Assessment of Soil, Water and Plant Pollution by Heavy Metals from Petroleum and Petrochemical Companies in Nigeria

(A Case Study of Eleme Petrochemicals, Warri Refinery, Atlas cove depot, Mosimi depot, Ilorin depot, Ibadan depot, Ejigbo depot, Ore depot)

***Adeodu A. O[1], Daniyan I. A[2], Yusuff A. S[3]**

[1,2] Department of Mechanical Engineering, 3Department of Chemical & Petroleum Engineering

Afe Babalola University, Ado- Ekiti. Nigeria.

[1]Femi2001ng@yahoo.com, [2]afolabiilesanmi@yahoo.com, [3]adeyinkayusuff@yahoo.com

Abstract

The intense consumption of refine petroleum products in Nigeria has put pressure on petroleum depots and companies thus becoming major sources of hazardous and air, water and soil pollution. Geo- accumulation (I_{geo}) Index approach was employed to predict the environmental impact on the contributions of petroleum depots and companies to soil, water and plant pollution. The results of the study are important to know the areas of the country that fall under the comparatively higher concentration of environmental pollution through petroleum companies. This is expected to assist researchers carry out measurement campaigns around the areas because of the inherent impact of the pollution upon living beings, crops production and environmental condition.

Analyses of the heavy metals through Atomic Absorption Spectrophotometer (AAS) and Geo-accumulation (I_{geo}) Index of the heavy metals reveal that four of the six considered petroleum depots and one petrochemical company located at Ilorin, Atlas cove, Ore, Mosimi and Eleme contributed most to environmental pollution by petroleum companies. Thus, south – west/ south-south part of the country have the potential to fall under the comparatively higher concentration of pollution through petroleum and petrochemical companies.

Key words: Geo- accumulation Index, Atomic Absorption Spectrophotometer (AAS), heavy metals, petro- chemical, petroleum depots, pollution, refinery.

Word Count: 200

INTRODUCTION

The domestic consumption demand of refined petroleum products in Nigeria has put extensive pressure on refining petroleum operation in the country [1]. Though at present, quite significant percentage of totally required refined petroleum products are imported into the country, the instability in the price regime has made it more necessary for the country to develop her local refining potential. The country has four petroleum refineries, (owned by the federal government), close to thirty depots and fourteen refineries (owned by private bodies) which are just licensed and at various stages of completions [8], [9]. Economically, this is a positive step as the locally driven Industrial sectors are bound to benefit maximally if refined petroleum products can be made available in required quantities [1].

From experience, petroleum refineries are associated with some environmental problems of air, water and soil pollution [10], [12] which could even result in climatic change [11] among other impacts. Air and water pollution has been a matter of great public concern worldwide [2] and petroleum industry has been identified as major source of the Volatile organic compounds (VOCs) [6] which are the primary air pollutants. Oil production and transportation, can disrupt the human population, animals and the fish life of the region [4]. Oil waste dumping, production pollution and spill wreck havoc on the surrounding wild life and habitat [4]. It threatens the extinction of several plants, and has already armed many land, air and sea animals and plants species [4].

Petroleum refineries and depots are major sources of hazardous and toxic air pollutants such as BTEX compounds (Benzene, toluene, ethyl benzene and xylene) [7]. They are also a major source of criteria air pollution particulate matter (PM), Nitrogen oxides (Nox), Carbon monoxides (Co), Hydrogen sulphide (H_2S), and some heavy metal constituents like Pb, Mg, Cd, Pt and Al [7]. These chemical released are known or suspected concern causing agents responsible for development and reproductive problems [1]. They may also aggravate certain respiratory condition such as childhood asthma, along with the possible health effect from exposure to these chemicals.

Refineries are also major contributors to ground water and surface water contaminations [1]. Some refineries use deep injection well to dispose effluent water generated inside the plant, and some of this water end up in aquifers and ground water.

Soil contamination is introduce by some hazardous waste, spent catalyst or coke dust, tank bottom and sludge from the treatment processes [7]. Leaks as well as accidents or spill off during transportation process also serves as sources of soil pollution. The effect of these pollutants on soil includes checking the life of terrestrial plants and life stock habituating in such environment.

