PROXIMATE AND QUALITY ASSESSMENT OF COAL DEPOSITS AT MAIGANGA IN AKKO LOCAL GOVERNMENT AREA, GOMBE STATE, NIGERIA.

by

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ABSTRACT

Recent quest for energy in Nigeria has made firms and organizations to look for alternative source of energy. This has necessitated the need for analysis of Maiganga coal used by Ashaka Cement Company Plc. for generation of energy. The analysis of coal sample was carried out using classical methods of analysis by A.O.A.C and the values obtained were; calorific value 5359 kcal/g and fixed carbon content 33.57%. Other parameters include; acidity with pH value of 0.36, alkalinity with pH values of 9.70, moisture content of 9.5%, Ash content of 65.6%, volatile mater with value of 47.4%.The result of analysis showed that Maiganga coal was lignite in nature and good source of energy and is comparable with any other coal in the world.

Keywords: *Coal, Proximate, Heat, Quality, Assessment*

Introduction

Coal is black compressible sedimentary rock that contains minerals due to depositions of weathered particles that contained elements, of which others are metals of bio toxic effects. (Pauline, 2010).The vast and varied solid minerals include deposits of Coal, Cassiterite, Columbite, marble, gypsum, limestone, clay bitumen, barite, quartz, tantalite and bauxite. However, some of these minerals are currently mined, while several have been identified to have huge potentials of being exploited in commercial quantities. The industrial growth and development of a developing country like Nigeria depends on her 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 are believed to represent accumulations of peat in which plants are growing in low lying swampy areas close to the sea. Sea water provides the high source of calcium carbonate in per mineralization process and it has been suggested that per mineralizing fluids were derived from percolating carbonate rich ground water. Coal bulls also contain reproductive parts of plants this can be observed on peels or in case of pollen grains and spores which can be macerated and studied. The preservation also reveals sometimes good delicate substances such as nuclei, chromosomes and membrane. (McGraw-Hill 1997)

The process of coal formation from organic compounds includes two distinct phases: ***biochemical and geochemical*****:**

Plant material – peat – lignite = ***biochemical phase***

Lignite – bituminous coal –Anthracite = Geochemical ***phase***

The chemical structure of coal consist of organic matter content of coal contains benzenes rings bonded with oxygen, hydroxyl groups, methyl groups, sulphur, phosphorus and amine groups. (Peter, 2012).

Coal is classified into three major types namely anthracite, bituminous, and lignite, coal is also further classified as semi- anthracite, semi-bituminous, and sub-bituminous. Anthracite is the oldest coal from geological perspective. Coal composed mainly of carbon with little volatile content and practically no moisture. Lignite is the youngest coal from geological perspective. It also composed mainly of volatile matter and moisture content with low fixed carbon. Fixed carbon refers to carbon in its free state, not combined with other elements. Volatile matter refers to those combustible constituents of coal that vaporize when coal is heated. Coal is classified according to origin and Coal rank as follows;

Coal Class	Content of Carbon
Peat	52-60%
Lignite	58-77%
Bituminous coal	76-93%
Anthracite	91-93%

Source……………….. (Peter, 2012).

Chemicals obtained as by products or primary products in coal gasification processing of coal to metallurgical coke were the main source of aromatic compounds used intermediates in the syntheses of drugs, dyes, antiseptics, and solvents. In recent development, Naphthalene, Phenanthrene, heterocyclic hydrocarbons such as Pyridines and Quinolines and some Phenols are still obtained from coal tar. Coal by products contains percentage of; coke oven gas, light oil and tar. Coke oven gas is a mixture of methane, carbon monoxide, hydrogen, and small amounts of higher hydrocarbons, ammonia and hydrogen sulphide (McGraw-Hill, 1997).

Materials and Methods

20 Samples of coal were gathered from Maiganga coal mine, at four seams (Layers) buried deep inside the soil. Five samples each were randomly collected from the four different seams at intervals of 50 m on an open excavated mining site. The samples were further grinded to form four major composite from each seam as described by Samuel and Maina 2010.

