HEAVY METALS ANALYSIS OF COAL DEPOSITS AT MAIGANGA IN AKKO LOCAL GOVERNMENT AREA,GOMBE STATE, NIGERIA.

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ABSTRACT: The effects of toxicity of heavy metals in mining areas in Nigeria have madethe need for analysis of Maiganga coal as adopted by this research to examine its environmental effluence. The analysis of coal sample was carried out by the used of X-ray fluorescence and Atomic Absorption Spectrophotometry (AAS). Thetrace metals examined were; lead, nickel, cadmium, calcium, magnesium, and manganese and the values obtained using AAS were;5.53 ppm, 8.2 ppm, 1.54 ppm, 25.2 ppm, 0.41 ppm, and 1.95 ppm respectively. Meanwhile, X-ray fluorescence Spectroscopy revealed that Maiganga coal contained the following metallic oxides of SiO2, Al2O3, Fe2O3, CaO, MgO, TiO2, MnO2, Na2O, with compositions per gramme of 45.67%, 14.85%, 8.56%,11.81%, 4.04%, 1.18%, 0.20% and 0.38% respectively. Non- metal oxides such as; P2O5, and SO3 were also present in small quantities of 0.43% and 12.02%.The result of analysis showed that Maiganga coal contained negligible amount of toxic metals when compared with the WHO recommended standards. The coal was good source of energy compared with any other coal in the world.

Keywords: Coal, Trace metals, Oxides

Introduction

Explorationsof vast deposits of minerals such as; Coal, Cassiterite, Columbite, marble, gypsum, limestone, clay bitumen, barite, quartz, tantalite and bauxite are currently mine in Nigeria,have been identified to have huge potentials of being exploited in commercial quantities for industrial growth and development of a developing country like Nigeria. These are available raw materials resources as well as their exploration utilization; most raw materials for industrial development are derived from natural resources (Samuel and Maina, 2010).

Coal and coal shale's therefore concentrate and accumulate the heaviest of metals, amongst other elements, most of which are bio-toxic and some of which are also radioactive (Pauline, 2010).

Coal sludge also contains many *heavy metals.* Small amounts of heavy metals can be necessary for health, but too much may cause acute or chronic toxicity (poisoning). Many of the heavy

metals released in the mining and burning of coal are environmentally and biologically toxic elements, such as lead, mercury, nickel, tin, cadmium, antimony, and arsenic, as well as radio isotopes of thorium and strontiumas reported by (Jeff, 2006).

Coal ash contains heavy metals which can betoxic especially where there is prolonged exposure;these toxic metals can cause several types ofcancer, heart damage, lung disease, respiratorydistress, kidney disease, reproductive problems,Gastrointestinal illness, birth defects, impairedbone growth in children, nervous system impacts,cognitive deficits, developmental delays and behavioral problems state by (Barbara et. al 2010).*In short, coal ash toxics have thepotential to injure all of the major organ systems,damage physical health and development, and even contribute to mortality.*

Material and Methods

20 Coal samples were gathered from Maiganga coal fields from four identified layers (seams). Samples collected were kept in polythene bag and later grinded into powder that formed fourmajor representative samples as adopted by (Tiza, 2010).

Methodology of AAS of Coal Samples

1g of finely divided powdered of each samples of coal were placed in respective Pyrex beakers and $20cm^3$ of aqua regia was added then $20cm^3$ of distilled water was added to each sample . The contents were placed on hot plate inside the fumes cupboard and heated for 1 hour at temperature range 90 ^oC to 100 ^oC for complete digestion. The digestion proceeded with evolution of brown fumes and irritating odour which changes to white fume at the completion of the digestion process. Then the temperature was reduced and the contents were allowed to cooled and filtered which removed the impurities, then filtrates were further diluted to $100cm^3$ with distilled water placed in clean plastic bottle taken for Atomic absorption spectroscopy(AAS) analysis of heavy metals content of the coal as adopted (Barbara et al. 2010)

Methodology of X-Ray Fluorescence of Coal

Accurately weighed 2g of coal ash samples from Maiganga were separately placed in crucibles and taken to furnace that were heated for 30 minutes at 970^{0c} that removed moisture and other impurities. The content were then allowed to cool and 1g of the coal was weighed again in a platinum crucibles, then 8 small spatula spoon of X-Ray Flux crystals containing 80% lithium tetraborate, 20% lithium metaborate were mixed together with $1cm^3$ 4% lithium bromated solution in a platinum crucible. The crucible with the content and empty platinum mold were placed closely in XRF burner or fusion machine (XRF Scientific VFD 4000)

Oxygen, Acetylene and compressor sources were connected to the machine at 4bar, 0.8bar and 6bar pressures respectively. The compressor bottom nozzle was open that removed water contaminants, then XRF burner was switch on and regulated that made the fused beat within 15 minutes. Crucible contents were drained into the oppositely placed platinum mold automatically after frequents shaken by the machine which was cooled after 10 minutes.

