Qualitative Characterisation of Coal Minerals Selected From 5 Different Locations in Nigeria: For Possible Studies on Gasification Technology

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ABSTARCT
Nigeria is abundantly blessed with coal, but little or no attention is being given regarding coal activities and mining. More attentions are being given to fossil fuel oil, hence neglecting coal which when harness could also be utilized to its optimum. This study was aimed at investigating the characteristic properties of 5 coal samples from different locations in Nigeria namely; Anambra (A), Benue (B), Enugu (C), Gombe (D) and Kogi (E) States. The characterization parameters used were; preliminary test, proximate and ultimate analysis. The result of the analysis conducted on the various coal samples shows that sample C and B have high carbon and hydrogen (N) content which is good quality for power generation, Coal Sample A had the highest Nitrogen (N) content of 1.83%, followed by the coal sample C, D, B and E with lowest value of 1.07% [$A \rightarrow C \rightarrow D \rightarrow B \rightarrow E$]. The Nitrogen (N) and Sulphur(S) contents are an indication of the environmental friendliness of coal relative to potential NOx and SOx pollutant emissions. Gasification technology was identified to be one of the effective ways of utilizing coal to meet the energy demand of the nation and to ensure a clean and safe environment. It is hope that this findings would be useful in maximizing the efficiency and economics of a zero-emission systems in Nigeria either through gasification technologies and or otherwise.

Keywords: *Coal, power generation, emission and gasification technology*

1.0 INTRODUCTION

Coal is the world's most abundant and widely distributed solid fuel with estimated reserves of about 990 billion tonnes, and is enough for 150 years at current consumption (Miller, *2009*). Coal fuel is about 42% of global electricity production, and likely to remain the key component of fuel mix for power generation to meet electricity demand, more especially in developing countries. As such, coal plays a unique role in meeting the demand for secured energy, as it is globally the most abundant and economical of fossil fuels. At current production levels, proven world coal reserves are estimated to last 147 years. It is also projected that the greatest demand for fossil fuels will be coal, which will remain the second largest primary fuel source until 2030 (*Wolde-Rufael, 2010a*). The quality of the coal deposit is mainly determined by the following: the different types of vegetation that constitute the coal, how deep the decayed plant deposit was buried, the temperature and pressure experienced at that depth and the length of time the coal has taken to form *Okolo and Mkpadi* (*1996*).

Coal is non-renewable source of energy and contains carbon, hydrogen, nitrogen, sulphur and oxygen. It is a cheap source of fuel, because it is found in abundance and not expensive to convert to energy. They are classified based on the level of carbon it contains and the amount of energy it can produce. Some updated classifications of coal form different parts of the world were presented (*Idris et al., 2016*) and (*Wolde-Rufael, 2010b*).

Gasification remains the process of converting organic (or fossil fuel) based carbonaceous materials into useful products: carbon monoxide (CO), hydrogen (H_2) and carbon dioxide (CO_2). This can be achieved by reacting the material at variable conditions, high temperatures (>700 ^{0}C), without combustion, with a controlled amount of oxygen and/or steam (*Idris et al., 2016*).

The significance of the study is to establish the potential viability of coal and how it could be harness to the greatest benefits. These were done through proper characterization of the coal, which involves both physical and chemical tests. The studies of gasification are virgin areas, which is yet to be harnessed to the fullness.

2.0 BACKGROUND OF STUDY

2.1 The Demand of Electricity

Currently, Nigeria is only generating about 7,000 MW of electricity, while energy demand is above 25,000 MW with increase in annual demand rate of 3,000 MW. With increasing pressure to adopt non-fossil fuel electricity-generating technologies, the abundant reserves and low cost of coal makes it the preferred energy source to meet these increasing demands for the foreseeable future. It is also foreseen that coal-based generation is likely to provide 50% of this demand. The challenge in the future is to enhance both the efficiency and environmental acceptability of coal use by adopting clean coal technologies (CCTs). CCTs are defined as *technologies* designed to enhance the efficiency and the environmental acceptability of coal extraction, preparation and useful applications. The increased efficiency of clean coal technologies results in reduced CO_2 emissions for a specified electric output. Also, the emission of other environmental pollutants such as NO_x, SO_x and particulates are significantly reduced (*Idris et al., 2016*).