Moisture Content of Coal

20g of each sample coal was weighed together with their crucibles and their content obtained was W2. The lid of the crucible was removed and the content was placed in an oven at 96^0c temperature that dried at constant weigh for 2 h.

After drying, the crucible and the content was allowed to cool for 30 minutes in the desiccators. The crucibles were covered with their lids and the contents were weighed that obtained W3. The process was repeated for the other samples as adopted by (Samuel and Maina, 2010)

Ashing Analysis of Coal

5 g each of coal samples were weighed into 20 crucibles with their lids, the lids were then removed and placed in a muffle furnace and heated for constant 4 hours at 825^0c, and then the residue were allowed to cooled for 1 hour in a dissector. Then crucibles were removed and covered with their lids that obtained W3. The mass of the ash and percentage ash was later calculated. The process was carefully done that ensured volatile elements such as Mercury Arsenic and even Lead were not removed in the ashing process as adopted by (Ryemshak and Jauro, 2013).

pH Values of Coal

2 g of each coal samples were dissolved in 100 cm^3 of distilled water at room temperature and equilibrium time of one hour intervals. The coal samples solutions were adjusted to the require pH values using 100cm^3 of 1M HCl and 100 cm^3 of 1M NaOH solutions separately, and the pH meter indicators were inserted into respective solutions and recorded at every hour intervals for five hours as adopted by (Tiza, 2010)

Fixed Carbon Analysis

These were also analyzed by using finely powdered Coal samples of about 0.25g were accurately weighed into crucibles and placed in an oven using a tong and heated at a temperature of 1335^0c that determined the sulphur and carbon. Computer attached to the analyzer automatically print out the result of each sample on the screen within 1 to 2 minutes depending on the nature of the coal. The analyzer was connected to the oxygen gas supply for effective analysis of curved of sulphur and carbon in percentage indicated on screen.

Calorific value determination

Finely powdered sample of coal of about 90um mesh sieve was weighed at 1g was pressed into pellets and placed into a Bomb calorimeter (Parr 6100 calorimeter). Then 10cm fused nickel-chrome wire was connected to bomb but restricted from touching the crucible. Then the lid of the bomb was closed and connected to the source of oxygen pump. 200cm^3 of distilled water was accurately measured and into the machine oval bucket, then the bomb was inserted into the oval bucket and connected to the electric source of current. Programming of the machine was done using the sample name or sample identification the machine was started, also the mass of pellet and benzoic acid added was recorded. Moreover the sulphur content of the Maiganga coal sample was found as (3.78%) which was feed into the computer attached to the machine as demand for effective calorific value determination; the machine runs the sample for 8 minutes that completed the analysis. However, care was taken which avoided errors during the process. Finally the gross heat and net heat were recorded as adopted by (Barbara et al. 2010)

Results and discussion

Table I Moisture Content of Coal Samples

Coal Seam	Sample Name	W_1 (g)	W_2 (g)	W_3 (g)	M	% MC
A_1	Coal A_1	58.8	78.8	78	0.8	4
A_1	Coal A_2	59.9	79.9	79	0.9	4.5
A_1	Coal A_3	60.7	80.7	79.6	1.1	5.5
A_1	Coal A_4	63.7	83.7	82.8	0.9	4.5
A_1	Coal A_5	62.1	82.1	81.1	1	5
A_2	Coal B_1	56.6	76.6	75.3	1.3	6.5
A_2	Coal B_2	58.3	78.3	77.3	1	5
A_2	Coal B_3	59.7	79.7	79.2	0.5	2.5
A_2	Coal B_4	63.3	83.3	82.7	0.6	3
A_2	Coal B_5	58.8	78.8	78	0.8	4
A_3	Coal C_1	60	80	79.6	0.4	2
A_3	Coal C_2	60.6	80.6	80	0.6	3
A_3	Coal C_3	63.7	83.7	83.1	0.6	3
A_3	Coal C_4	62.1	82.1	81.6	0.5	2.5
A_3	Coal C_5	55.3	78.3	77.3	1	5
B	Coal D_1	56.6	76.6	76.0	0.8	4
B	Coal D_2	58.2	78.2	77.4	0.8	4
B	Coal D_3	59.7	79.7	78.8	0.9	4.5
B	Coal D_4	63.3	83.3	82.6	0.7	3.5
B	Coal D_5	58.7	78.7	78.1	0.6	3

Moisture Content of Coal Samples

Table I indicated that seam A1 which was the uppermost Layer, retains high moisture contents than the other seams due to closeness to the earth surface. While seam A2 and Seam A3 moisture content of the coal varies. The bottom seam B coal has moderately stable moisture content. High moisture content would result in a decrease plant capacity and an increase in operating cost and it also affects calorific value and concentration of other constituents as adopted by (Jauro et al. 2008).