The fused glass coal samples made from the burner, were later removed and placed in a XRF detector machine that automatically detected the compositions of the sample metallic oxides on the computer screen attached to the machine, when the machine was programmed as reference curve of fine coal composite as adopted by (Karl and Andy 2012)

Results and discussions

Mineral Concentrations in Different Coal Seams

Table I showed that the semi metallic oxides contents of the coal such as SiO_2 and Al_2O_3 have the highestcomposition in the Maiganga coal samples 45.67% and 14.85% respectively, while the composition of other heavy metals, MnO_2 and TiO_2 form the least valuesof 0.20% and 1.18% in the coal samples.

Table I Mineral Compositions in different Coal Seams

Compounds/Oxides	SEAM A1 (%)	SEAM A2 (%)	SEAM A3(%)	SEAM B(%)	Average%
SiO_2	57.57	60.86	28.58	35.66	45.67
Al_2O_3	23.11	20.63	7.70	7.95	14.85
Fe_2O_3	4.90	4.62	14.10	10.62	8.56
CaO	4.12	4.93	20.93	17.24	4.0

MgO	1.39	2.37	5.35	7.04	4.04
Na_2O	0.10	0.10	0.12	0.13	0,11
K_2O	0.61	0.40	0.21	0.28	0.37
P_2O_5	0.10	0.16	0.52	0.95	0.43
TiO_2	1.31	1.80	0.71	0.89	1.84
MnO_2	0.11	0.10	0.47	0.13	0.20
SO_3	6.50	2.08	20.70	18.79	12.02

The analysis on the table above also indicated that the mineral coal contained metallic oxides as Fe_2O_3, CaO, MgO, Na_2O, K_2O with composition of 8.56%,11.81,4.04%, 0.17% and 0.37% respectively. In addition to that the coal also contains non -metals of P_2O_5 and SO_3 with composition of 0.43% and 12.02% respectively.

Concentrations of Lead in Coal Samples

The concentration of lead in four seams of Maiganga coal as indicated from the plot of absorbance's versus concentrations from the result of analysis as; Seam A1 with concentration of3.0 ppm, Seam A2 with concentration of 5.0 ppm, Seam A3 with concentration of 6.1 ppm, and Seam B with concentration of 8.0 ppm.

The four coal seams have average concentrations of Pb as 5.53 ppm.The result of concentrations of Leadfrom the plots was recorded as indicated in Table II.

Table II Heavy Metals Concentrations in Maiganga coal samples

Metals	SEAM	Concentrations(ppm)	Average conc.(ppm)
LEAD	A1	3.0	
	A2	5.0	
	A3	6.0	
	B	8.0	5.53
NICKEL	A1	4.8	
	A2	6.0	
	A3	9.0	
	B	13	8.2
CADMIUM	A1	0.55	
	A2	1.3	
	A3	1.8	
	B	2.5	1.54
CALCIUM	A1	10.0	

	A2	21	
	A3	30	
	B	40	25.25
MAGNESIUM	A1	0.22	
	A2	0.35	
	A3	0.48	
	B	0.60	0.41
MANGANESE	A1	1.1	
	A2	1.5	
	A3	2.1	
	B	3.1	1.95

Concentrations of Nickel in Coal Samples

The concentration of nickel in four seams of Maiganga coal as indicated from the plot of absorbance's versus concentrationsfrom the result of analysisas; Seam A1 with concentration of4.8 ppm, Seam A2 with concentration of 6.0 ppm, Seam A3 with concentration of 9.0 ppm, and Seam B with concentration of 13 ppm.

The four coal seams have an average concentration of Ni as 8.2 ppm. The result of concentrations of Nickel from the plots was recorded as indicated in Table II.

Concentrations of Cadmium in Coal Samples

The concentration of Cadmium in four seams of Maiganga coal as indicated from the plot of absorbance's versus concentrationsfrom the result of analysis as; Seam A1 with concentration of0.55 ppm, Seam A2 with concentration of 1.3 ppm, Seam A3 with concentration of 1.8 ppm, and Seam B with concentration of 2.5 ppm.

The four coal seams have an average concentration of 1.54ppm.The result of concentrations of cadmium from the plots was recorded as indicated in Table II.

Concentrations of Calcium in Coal Samples

The concentration of calcium in four seams of Maiganga coal as indicated from the plot of absorbance's versus concentrations from the result of analysisas; Seam A1 with concentration

of10.0 ppm, Seam A2 with concentration of 21.0 ppm, Seam A3 with concentration of 30.0 ppm, and Seam B with concentration of 40.0 ppm.

The four coal seams have average concentrations of 25.25ppm. The result of concentrations of calcium from the plots was recorded as indicated by Table II.

Concentrations of Magnesium in Coal Samples

The concentration of magnesium in four seams of Maiganga coal as indicated from the plot of absorbance's versus concentrationsfrom the result of analysisas;Seam A1 with concentration of0.22 ppm, Seam A2 with concentration of 0.35 ppm, Seam A3 with concentration of 0.48 ppm, and Seam B with concentration of 0.60 ppm.

The four coal seams have an average concentration of 0.41 ppm. The result of concentration of magnesium from the plots was recorded as indicated in Table II.