2.2 Nigeria's Coal Deposits Identified

Nigeria has major unexploited coal resources. The government has recently placed a high priority on utilizing these resources to increase Nigeria's electricity generating capacity. Nigeria's goal is to revitalize the coal mining industry and expand power generation by attracting companies to develop these large coal resources and construct coal-fired generating plants that will connect to the country's electrical distribution grid. There is also significant potential domestic demand for coal briquettes to replace wood for cooking and heating. The use of wood by the country's growing population is causing increasingly rapid deforestation in many parts.

The domestic coal market is latently large. Besides the potential for power generation, Nigeria currently imports coals of various grades and qualities. There is also the potential for coal exports to countries such as China, Israel, Japan, Ghana, United States, Europe and

India.

Nigerian coal has been found suitable for boiler fuel, production of high calorific gas, domestic heating, briquettes, formed coke and the manufacture of a wide range of chemicals including waxes, resins, adhesives and dyes. Their characteristic properties (low sulphur and ash content and low thermoplastic properties), make these sub-bituminous coals ideal for coal-fired electric plants. Some Nigerian coals can be used to produce formed-coke of metallurgical quality.

As a consequence of the privatization drive by the government, the coal resources of Nigeria were delineated into 10 prospective blocks and placed for bidding by companies with proven financial and technical abilities. Nine of the blocks were bid for and won by four companies, one Nigerian and three foreign. Abundant opportunities abound in the area of partnering with the block winners with a view of mining the coal resources for power generation (*Obaje, 2009*). The coals from some of the 5-selected locations for this study are presented as follows:

2.2.1 Kogi District

The Kogi Coal District, covering 225,000 hectares of the Anambra Coal Basin, lies on the north-eastern side of the basin. Two areas within the district have been explored to a limited degree. The more northern of the two areas, Ogboyoga, has the greatest amount of available drill data, where 27 holes have been drilled and cored and 15 separate measurements have been taken of outcrops of the main coal seam in stream drainages.

Behre Dolbear used the guidelines of the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (also known as the JORC Code) to delineate a total of 123 million metric tonnes of coal underling an estimated 8,900 hectares. An additional 165 million tonnes of coal classed as non-reportable resource by the JORC Code definitions, is projected to lie in Ogboyoga area.

The coal thickness in this area is approximately two metres. The other area of interest is Okaba, the site of a small idle surface mine. Near Okaba, 17 core holes have been drilled, all of which intersected the main coal stream. No outcrop samples have been reported for this area. A total of 100 million tonnes of demonstrated coal (JORC) have been estimated to underlie 2,770 hectares in the Okaba area and an additional 435 million tonnes of non-reportable coal resource are projected to the west of existing drilling. In total the Kogi District is estimated to have a demonstrated coal resource of 223 million tonnes averaging 3.6 metres thick, which underlies 8,900 hectares (4%) of the district. The total non-reportable resources by JORC Code are 600 million tonnes.

2.2.2 Benue District

The Benue Coal District, covering 175,000 hectares of the coal basin, is immediately south of the Kogi District along the eastern outcrop of the Anambra Basin. It also has two areas of interest. The more northern of the two, Orukpa, includes a small idle surface mine and a total of 11 drill holes. Six coal outcroppings have also been measured in streams in the area. Based on this data, Behre Dolbear estimates that a reportable coal resource of 81 million tonnes (demonstrated – JORC) exists along the outcrop. Another 117 million tonnes of non-reportable coal, as defined by the JORC Code, is projected to exist west of the existing drilling. The average coal thickness is 3.1 metres.

Immediately south of the Orukpa area is the Ezimo area. This area has limited exploration, with only four drill holes penetrating the main coal stream. Ten coal outcroppings have also been measured, not all of which have exposed the entire seam. Based upon this limited data, a total of 43 million tonnes of demonstrated coal resource have been projected for the Ezimo area. An additional 263 million tonnes of non-reportable coal resource is projected to exist west of the existing drilling. The average coal thickness in this area is also 3.1 metres. In total the Benue District (Orukpa-Ezimo) is estimated to have a demonstrated coal resource of 124 million tonnes, which underlies 4,700 hectares (3%) of the district. The total non-reportable resources, as defined in accordance with the JORC Code, are 380 million tonnes.