The importance of pollution control and the various advantages obtained by man through a perfect knowledge of the quality of air he takes in every second cannot be overlooked. For environmental protection of the host communities, workers and visitors to the refineries, and the Nigeria air shed in general, appropriate tools need to be put in place to prepare for any environmental pollution problem that may arise during operation.

Barletta et al [5] stressed the importance of improved environmental efficiency of oil refineries in air pollution control and one of the ways in which this can be achieved is the proper identification of potential sources of air pollutants and accurate prediction of anticipated quantities.

MATERIALS AND METHODS

The research is a case study of eight (8) petroleum depots and petrochemical company in Nigeria. Five of the companies are situated in the western part of the country: Ore depot (Ondo-State), Ibadan depot (Oyo-State), Ejigbo depot, Mosimi depot, Atlas cove depot (Lagos-State). Two are situated in the south-south region of the country: Eleme petrochemical (River-State), Warri Refinery (Delta-State), and finally north central, Ilorin depot (Kwara-State). These companies are surrounded by residential settlements. The control sites were 20km from the companies, but within the same geographical area as the sites.

ISSN 2229-5518

Soil Sampling, Digestion and Analysis

Five soil samples were randomly collected within and around each of the companies with sampling depth (0-15cm) which represents the main feeding zone of the plant. One additional sample was taken at 20km away from each of the plant to serve as control sample. These samples were dried for 8 days, ground using agate mortar and sieved with a 0.5mm mesh size sieve to remove stones, plant roots and have the soil of uniform particle size. The soil samples were packed in polythene bag and kept in a dry place until analysis. The air-dried soil samples (5g) each was accurately weighed into a series of 100ml beaker and dissolved in 10ml of Nitric acid. These were shaken properly and transferred for heating in fume chamber at temperature between $95^0C\pm5^0C$ for 10min [3]. The reflux will be heated continuously by adding 5ml Nitric acid at the above duration, until there is no trace of brown fume of $N0_2$ gas (not to dryness). The reflux was allowed to cool down, and 10ml of concentrated HCL was added together with distil water to make 50ml. The samples were sent for analysis using Atomic Absorption spectrophotometer (2003 model). The acid-extractable Pb, Cd, Cr, Ni, Fe, Cu, Mn, Hg, Co, Zn was leached for 4hr in each of the samples. A reagent blank sample was taken through the method, analysed and subtracted from the samples to correct for reagent impurities and other sources of errors from the environment.

Plant Sampling, Digestion and Analysis

Five plant samples with roots included were taken at the same area where the soil samples were taken in each of the companies. One control plant sample was also taken about the same distance with the soil control sample for each company. The samples were taken with the aid of stainless steel pen-knife and kept in well labelled polythene bags. The samples were placed under a running tap to wash off soil particles and then sun-dried for 1 week. Each sample of the dried plant material was grounded to a fine powder. The ground plant samples were kept in desiccators for further removal off any moisture. 1grams of each sample was weighed accurately into clean platinum crucible at 45^0C and cooled to room temperature. Digestion of the plant samples were carried out the same manner as soil sample.

Water Sampling, Digestion and Analysis

Effluent water sample was taken from all the companies and preserved into a plastic bottle. 50ml of the water samples were taken for digestion and analyses.

Quality control/assurance

Soil samples were collected with plastic-made implements to avoid contamination. Samples were kept in polythene bags that were free from heavy metals and organics and well covered while transporting from field to the laboratory to avoid contamination from the environment. Reagent blanks were used in all analyses to check reagent impurities and other environmental contaminations during analyses. Analytical grade reagents were used for all analyses. All reagents were standardized against primary standards to determine their actual concentrations. All glassware used were soaked in appropriate dilute acids overnight and washed with teepol and rinsed with deionised water before use. All instruments used were calibrated before use. Tools and work surfaces were carefully cleaned for each sample during grinding to avoid cross contamination. Duplicate samples were analysed to check precision of the analytical method and instrument.

