of soil pollution; heavy metals from the mining activities are known to be the major contributors to accumulated metals in the environment. Heavy metal pollution makes soil pollution an inevitable problem and a big challenge to policy makers. For healthy sustainable future generations, the soil reserves should be protected against pollution by heavy metals released into the environment.

Land use activities contribute to the overall development of a country, but they equally produce negative impact on the environment. Some of these land use activities are mining, industrial and domestic waste disposal, bush burning, smelting, fossil fuel combustion agricultural practices and so on. The above activities introduce metals into the environment increasing their natural levels in the various ecosystems.

The iron and steel industry generates tar, SO_2, ammonia and oven gas. For integrated iron and steel making plant like the Ajaokuta steel company, the black furnace is a source of fuel gases and particulates. The rolling mills, like the ones located in Aladja Oshogbo, Jos and Katsina, use large quantity of picking liquor containing sulphuric acid for removing dirt, grease and iron oxide scale.

Agriculture, through soil fertilization is one of the main sources of pollution with heavy metals. Soils are threatened by excessive imputes of toxic metals through use of manure, fertilizer, irrigation, animal dung, etc, as soil nutrients to improve soil fertility. The use of these agricultural practices are increasing due to the need to maximize food production for the over growing world wide populace. World wide heavy metals such as Cd, Pb, Cu, Zn are dispersed during application of these materials into the atmosphere.

MATERIALS AND METHODS

Stainless steel spoon, polyethylene container (acid treated), oven, electronic crusher (Hertzog D4500, Osmabruck, type HSM100, Fabr.Nr. 623414), pH meter, AAS, etc.

The steel complex which comprises the steel plant and township is located on a sprawling 24,000 hectares of land on the west bank of the River Niger. It is bounded to the south by Ajaokuta village (from w here the company's name was derived), to the west by hills and is 65 kilometres from Okene. The climate of the study area is tropical and consists of six months (May – October) of wet season and six months (November-April) of dry season. Agriculture is the major

activities of the inhabitants of this area. They cultivate economic food crops such as melon, groundnut, cassava, yam, cowpea and fishing.

A composite soil sample from six different sites was collected with a stainless steel spoon at a depth of 0-20cm from the top into acid treated polyethylene containers. The samples were dried in an oven at 105 ^{0}C until a constant weight was attained and then pulverized using the electronic crusher (Hertzog D4500, Osmabruck, type HSM100, Fabr.Nr. 623414) into finely ground soil and sieved through 2mm mesh screen and kept for digestion. The six soil samples were labeled S1, S2, S3, S4, S5 and S6, respectively.

The pH

The pH meter was calibrated with buffer 4 and 6. It was then rinsed with distilled water. The pH of the samples was determined by the use of pH meter *(Kent, EIL, 7020).*

10g of the pulverized sample was collected in a beaker, 50 ml distilled water was added and then agitated for about 10 minutes. The pH was determined for each of the sample.

Wet Digestion of samples

5g of soil samples was mineralized with mixture of nitric acid, percloric acid and hydrochloric acid mixture (5:4:1) and heated in a fume cupboard at temperature of 110^{0}C for 3hours. After which the digest was filtered and diluted with 100ml of distilled water. The sample solution was subsequently analyzed using atomic absorption spectrophotometer.

Instrumental Analysis

Atomic Absorption Spectrometer model AAS 240FS was used to determine the concentration of the metallic elements As, Cr, Cd, Cu, Pb, Fe and Zn at parts per million (ppm) level, and hence its measurements are very sensitive. It involves the aspiration of a liquid sample into a flame, evaporation of the liquid and breaking of the molecules into atoms which are excited into higher energy states. The concentrations of the elements are then measured by absorption or emission of light from atoms in the flame. The intensity of absorption or emission is directly proportional to the concentration of the analyte in the aspirated solution. All analytical determination was carried out in triplicate.

RESULTS AND DISCUSSION

Table 1: Metal Concentration (PPM)

Sample code	Cu	Zn	Cr	Cd	Pb	Fe	As	pH
S1	0.10±0.01	ND	0.1±0.01	ND	0.20±0.01	114.10±6.30	0.20±0.01	7.50
S2	ND	ND	0.1±0.01	ND	0.10±0.01	116.50±4.50	ND	7.60
S3	0.02±0.01	ND	ND	ND	ND	96.30±3.80	0.20±0.01	7.10
S4	0.10±0.01	ND	ND	ND	ND	112.5±5.16	0.20±0.01	6.10
S5	ND	ND	ND	ND	ND	110.20±4.80	ND	7.20
S6	0.10±0.01	ND	ND	ND	ND	97.4±5.40	ND	6.90

S_1: Soil sample from light session mill (LSM), S_2, soil sample from rolling mills (RM), S_3, Soil sample from FFN, S_4, soil sample from FFN site B, S_5, social sample from Itobe, S_6 – soil sample from PYN

NOTE: ND = Not detected

Each value is the mean of the three determinations.

Discussion

From the table, the results showed that the concentrations of copper (0.2±0.01 mg/kg). As 0.02 atom area with the highest in sample (S_3) compared to other areas.

The pH value of sample S_1, S_2, S_3 and S_5 were slightly basic. This could be attributed to the industrial activity in the area. Sample S_4 and S_6 are slightly acidic and this could be due to the traces of heavy metals in the samples. From table 1, the results indicated that the soil accumulated the highest concentration of iron in sample S_2 (1165±4.50 mg/kg) compared to the other areas sampled.

The traces of Copper found in the samples 1,2,3 and 4 could be as a result of the clayey nature of the soil in the environment, mining contamination and agricultural activities from the community. Lead (Pb) was detected in minutes quantities in sample 1, 2 and 5. This may be probably due to presence of Pyrite (lead ore) in the geographical structure of the study area. The undetectable level of the remaining metal could be as a result of the long time effect caused by the non-operational nature of the iron and steel industry. The levels of these metals in the analyzed samples were still less than the World Health Organization Standards.

CONCLUSION

Heavy metal pollutants in the environment are of immense concern globally because of their toxic nature to both plants and animals habitats. The Ajaokuta Iron and Steel Industry is an industry that can launch Nigeria into the era of industrialization, should be handled in such a way that direct awareness with particular respect to industrial friendly environment.

The result obtained from the study areas are also within the recommended range provide by WHO, NAFDAC and seal.

The results indicated that , even though the concentration of most of the heavy metals analysed were within the maximum allowable level, there is the risk of increase of this heavy metals in these farming areas since they use municipal wastes and fertilizers to support agriculture.

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