2.2.3 Enugu District

The Enugu Coal District, covering 270,000 hectares of the coal basin, is centered on Enugu City, south of the Benue District. It has supported the largest amount of commercial mining in the past. In addition to two underground mines, there are a total of 36 drill holes drilled in the area. Previous studies have estimated the demonstrated coal resource to be 49 million averaging 2.2 metres thick. An additional 111 million non-reportable of in place coal are inferred to exist west of the old mine workings.

More details about coal occurrences in Nigeria and its compositions can be found from (*Idris et al., 2016*). Figure 1 represents the locations of coal in the sedimentary basins of Nigeria (*Obaje, 2009*).

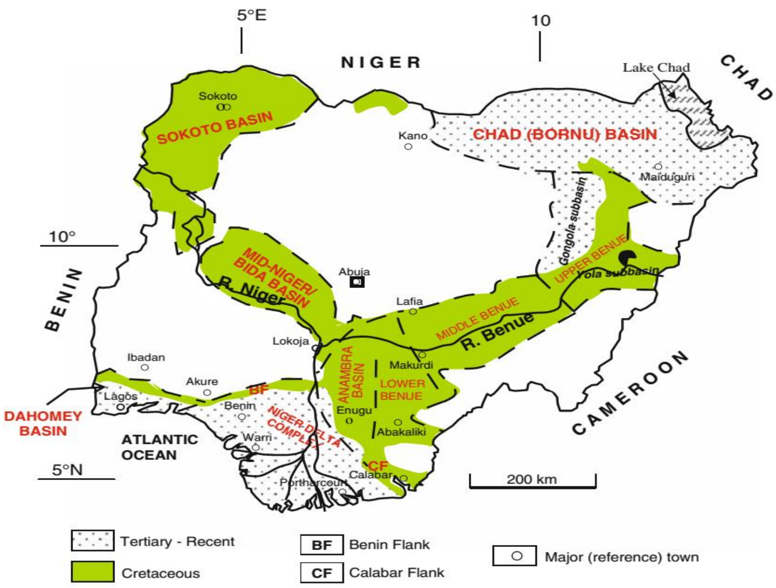

Figure 1 Locations of coal in the Sedimentary basins of Nigeria (*Obaje, 2009*)

3.0 MATERIALS AND METHODS

3.1 Materials

The coal samples were collected from five (5) deposits locations in Nigeria namely; Gombe, Enugu, Benue, Anambra and Kogi state. Utmost care and precaution was applied in the sample collection and preparation in order to avoid impurities/extraneous materials from interfering in the final results in accordance with established standard procedures from open literatures. The samples were stored in appropriately labeled airtight containers to retain their as-received conditions. For an easy record, the samples were labeled as follows: A – Anambra, B – Benue, C – Enugu, D – Gombe and E – Kogi State. The detail pictorials of all the coal samples (A - E) are shown in Figures (2 - 6) below;

Fig 2: Coal Sample A Fig 3: Sample B Fig 4: Sample C

Fig 5: Sample D

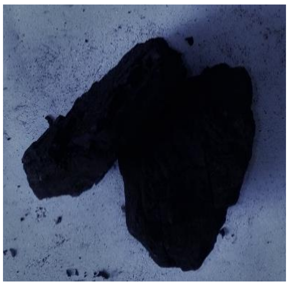

Fig 6: Sample E

Some of the equipments and technical tools used in this work are presented below (Figures 7 - 9).

Fig 7: Dr. Watts Filter Paper

Fig 8: Capacity Oven

Fig 9: Heating Mantle setting in operation

3.2 Methods

3.2.1 General Sample Preparation

The selected lumps of coal samples were air-dried and then pulverized with clean mortar and pestle to increase its surface area and it is then sieved into selected mesh powder. The powdered samples with particles diameter less than 50 mm were retained for all observations.

3.2.2 Quantitative Characterization of Coal Sample Materials

The quantitative characteristics of coal are the physical properties of the coal sample. They are those qualities/properties which may be seen or felt in the different coal samples. They are many physical parameters to mention but the few studied in this research are; Hardness/Softness, Colour, Texture and Appearance.

The preliminary test is the physical test which can easily be detected without necessarily taken the coal sample to the laboratory, they include; hardness/softness, colour, texture and appearance. The proximate analysis can be said to be a chemical/analytical test that includes determination of parameters like moisture content, ash content, volatile matter, fixed carbon etc.