RESULTS AND DISCUSSION

Table 1. Ilorin plant samples (ps) in percentage per million (ppm) and effluent water

Pollutants	Ps 1	Ps 2	Ps 3	Ps 4	Ps 5	control	EFLW
Co	0.13	0.09	0.76	0.20	0.00	0.00	0.00
Zn	0.07	0.06	0.16	0.04	0.00	0.00	0.00
Cr	6.75	0.23	3.68	0.00	0.00	0.00	0.00
Cd	0.675	0.00	2.08	0.00	0.48	0.01	0.00
Ni	0.9	0.40	7.50	2.30	0.20	0.00	0.00
Cu	7.15	2.93	10.00	3.88	0.00	0.09	0.00
Mn	10.89	1.32	11.20	11.20	2.83	0.00	0.00
Pb	6.58	6.30	9.75	0.00	0.00	0.00	13.69
Fe	200.00	12.60	200.00	200.00	21.4	0.00	4.30
Hg	2.56	0.00	3.54	1.98	0.00	0.00	1.25

Table 2. Soil samples (ss)/ppm

pollutants	Ss 1	Ss 2	Ss 3	Ss 4	Ss 5	control
Hg	5.33	4.00	3.82	3.66	4.69	0.00
Co	0.76	0.63	0.00	0.54	0.94	0.03
Zn	0.17	0.11	0.00	0.14	0.22	0.00
Cr	1.20	0.45	1.13	0.00	0.00	0.00
Cd	1.92	0.68	0.54	1.24	1.59	0.00
Ni	8.10	6.50	0.00	6.60	9.60	0.00
Cu	10.00	10.00	0.00	10.00	10.00	0.05
Mn	11.20	11.20	10.16	11.20	11.20	0.02
Pb	22.99	16.08	10.18	4.88	0.00	0.00
Fe	200.00	200.00	130.00	200.00	200.00	0.00

Table 3. Atlascove plant samples (ps)/ppm and effluent water

Pollutants	Ps 1	Ps 2	Ps 3	Ps 4	control	EFL W
Hg	0.00	3.32	2.28	2.11	0.00	4.96
Co	0.19	0.15	0.17	0.28	0.00	0.22
Zn	0.43	0.40	0.17	0.00	0.00	0.00
Cr	1.24	0.18	0.84	0.22	0.01	6.93
Cd	0.00	0.00	8.990	0.00	0.05	2.26
Ni	1.30	2.90	1.60	2.00	0.02	2.10
Cu	3.39	10.00	8.25	10.00	0.00	10.00
Mn	4.11	6.87	5.42	11.14	0.05	11.20
Pb	4.08	7.93	0.00	11.48	0.02	12.92
Fe	34.60	100.60	82.00	198.40	0.00	200.00

Table 4. Soil samples (ss)/ppm

Pollutants	Ss 1	Ss 2	Ss 3	Ss 4	Control
Hg	0.00	1.62	1.05	0.00	0.06
Co	0.49	0.47	0.48	0.38	0.02
Zn	0.49	0.45	0.37	0.21	0.08
Cr	0.93	0.93	1.00	2.82	0.01
Cd	0.00	0.00	0.00	8.99	0.01
Ni	3.00	3.50	6.30	3.80	0.00
Cu	10.00	10.00	10.00	10.00	0.00
Mn	8.52	11.20	11.20	7.55	0.02
Pb	0.00	0.00	14.77	6.92	0.04
Fe	151.80	200.00	200.00	151.60	0.00

Table 5. Ejigbo plant samples and effluent water sample/ppm

pollutants	Ps 1	Ps 2	Ps 3	Ps 4	Ps 5	control	EFLW
Hg	1.61	1.54	3.05	1.29	5.26	0.00	0.00
Co	0.22	0.12	0.49	0.79	0.66	0.00	0.12
Zn	0.00	0.16	0.31	0.62	0.47	0.05	0.54
Cr	1.45	0.41	2.38	5.90	3.06	0.05	3.79
Cd	0.89	1.29	1.53	1.60	1.38	0.00	0.77
Ni	1.70	1.20	6.20	8.30	5.90	0.05	2.90
Cu	10.00	10.00	10.00	10.00	10.00	0.00	10.00
Mn	6.75	7.24	11.20	11.20	11.20	0.08	6.45
Pb	0.00	4.47	22.39	17.64	0.00	0.05	5.62
Fe	91.80	118.00	200.00	200.00	200.00	0.03	106.1