Ash Content of Coal Samples

Table II showed that result of dry ashing process of 20 coal samples from four major seams. The upper seam A1 contain high ash content of 86%, while seam A2,A3 and seam B has lower or moderate ash content ranging 40% to 74%. Thus, seam A2, A3 and B coals are very good for making coke for heating in industries.

Table II Ash Content of Coal Samples

Coal Seam	Sample Name	W_1 (g)	W_2 (g)	W_3 (g)	Ash	% Ash
A_1	Coal A_1	57.1	62.1	58	4.1	82
A_1	Coal A_2	59.4	64.4	60.2	4.2	84
A_1	Coal A_3	62.3	67.3	64	4.3	86
A_1	Coal A_4	58.8	63.8	61.1	2.7	54
A_1	Coal A_5	59.3	64.3	60.5	3.8	76
A_2	Coal B_1	56.2	61.2	58.8	2.4	48
A_2	Coal B_2	58.2	63.2	59.9	3.3	66
A_2	Coal B_3	59.7	64.7	61.4	3.3	66
A_2	Coal B_4	63.3	68.3	65.8	2.5	50
A_2	Coal B_5	58.8	63.8	61.1	2.7	54
A_3	Coal C_1	57.2	62.2	58.8	3.4	68
A_3	Coal C_2	60.6	65.6	62.7	2.9	58
A_3	Coal C_3	66.3	71.3	67.6	3.7	74
A_3	Coal C_4	62.1	67.1	63.9	3.2	64
A_3	Coal C_5	63.0	68.0	64.7	3.3	66
B	Coal D_1	62.9	67.9	65.9	2	40
B	Coal D_2	59.6	64.6	61.1	3.5	70
B	Coal D_3	60.2	65.2	61.2	3.5	70
B	Coal D_4	69.3	74.4	71.6	3.7	74
B	Coal D_5	57.6	62.6	59.5	3.1	62

Low ash content is an essential requirement for coke making coals as reported by (Jauro et al, 2008). Thus Maiganga coal retains moderate amount of ash content which was moderate for coke making, as indicated by Figure 4.1

The table explained that seam A1 coal samples showed high ash content ranging from 80-87% than other samples of A2, A3 with range of 49-75%, while ash content of seam B with a shows low ash content of 39%. Both seams have ash composition of 65.6%

Acidity and Alkalinity change of Maiganga Coal samples

Table III indicated that the acidity and alkalinity change of coal samples with time using pH meter. The also showed the average acidity and alkalinity change of five samples within seam or layers of coal.

There was a stability of acidity and alkalinity in seam A1 coal with slide variation of time on hourly bases due to high content of ash of the coal samples in this layer. However, in seam A2 the acidity and alkalinity increases up to the third hour but decreases from within four and five hour due to moderate content of ash in the samples. Seam A_3 coal shows increase in acidity while alkalinity change fluctuate with time. The bottom seam B shows negligible change in alkalinity and acidity due to hardness stability of coal in that seam.

Table III P^H Values of Seam Coal Samples

			1hr		2hr		3hr		4hr		5hr
Coal Seam	Sample Name	1m HCl	1mNaOH	1m HCl	1mNaOH	1m HCl	1m NaOH	1m HCl	1mNaOH	1m HCl	1mNaOH
A_1	Coal A_1	0.35	12.37	0.37	12.37	0.43	12.32	0.43	12.30	0.40	12.34
A2	Coal A2	0.43	12.24	0.43	12.48	0.71	12.50	0.59	12.39	0.38	12.39
A3	Coal A3	0.37	10.76	0.73	10.54	0.46	11.17	0.73	11.33	0.72	11.60
B	Coal B	0.33	12.59	0.39	12.61	0.58	12.56	0.61	12.59	0.35	12.59

Calorific Values of Maiganga Coal Samples

Table IV showed that the calorific value of coal, which was the suitability of heat capacity retention and generation of viable coal to produce heat and light.