Concentrations of Manganese in Coal Samples

The concentrations of Manganese in four seams of Maiganga coal as indicated from the plot of absorbance's versus concentrations from the result of analysisas;Seam A1 with concentration of1.1 ppm, Seam A2 with concentration of 1.5 ppm, Seam A3 with concentration of 2.1 ppm, and Seam B with concentration of 3.1 ppm.

The four coal seams have an average concentration of 1.95 ppm. The result of concentrations of manganese from the plots was recorded as indicated in Table II.

Composition of Mineral and Heavy Metals Contents of Maiganga Coal

The result of X-ray fluorescence analysis results as indicated on Appendix X of Maiganga coal has shown that, the coal contain heavy metals in form compound or oxides of; Fe_2O_3, K_2O, CaO, MgO, Na_2O, with values of 8.56% 0.38%, 11.81%, 4.01% 0.17%, respectively and oxides of semi metals such as $Al_2O_3$and Si_2O with values of 14.85%, 45.67% others were oxides of non-metals such as, $P_2O_5$and SO_3have values of 0.43% and 12.02% were also discovered.

On the other hand, the AAS analysis of the Maiganga coal was able to capture heavy metals directly such as, Pb, Ca, Cd, Ni, Mg and Mn,with values of; 5.53 ppm, 8.2 ppm, 1.54 ppm, 25.25 ppm,0.41 ppm and 1.95 ppm respectively. Others such as, Hg, As, Sn, Sb were not the determined.

Conclusion

The analysis of Maiganga coal using X-ray fluorescence and Atomic absorption Spectrometry has found that; Maiganga coal contained metallic oxides of; Fe_2O_3, K_2O, CaO, MgO, Na_2O, with values of 8.56% 0.38%, 11.81%, 4.01% 0.17%, respectively and oxides of semi metals such as $Al_2O_3$and Si_2O with values of 14.85%, 45.67% others were oxides of non-metals such as, $P_2O_5$and SO_3have values of 0.43% and 12.02% were also discovered.It can be compared with any other coal in the world. Moreover, AAS analysis of the Maiganga coal was able to capture heavy metals directly such as, Pb, Ca, Cd, Ni, Mg and Mn,with values of; 5.53 ppm, 8.2 ppm, 1.54 ppm, 25.25 ppm,0.41 ppm and 1.95 ppm respectively, whose toxic levels were low.

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REFERENCES

Bamford S.Dargie, M., Greaves, E., Holynska, B. ,Markowicz, A., Van Grieken, R.,Vis,R.D.andWalsh, R.L. (1997) Sampling, storage andsample preparation procedures for X-Ray Fluorescence analysisof environmental materials. International Atomic EnergyAgency (IAEA) Wagramerstrasse 5PO Box 100A 1400 Vienna, Austria.
http://wwwpub.iaea.org/MTCD/publications/PDF/te_0950_scr.pdf

Barbara Gottlieb with, Steven G. Gilbert, PhD, DABT ,and Lisa Gollin Evans.(2010). A Report FromPhysicians for Social Responsibility and Earth justice. Printed with soy Links on 100% post-consumer recycled paper by a union printer USA.pp. 9-11.

Jauro A, Akpabio I. O, Chagga M.M.(2008). Assessment of some Nigerian coals for metallurgical applications. Journal of minerals and materials Characterization and Engineering vol. 7 No. 4 pp- 301-306 immce .org USA.

Jeff Godell, (2006) Big Coal. The dirty secret behind Americas Energy. New York N. Y Houghton-Mifflin, USA.

Karl W. and Andy B. (2012)Geochemical Instrumentation and AnalysisIndiana University Purdue University, IndianapolisUSAwww.spectroscopynow.com/userfiles/sepspec/file/specNOW/Enc_Anal_Chem_6801.pdf

McGraw-Hill Encyclopedia of Science and Technology (1997).8th Edition Vol. 4 R.R. Donnellyand sons company New York USA.P 68-91.

Nasirudeen M.B and Jauro A.(2011).Quality of some Nigerian Coals as a Blending Stock In Metallurgical Coke Production. Journal of Minerals and Materials characterization and engineering Immce. Org. USA.Vol. 101 No.1 pp 101-109 *ngsa-ng.org/coalpdf*

Pauline Roberts, (2009). Hunter Valley Research Foundation's 2008/09 report into Newcastle Australia.

Ryemshak A. S. and Jauro A. (2013). Proximate analyses, rheological properties and technological applications of some Nigerian Coals. International Journal of Industrial Chemistry 4:7doi10.1186/2228-5547-4-7*http://www.industchem.com/content/4/1/7*

Samuel T. M. and Maina H. M (2010) Analysis of Guyuk limestone in Adamawa State,using X-ray fluorescence, spectrometry. International Journal of Chemistry,Volume 2 (1)pp 84-89

Tiza K Z.(2010).Removal of Heavy Metal from aqueous Solution by Adsorption. (M.Tech Thesis). Department of Chemistry ModibboAdama University of Techonology.Yola Nigeria.