Table 6. Soil samples/ppm

pollutants	Ss 1	Ss 2	Ss 3	Ss 4	Ss 5	control
Hg	3.47	3.02	4.64	0.00	1.90	0.08
Co	0.28	0.54	0.69	0.43	0.00	0.00
Zn	0.14	1.27	0.34	0.00	0.00	0.03
Cr	1.17	0.83	3.95	1.81	0.83	0.00
Cd	0.06	0.56	1.04	0.58	0.34	0.00
Ni	2.00	4.80	7.50	3.90	4.10	0.00
Cu	10.00	10.00	10.00	10.00	10.00	0.00
Mn	5.23	11.20	11.20	11.20	11.20	4.72
Pb	0.93	19.17	12.45	27.39	0.00	0.04
Fe	66.00	200.00	200.00	200.00	200.00	0.00

Table 7. Waari refinery plant samples and water sample/ppm

Pollutants	Ps 1	Ps 2	Ps 3	Ps 4	Ps 5	control	EFLW
Hg	1.54	1.56	2.92	0.00	1.73	0.09	0.00

Co	0.08	0.08	0.01	0.16	0.06	0.00	0.00
Zn	0.05	0.05	0.11	0.14	0.10	0.00	0.00
Cr	2.47	0.85	1.03	0.00	1.17	1.05	1.17
Cd	0.71	0.37	1.10	0.80	0.44	0.00	0.08
Ni	0.60	1.20	0.50	1.30	0.60	0.00	0.00
Cu	2.48	2.15	4.71	3.06	2.29	0.00	1.83
Mn	0.17	0.84	3.06	1.12	2.82	0.14	0.00
Pb	6.22	0.00	0.00	0.00	0.00	0.03	10.61
Fe	0.60	13.30	38.60	9.20	3.01	0.00	0.20

Table 8. Soil samples/ppm

pollutants	Ss 1	Ss 2	Ss 3	Ss 4	Ss 5	control
Hg	1.16	2.87	0.00	1.93	0.70	0.00
Co	0.34	0.26	0.02	0.03	0.14	0.00
Zn	0.13	0.07	0.05	0.13	0.00	0.07
Cr	0.00	1.60	0.00	7.46	1.03	0.05
Cd	0.12	0.61	1.24	0.00	0.42	0.01
Ni	4.50	3.40	4.00	3.80	3.30	0.09
Cu	10.00	10.00	10.00	10.00	10.00	0.09
Mn	11.20	6.40	5.37	7.36	2.22	0.01
Pb	0.00	6.88	0.00	0.00	0.00	0.00
Fe	200.00	94.20	47.00	97.80	100.50	0.00

Table 9. Ibadan plant soil sample/ppm

pollutants	Ss 1	Ss 2	Ss 3	Ss 4	Ss 5	control
Hg	4.02	4.67	3.34	2.23	5.13	0.01
Co	0.78	0.73	0.47	0.03	0.00	0.00
Zn	0.10	0.22	0.35	0.43	1.76	0.07
Cr	9.23	1.02	4.66	2.59	0.28	0.03
Cd	1.15	0.86	1.66	1.53	0.99	0.07
Ni	7.10	5.90	5.10	4.20	8.20	0.09
Cu	10.00	10.00	10.00	10.00	10.00	0.00
Mn	11.20	11.20	11.20	11.20	11.20	1.20
Pb	13.07	0.00	17.37	17.92	17.92	1.03
Fe	200.00	200.00	200.00	200.00	200.00	0.00