It indicated that seam B has the highest calorific value of 6018kcal/g than seam A3 and A2, which signifies that seam B coal, has high potentials in coke formations while seam A1coal is the lowest coal range in heat generation capability this agrees with the findings of Nasirudeen and Jauro, 2011. However both seam have a calorific values of 5359kcal/g.

Table IV Calorific Values of Coal Samples at Different Locations

Coal Seam	Sample Name	Gross CV kcal/g	Net CV kcal/g
A_1	Coal A	3900-4400	4279
A_2	Coal B	4500-5400	5161
A_3	Coal C	500-6200	5978
B	Coal D	5500-6300	6018

Fixed Carbon Content of Coal Samples at Different Locations

Table V indicated that Seam A3 showed the highest carbon content of 41.35% followed by seam B with carbon values of 38.93%. While Seam A1 has the lowest carbon content of 21.17% which was least carbon content as clearly illustrated by table V. Both seams have carbon content of 33.57%.Seam A3 appears to be the best Seam among the other seams in Maiganga coal fields that can effectively use in coke making as stated by (Jauro et al. 2008)

Table V Fixed Carbon Content of Coal Samples at Different Seams

S/N	Coal Seams	Sample Name	Fixed carbon %
1	A_1	Coal A	21.17
2	A_2	Coal B	32.83
3	A_3	Coal C	41.35
4	B	Coal D	38.93

Table VI Comparative Analysis and Compositions of Maiganga Coal and other Coals

S/N	Parameters	Samples			
1.	**Proximate Analysis**	Maiganga	Lafia-obi	Doho	Lamja
A.	Moisture (wt%)	9.5	2.91	3.90	3.08
B	Ash %	65.6	20.66	29.91	11.87
C	P^H Values(Acidity)	0.36	NA	NA	NA
D	P^H Values(Alkalinity)	9.70	NA	NA	NA
E	Volatile matter(%db)	47.4	27.29	43.44	40.01
F	Fixed carbon %	33.57	46.23	21.98	44.23
G	Calorific Value(kcal/g)	5359	NA	NA	NA
H	Plastometric values (^{o}C)	NA	330	NA	NA

Table VII showed that the analysis of moisture of content of Maiganga coal of 9.5% which was higher than other coals of Lafia-obi with 2.91% Doho with 3.90% and Lamja with 3.08% as stated by (Jauro et al. 2008).This indicated that the highest moisture content of Maiganga coal would result in decrease plant capacity and increase in operating cost as stated by Jauro et al. (2008)

The Maiganga coal has the high ash content of 65.6% as compared to others particularly those of Lafia-obi, Doho and Lamja which have 20.66%, 29.91% and 11.87% respectively. The low ash content is essential requirement for coke making as stated by Jauro et al.(2008) Therefore Maiganga coal would influence slag volume and composition in blast furnace, thus poor in coke making as reported by Ryemshak and Jauro, 2013.

The fixed carbon content as shown in Table V revealed that Doho and Maiganga has the lowest values of 21.98% and 33.57% while Lamja and Lafia-obi have the highest values of 44.23% and 46.23% respectively. This shows that Lafia-obi coal has the highest value of carbon for effective coke formation as reported by Jauro et al. (2008). The calorific value and fixed carbon content are the major terms of quality of a coal for heat generation capacity as stated by (World coal

Institute 2010); hence Maiganga coal with moderate calorific value of 5359 kcal/g is within the lignite coal range which is good in coke formation as compared to that of Lamja and Lafia-obi.

Conclusion

The analysis of Maiganga coal has been found that Maiganga coal has moderate fixed carbon of 33.57% and very high colorific values of 5359kcal/g that can be compared with any other coal in the world. Maiganga coal if well harnessed can be a means of heat/electricity generation to Gombe State.

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