3.2.3 Further Qualitative Characterization

3.2.3.1 Proximate Analysis

The characterization parameters analyzed for in the coal samples were; moisture content, ash content, volatile matter and fixed carbon etc.

3.2.4 Determination of % Moisture Content of Coal

The mass of an empty tray was weighed and recorded as (M_1), then 10g coal to be tested was spread evenly on the tray, weighed and recorded as (M_2), the tray was placed into the drying Oven with a temperature of 110^0C and then allowed to be dried for a period of 2 hours after which, It was removed and placed in a dust free area to cool for 30 min. The tray and its content, was re-weighed and recorded as (M_3).

The following calculation was done in determining the %free moisture

The weight of the sample:

$$S_1 = M_2 - M_1 \quad (1)$$

The weight of the dried coal sample:

$$S_2 = M_3 - M_1 \quad (2)$$

$$\%F = \frac{S_1 - S_2}{S_1} \times 100 \quad (3)$$

Where % F = Free moisture, S = Sample, M_1 = Mass of empty tray, M_2 = Mass of sample used and M_3 = Mass of empty tray + Mass of sample used (After oven-dried).

3.2.5 Determination of % Ash Content of Coal

The furnace was ON, to a set temperature of 200^o C, then the silica crucible was weighed (M_1) and 1g of coal sample was weighed and been spread out uniformly onto the dish, the dish and the sample was weigh as (M_2). After the weighing of the masses, the sample was put into the furnace then the up and down arrow keys on the furnace was been press together for 2 sec and the control console was be displayed and the temperature of 815^0C was set, as the set point temperature and also the set point ramp rate was set to 40^0C. After then, the time taken was set to 1 hour, the furnace was close for it to start heating the time key was press, the time and power light started blinking and the 1 hour countdown begins. After been heated for 1 hour the sample was removed and inspected to make sure it was completely ashed, and then it was place in a desiccator to cool. After cooling it was then weigh and record as (M_3). The following calculation was done in determining the % ash content:

$$\%ASH = \frac{M_3 - M_1}{M_2 - M_1} \times 100 \quad (4)$$

Where: M_1=Mass of empty dish, M_2=Initial mass of dish plus test sample and M_3=Mass of dish plus test sample after drying.

3.2.6 Determination of % Volatile Matter Content of Coal

The sample was conditioned and exposed in a thin layer for at least 30 minute in the balance room. The empty crucible and lid was weigh (M_1) and transfer 1g of the sample into crucible. The lid was replaced and accurately the initial mass (M_2) was determine of the crucible, lid, and the test sample. The crucible was place on a clean hard surface until the test sample forms a layer of uniform thickness on the bottom of the crucible and the lid was replaced, the crucible and lid was place within a uniform temperature in the furnace and then pre-heated to 900^0C for exactly 7 minute. After that the sample was removed and place on a thick metal plate to allow it cool. After cooling, it was weighed and recorded as final mass (M_3).

Volatile Matter Content = 100

$$\frac{(M_2 - M_3)}{(M_2 - M_1)} - M \quad (5)$$

Where: M_1 - Mass of the empty crucible + lid, (g), M_2 - Initial mass of the crucible + lid + test sample, (g), M_3 - Mass of the crucible + lid + residue after heating, (g) and M - Residual moisture determined.

3.2.7 Determination of % Fixed carbon Content of Coal

Determination of fixed carbon content is the simplest analysis of all the analyses obtained, because coal has more carbon than all the properties obtain. After obtaining the %free moisture, %residual moisture, %total moisture, %volatile matter, % ash content. Then ash content and %volatile matter was sum and subtracted from 100.

3.2.8 Ultimate analysis

Prepared samples were dried at 35^0C, about 200 µg of coal sample was weighed into silver crucibles on a microbalance. The determination of carbon, hydrogen, nitrogen and sulphur was performed on LECO-932 analyser after calibration with sulfamethazine as standard. The data processing was simply performed by the software incorporated in the instrument and the results are given in percentage of carbon, hydrogen, nitrogen and sulphur in the sample. The analysis was done in replicate and the average values were taken and recorded.

4.0 RESULTS AND DISCUSSION

4.1 Preliminary Analysis (Physical Test)

The Preliminary Analysis (or quantitative characteristics) of coal is regarded as the physical properties of the coal sample. They are those qualities which may be seen or felt in the various coal samples. They are many physical parameters to mention but a few in this research which are; hardness/softness, colour, texture and appearance.