Table 10. Plant samples and effluent water/ppm

pollutants	Ps 1	Ps 2	Ps 3	Ps 4	Ps 5	control	EFLW
Hg	4.38	3.32	3.44	3.55	3.98	0.00	1.71
Co	0.41	0.14	0.01	0.22	0.03	0.00	0.14
Zn	0.32	0.40	0.19	0.16	0.01	0.03	0.12
Cr	0.46	1.43	3.82	0.39	0.36	0.08	0.76
Cd	0.88	0.43	0.30	1.03	0.75	0.03	1.09
Ni	1.10	0.30	0.00	1.40	0.00	0.10	1.30
Cu	10.00	7.55	0.00	10.00	3.71	0.02	7.21

Mn	11.20	5.11	5.34	8.98	4.10	0.01	5.41
Pb	0.00	3.88	2.79	8.52	0.00	0.00	9.25
Fe	200.00	73.60	13.70	158.50	72.8	0.90	85.9

Table 11. Ore plant soil samples and water sample/ppm

pollutants	Ss 1	Ss 2	Ss 3	Ss 4	control	EFLW
Hg	5.20	5.81	4.41	7.40	0.26	6.54
Co	0.59	0.66	0.62	0.80	0.00	1.01
Zn	0.35	0.16	0.12	0.37	0.00	0.40
Cr	0.46	5.42	0.42	0.21	0.06	3.58
Cd	1.36	1.20	1.61	2.15	0.03	2.10
Ni	7.10	6.20	7.40	8.80	0.00	7.80
Cu	10.00	10.00	10.00	10.00	0.00	10.00
Mn	11.20	11.20	11.20	11.20	0.00	11.20
Pb	18.33	1.15	0.00	18.92	0.02	0.82
Fe	200.00	200.00	200.00	200.00	0.00	200.00

Table 12. Plant samples/ppm

pollutants	Ps 1	Ps 2	Ps 3	Ps 4	Ps 5	Control
Hg	2.80	1.41	2.10	2.48	3.18	0.00
Co	0.13	0.05	0.00	0.00	0.04	0.00
Zn	0.07	0.06	0.10	0.00	0.10	0.05
Cr	3.35	3.66	0.95	3.04	4.04	0.03
Cd	0.39	0.00	0.00	0.00	0.09	0.00
Ni	0.00	0.90	1.50	0.00	0.70	0.06
Cu	4.12	4.23	2.27	0.73	0.00	0.00
Mn	11.20	5.93	4.74	0.71	7.66	0.11
Pb	0.00	18.18	0.91	1.79	0.00	0.00
Fe	200.00	102.00	71.1	2.60	155.20	0.1

Table 13. Mosimi plant samples and effluent water sample/ppm

pollutants	Ps 1	Ps 2	Ps 3	Ps 4	Ps 5	Ps 6	control	EFLW
Hg	1.56	1.10	6.37	4.04	2.45	3.21	0.10	0.99
Co	0.42	0.25	0.36	0.82	0.32	0.50	0.05	0.20
Zn	0.07	0.18	0.22	0.45	0.29	0.17	0.11	0.05
Cr	0.30	5.23	9.12	0.26	0.81	0.72	0.05	0.34
Cd	0.42	0.25	0.36	0.82	0.32	0.50	0.05	0.20
Ni	3.10	1.10	2.90	7.00	2.60	0.00	0.00	0.00
Cu	10.00	10.00	10.00	10.00	10.00	10.00	0.00	3.96
Mn	11.20	4.53	11.20	11.20	11.05	11.20	0.20	11.20
Pb	12.20	0.00	11.68	9.62	0.00	11.14	0.03	0.00
Fe	0.00	68.80	200.00	200.00	188.30	200.00	0.00	15.00

Table 14. Soil samples/ppm

pollutants	Ss 1	Ss 2	Ss 3	Ss 4	Ss 5	Ss 6	control
Hg	3.54	4.30	3.33	0.77	2.67	6.80	1.70
Co	0.60	0.86	0.45	0.11	0.22	1.00	0.00
Zn	0.24	0.39	0.20	0.12	0.13	0.78	0.05
Cr	1.20	0.26	0.34	3.50	8.69	4.42	0.00
Cd	0.24	0.87	0.93	0.16	1.26	2.26	0.00
Ni	6.00	7.20	2.90	0.00	2.90	8.40	0.00
Cu	10.00	10.00	10.00	1.45	10.00	10.00	0.67
Mn	11.20	11.20	11.20	3.83	10.16	11.20	0.12
Pb	10.54	10.75	12.37	0.00	8.92	13.40	2.34
Fe	200.00	200.00	200.00	48.30	191.10	200.00	0.00

Table 15. Eleme petrochemicals soil samples

pollutants	Ss 1	Ss 2	Ss 3	Ss 4	Ss 5	Ss 6	Ss 7	control
Hg	3.00	5.49	3.49	3.38	6.90	4.78	5.33	0.02
Co	0.16	0.54	0.82	0.63	0.91	0.18	0.76	0.01
Zn	0.09	0.28	0.32	0.06	0.52	0.21	0.17	0.25
Cr	0.64	5.30	2.88	9.23	1.64	3.35	5.30	0.11
Cd	1.21	1.30	1.30	0.84	2.19	0.79	1.92	0.03
Ni	1.80	1.80	6.40	4.80	9.10	2.30	8.10	1.20
Cu	>10.00	>10.00	>10.00	>10.00	>10.00	>10.00	>10.00	0.90
Mn	6.56	>11.20	>11.20	>11.20	>11.20	10.92	>11.20	0.14
Pb	12.40	12.15	12.35	15.21	11.76	1.58	22.99	0.11
Fe	98.70	>200.00	>200.00	>200.00	>200.00	>200.00	>200.00	0.54

Table 16. Plant Samples and Effluent water sample

pollutants	Ps 1	Ps 2	Ps 3	Ps 4	control	EFWS
Hg	3.00	3.47	4.57	4.76	0.00	2.00
Co	0.48	0.22	0.35	0.61	0.00	0.07
Zn	0.12	0.17	0.19	0.48	0.01	0.12
Cr	0.87	1.02	1.43	2.87	0.03	0.39
Ni	2.90	1.70	2.20	6.00	1.04	0.10
Cu	>10.00	6.72	7.57	>10.00	0.05	3.00
Mn	>11.20	>11.20	>11.20	>11.20	1.20	0.32
pb	5.84	5.35	5.00	9.00	1.00	14.70
Fe	>200.00	>200.00	>200.00	>200.00	0.00	4.40
Cd	0.77	0.39	1.08	1.18	1.00	0.56

The results from the heavy metals analyses for all the considered petroleum depots, refinery and petrochemical company were presented in the tables 1-16 above. The analyses were conducted on the major heavy metals (Hg, Co,

ISSN 2229-5518

Zn, Cr, Cd, Ni, Cu, Mn, Pb and Fe) that are the cause of oil pollution.
Note: The analyses were limited to I_{geo} Index of the soil, plant and water samples. The physio-chemical properties like PH, Nitrate, and Sulphate and % carbon were not included in the analyses.

Geo- accumulation Index of the Heavy Metals

Geo- accumulation Index of the heavy metals was conducted to determine the degree of contamination by the pollutants on all the samples (Soil, Plant, Water).

The Geo-accumulation Index (I_{geo}) is classified into six descriptive classes as follows:

1; < 0 = practically uncontaminated
2; 0 – 1= uncontaminated to slightly contaminated
3; 1 – 2 = moderately contaminated
4; 2 – 3 = moderately to highly contaminated
5; 3 – 4 = highly to very highly contaminated
6; > 5 = very highly contaminated to strongly contaminated

Note: the grading was done base on the average concentration of the heavy metals in the samples from all the petroleum depots, refinery and company.