4.2 Hardness / Softness

As a general rule, the harder the coal the higher its energy value so also its rank. Coal hardness shows the ability to withstand external force. Coal hardness is related to coalification. (*The degree of change undergone by a coal as it matures from peat to anthracite is known as coalification*).

The hardest Coal Sample was Sample D whereas the softest amongst it was Sample A. it then followed this manner from hard to soft as illustrated below;

D→C→B→E→A

We know from the classes of coal that Lignite which has a low Coalification degree is softer whereas anthracite with a high Coalification degree will be harder. Lignite coal is suitable for generating electricity while the anthracite is used for domestically at home. This shows that the softness of coal is an indication for used in generating power while the hardness is an indication of its vast applications in our homes.

4.3 Colour

The secret behind the colour of coal is their composition and origin. Coal colour also depends on the environment in which it is found. The colour of the 5- coal samples are as below; Sample A: Black, Sample B: Light Black, Sample C: Grey, Sample D: Black and Sample E: Black.

4.4 Texture

Coal texture provides information about the shape of the coal and the orientation of crystals within it. Coal texture also provides additional information about the formation of coal from its magma or lava. The texture of coal is either Amorphous or Glassy. Amongst the 5 different Coal sample only Coal Sample C and D are slightly glassy the rest of them i.e. Samples A, B and E are only Amorphous.

4.5 Appearance

The appearance of coal depends on its formation, texture and properties of the coal. It also depends on the percentage of impurities in it. Appearances can be dull, rough or skeletal or rather in a more technical term as either veined or pebbled. The four (4) out of the 5-Coal samples appeared to be dull and rough but Coal Sample C appears to be skeletal.

4.6 Proximate Analysis (Chemical Analysis)

The results obtained from the proximate analysis of the five (5) coal samples are shown on an air-dried basis, as presented in Table 1.

Table 1: Proximate Analysis of the Coal Samples

Properties	Symbols	A (%)	B (%)	C (%)	D (%)	E (%)
Moisture Content	MC	15	13.5	7.8	6	4.4
Ash Content	AC	6.5	4.8	19.5	9.4	26.5
Volatile Matter	VM	37.6	40	33.3	36.7	27.4
Fixed Carbon	FC	43.6	47.2	42	48	40
Fuel Ratio	FR	1.16	1.18	1.26	1.31	1.46

$N/B : FR = \frac{FC}{VM}$

The Moisture Contents (MC) range from 15% to 4.4% as reported in open literature. Coal Sample A had the highest moisture content of 15%, followed by Samples B, C, D and E (A→B→C→D→E) with 13.5%, 7.8%, 6% and 4.4%, respectively. Consequently, the results for the Moisture Content (MC) of coal corroborate the order of maturity of the coals. There is no much difference between the volatile matter contents (VM) of Coal Samples A and D.

Coal sample E had the lowest volatile matter content (27.4%). The volatile matter content (VM) of coals is an index for evaluating the quality and potential application of different coals. Furthermore, the classification of coals as either agglomerating or non-agglomerating is based on the determined volatile matter (VM) values (*Speight, 2013*). The lower the volatile matter content, the higher the ranking of the coal. The volatile matter content (VM) of coal also affects storage behavior (oxidation, danger of spontaneous combustion and loss of heating value) pulveriser outlet temperature and required fineness for pulverization, burner settings, furnace, combustion behavior and efficiency (ignition, flame shape and stability, and burnout and carbon content of fly ash (Carpenter et al., 2007). Coal Sample E with the lowest VM (27.4%) would have the least danger of spontaneous combustion followed by Coal Samples C (33.3%), D (36.7%), A (37.6%), and B (40%) [E→C→D→A→B] as presented in Table 2. The highest Fixed Carbon (FC) content of 48% was recorded in Coal Sample D, followed by samples B, A, C and E with values of 47.2%, 43.6%, 42% and 40% respectively [D→B→A→C→E]. Ash content (AC) affects coal and ash handling systems, pulverisers (abrasion), furnace, superheater, economizer, soot-blowing intervals (slagging and fouling propensity, erosion and corrosion), pollution control equipment and unburnt carbon in ash (*Carpenter and Niksa 2007*), *DME* (*2010*). It also used to determine the fouling or slagging potential of coals during thermal conversion (Speight, 2012). Sample B with the lowest ash content (4.8%) would cost less in terms of investment in ash handling equipment and pulveriser abrasion followed by A (6.5%), D (9.4%), C (19.5%) and E (26.5%) coal samples [B→A→D→C→E]. The fuel ratio has also been computed by the ratio of Fixed Carbon (FC) to Volatile Matter (VM). The ratio of fixed carbon to volatile matter (i.e. fuel ratio) indicates the ease of ignition and burnout, but the heat content of the volatile matter is a more reliable guide to ignition. The volatile matter content influences NOx formation. Generally, for the same burner and constant nitrogen content, the higher the volatile matter, the lower the NOx. It is clearly seen from Table 2 that Coal Sample E possesses the highest fuel ratio. The chart below shows a detail explanation to the variation of all the Proximate Analysis that was carried on the 5-different coal samples *Lomax, Simon (2011*).