Table 17. Assessment of heavy metals contamination using Geo-accumulation Index (I_{geo})

Heavy metals	I_{geo} Level	Descriptive class
Mercury (Hg)	79.2% majorly on soil samples	2 - 3
	20.8% on water samples	< 0 - 1
Cobalt (Co)	95.8% partly on soil and plant samples	< 0 - 1
	4.2% on water samples	1 - 2
Zinc (Zn)	100% on all samples	< 0 – 1
Chromium (Cr)	66.7% majorly on soil samples	2 - 3
	33.3% majorly on water samples	< 0 – 1
Cadium (Cd)	66.7% majorly on water	< 0
	33.3% majorly on soil samples	1 – 2
Nickel (Ni)	66.7% majorly on soil samples	> 5
	33.3% majorly on water samples	< 0 -1
Copper (Cu)	91.6% majorly on soil samples	> 5
	8.4% majorly on water samples	< 0
Manganese (Mn)	83.3% partly on soil and plant samples	> 5
	16.7% majorly on water samples	< 0 – 1
Lead (Pb)	91.6% on soil samples	> 5
	8.4% on water samples	< 0
Iron (Fe)	91.6% partly on soil and plant samples	> 5
	8.4% on water samples	< 0 - 1

ISSN 2229-5518

Table 18. Average concentrations of heavy metals in the samples

	Ilorin	Atlas cove	Ejigbo	Eleme	Warri	Ibadan	Ore	Mosimi
SOIL SAMPLE	227.84	216.46	58.95	232.88	139.15	253.88	252.01	217.14
PLANT SAMPLE	150.56	133.54	191.15	235.89	33.46	122.76	128.86	217.76
WATER SAMPLE	19.24	250.59	136.28	25.66	13.88	0	243.45	31.94

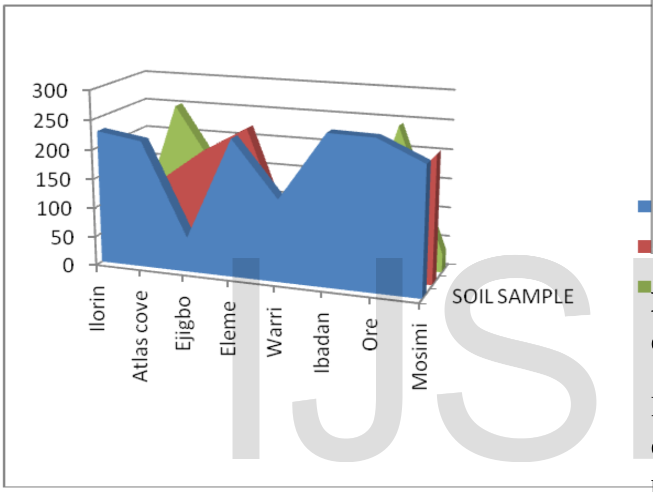

Figure 1. Description of levels of contamination in the samples

The figure 1 shows that the total average concentrations of the heavy metals in all the petroleum depots, refinery and petro-chemical Company was highest in soil samples by 45% followed by plant samples by 34% and least in water samples by 21%.

From the AAS analyses tables show that the control samples from all the companies were not polluted, as they fall under practically uncontaminated descriptive class.

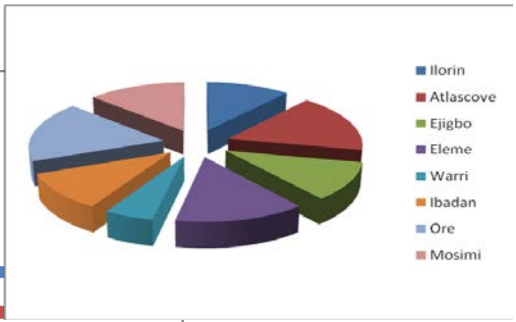

Figure 2. Description of order of contamination by companies

Figure 2 depicted the order by which the companies contributed to soil, plant and water pollution in Nigeria. Warri (19^0) < Ibadan (38.4^0) < Ejigbo (39.4^0) < Ilorin (40.5^0) < Mosimi (47.6^0) < Eleme (50.4^0) < Atlas cove (61.2^0) < Ore (63.6^0)

CONCLUSIONS

The focus of this research is on the environmental impact on the contributions of petroleum depot and petroleum companies to Soil and Water pollution in Nigeria. This research has confirmed that soil sample is mostly contaminated by heavy metals. It was estimated that four of the six considered petroleum depots and one petrochemical company located at Ilorin, Atlas cove, Ore, Mosimi and Eleme contributed most to environmental pollution by petroleum companies. Thus, south – west/ south-south part of the country have the potential to fall under the comparatively higher concentration of pollution through petroleum and petrochemical companies.