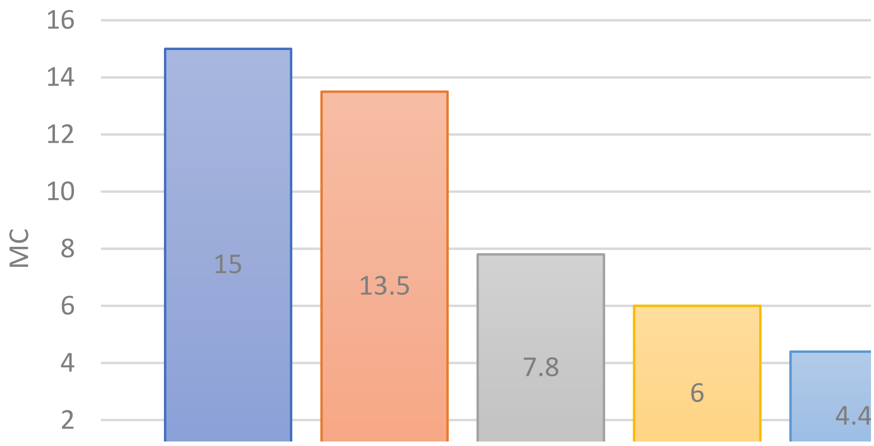

Figure 10: Moisture Content of the Coal Samples

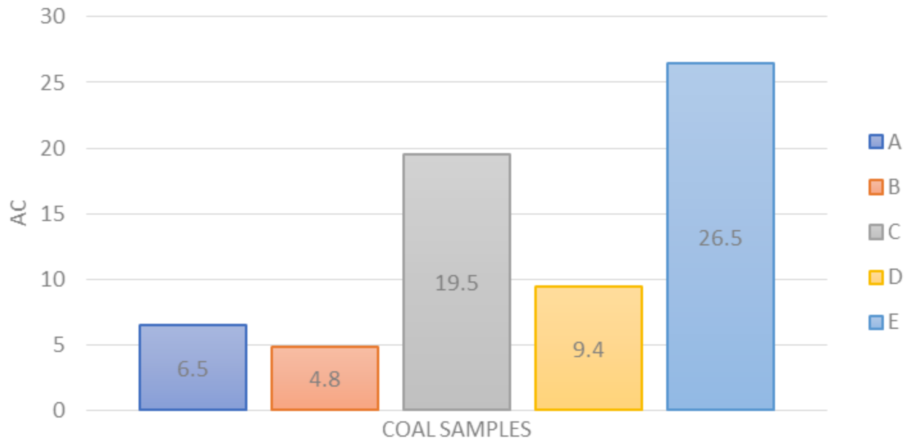

Figure 11: Ash Content of the Coal Samples

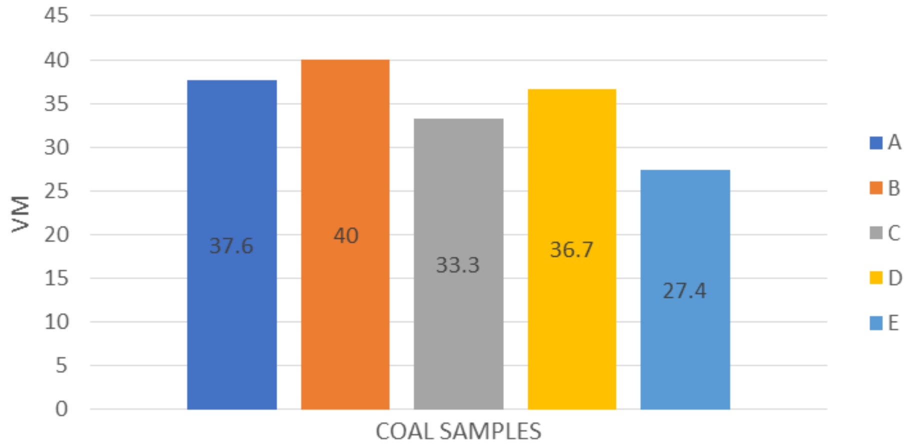

Figure 12: Volatile Matter of the Coal Samples

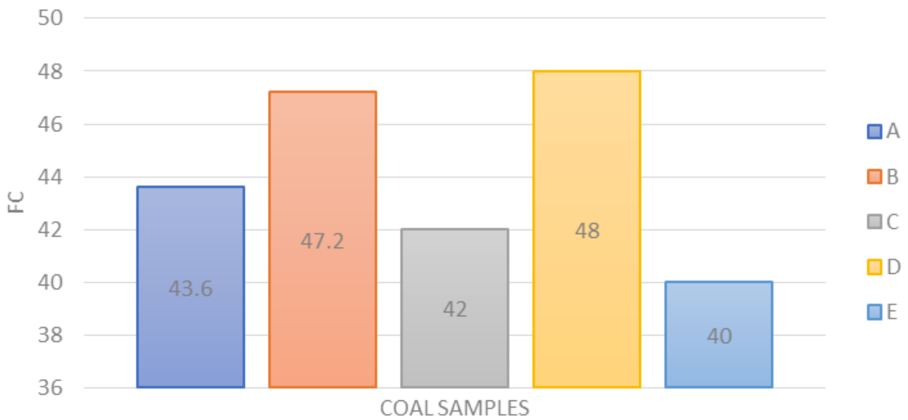

Figure 13: Fixed Carbon of the Coal Samples

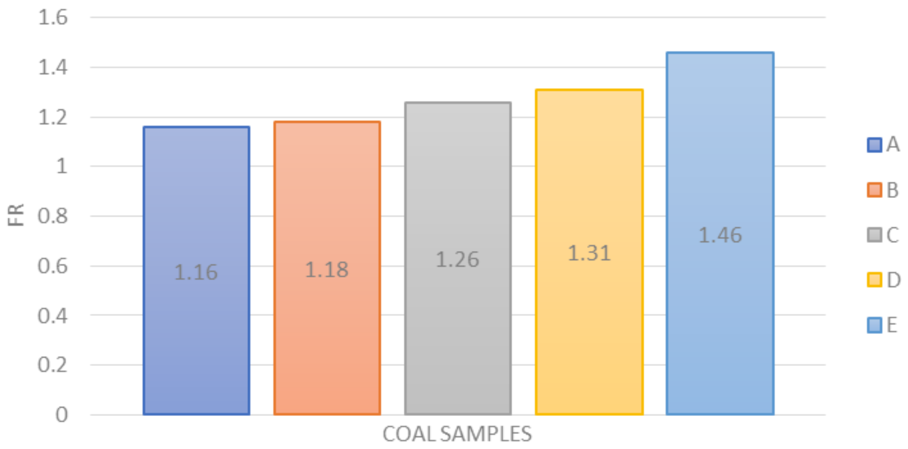

Figure 14: Fuel Ratio of the Coal Samples

4.7 Ultimate Analysis

The results obtained from the Ultimate Analysis of the five (5) coal samples are shown on an air-dried basis, as presented in Table 2.

Table 2: Ultimate Analysis of the Coal Samples

Elements	**Symbols**	**A (%)**	**B (%)**	**C (%)**	**D (%)**	**E (%)**
Carbon	C	52.96	**70.42**	68.24	50.16	60.21
Hydrogen	H	5.6	5.42	**6.48**	6.09	5.89
Nitrogen	N	**1.83**	1.09	1.67	1.34	1.07
Sulphur	S	0.46	0.88	0.97	**1.40**	0.58
Oxygen	O	**11.67**	10.84	10.43	9.79	9.46

Carbon (C) and Hydrogen (H) are the major combustible constituents of coal and both of them are high in the coal samples. The higher the Carbon (C) content, the better the quality of the coal for power generation (*Bemgba and Jauro*, *2016*). The C and H content of coal is significantly related to the maturity and chemical reactivity during thermal conversion (*Jauro and Chuckwu 2013*), *Kibiya* (*2012*), *Chirons* (*2008*) and *WCI, 2008*.