Ability to adopt appropriate control measures in these depots and petroleum companies will determine the extent the impact of the pollution on soil, plant and water in Nigeria.

RECOMMENDATIONS

In all approved petroleum depots and petroleum companies, identification of the potential sources of environmental pollution can assist in adopting efficient control technology during the design stage. Cracks or leaks on the oil tanks should be avoided and effluents from these petroleum companies must not be discharged into the drain without prior treatment.

Finally, Nigeria should develop a policy that will be fully implemented for the Air, Soil and Water pollution from all petroleum companies to be adequately tackled. This should include the setting up of realistic permissible limit, taking into consideration the peculiarity of the operating environment.

Acknowledgments

The Author will like to sincerely appreciate the managements of the NNPC petroleum depots, refinery and petro-chemical Company used as study sites for their kind gestures of accommodation and permitting samples to be taken within the plant.

The Author will also give special thanks to students of Environmental major in the department of Chemical Engineering, Ladoke Akintola University of Technology, Ogbomosho, Oyo-State (set 2005) for their financial contributions and making themselves available for the collection of samples from petroleum companies.

References

[1] Akeredolu, E.A, and Sonibare,J.A. Modeling of Volatile Organic Compounds (VOCs) Emissions from a Nigeria Refinery. Ife Journal of Technology 10(1), 49-54, (2001)

[2] Akeredolu, F.A., and Sonibare, J.A., Measurement of Benzene, Toluene, and Xylene (BTX) within Nigeria Refinery and its Environs by the Carbon Addition Techniques. Journal of Nigeria Society of Chemical Engineers, Lagos, Nigeria Vol.16 No. 1&2, pp. 123-132, (1997)

[3] Alloway BJ (1995). Heavy metals in soils, 2nd Ed. Chapman and Hall, India: Australia.

[4]Anonymous A. Environmental Impact. www.epa.gov (1979)

[5] Barletta, B., Meinardi, S., and Simpson, I.J. Mixing Ratios of Volatile Organic Compounds (VOCs) in the Atmosphere of Karachi, Pakistan. Atmospheric Environment 36(21), 3429-3443, (2002)

[6] Cetas, F., Odabasi, M., and Seyfoghn, R. Ambient Volatile Organic Compound (VOCs) Concentrations around a Petrochemical Complex and a Petroleum Refinery. The Science of the Total Environment 312(1-3), 103-112, (2003)

[7] Charles, E. Kupchella, Marganet, C. Environmental Science, Bioscience Journal 29(2) 244-305, (1999)

[8] DPR. Nigeria Oil Industry Statistical Bulletin. Department of Petroleum Resouces, Ministry of Petroleum Resources, Lagos, Nigeria, (2001)

[9] DPR. Nigeria Oil Industry Statistical Bulletin. Department of Petroleum Resouces, Ministry of Petroleum Resources, Lagos, Nigeria, (2004)

[10]Lin, M. C., Chiu, H. H., Yu, H. S., Tsai, s.s., Cheng, B.H., Wu T.N and Yang, C.Y. Increased Risk of Petroleum Delivery in Areas with Air Pollution from a Petroleum Refinery

Plant in Taiwan.J. Toxicol. Environ Health A. 64(8), 637-644, (2001)

[11] Skodvin, T., and Skjaerseth, J.B. Shell Houston, We Have a Climate Problem, Global Environmental Change 11(2), 103-106, (2001)

[12] Yang. C. Y., Cheng. B.h., Hsu, T. Y., Tsai, s.s., Female Lungs Cancer Mortality and Sex Ratio at Birth near a Petroleum Refinery Plant. Environmental Research 83(1), 33-40, (2000)