Coal Sample A had the highest Nitrogen (N) content of 1.83%, followed by the coal sample C with 1.67%, coal sample D with 1.34% and then coal sample B with 1.09%, while coal sample E had the lowest value of 1.07% [A → C → D → B → E]. The Nitrogen (N) and Sulphur (S) contents are an indication of the environmental friendliness of coal relative to potential NOx and SOx pollutant emissions. Hence, the high S Content in Coal Sample D (i.e. 1.40%) may limit its future application particularly in steel manufacturing. Overall, Coal Samples A and E with values of (0.46% and 0.58%) respectively showed the lowest S content and may be considered the coals with the lowest potential environmental pollutants. Based on the study by (*Jauro and Chuckwu 2013*), the properties of Coal Samples B and C are suitable for cement and steel manufacture, power generation as well as industrial and domestic heating (*Nasir et al., 2015; SCCR, 2012*). Figure 15 demonstrate the various analytical approach/ultimate analysis used in the cause of this research study.

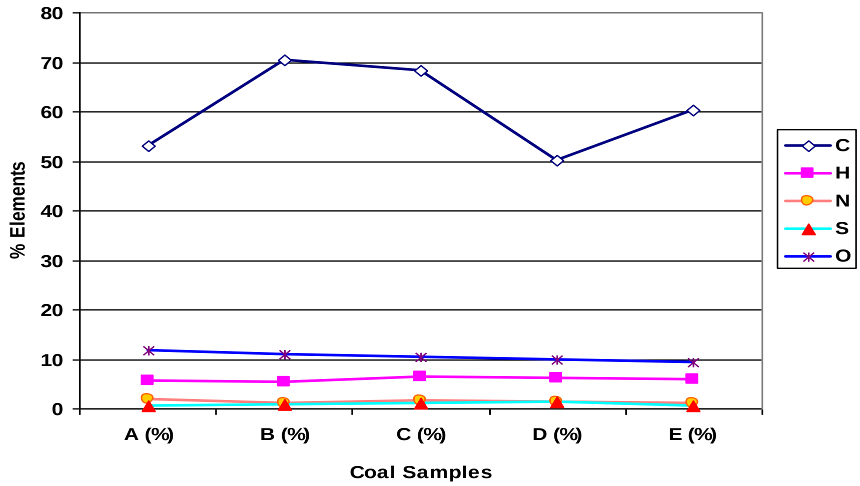

Figure 15: Comparison of % elemental components of the Coal Samples

From Figure 15, it was observed that the coal sample (B) has the highest percentage carbon contents when compared with the rest samples.

5.0 CONCLUSION

Five (5) different samples of coal were gotten from five (5) different locations in Nigeria. These locations are namely labeled as: Anambra (A), Benue (B), Enugu (C), Gombe (D) and Kogi (E). The coal samples were then examined physically which is the preliminary test and then analysed chemically and analytically through laboratory tests (i.e. Proximate and Ultimate Analysis) were carried out to determine the composition of volatile and non-volatile matter and also the elemental composition found in each of the different coal sample. The coal samples from Benue, Enugu and Kogi States (i.e. Samples B, C and E) respectively shows higher economic value based on their carbon contents. The rich mineral contents in these coal samples buttressed their wide use and application in electricity generation and steel manufacturing. Also, the study of gasification is said to be a new trend that offers a more versatile and clean way of utilizing coal and converting it into electricity and other valuable energy products.

6.0 RECOMMENDATION

Based on the findings in this research work, it is worthy to say that coal from different location in Nigeria has different and peculiar characteristics which make it suitable for used for different purposes. These variations in characteristics in the different coal samples pimp point those that are most suitable for a particular purpose like; domestic used, power generation, iron and steel manufacture etc. Coal can serve as an alternate source of energy and reducing the over-dependency on crude oil. Therefore, we recommend that:

1. Coal should be a use as an alternate source of energy, because of it cleanliness and safe to the environment.
2. The adoption of gasification technology (GT) is the best method to achieving the required processing, due to the fact that it provides basis for technological solutions to

future demands of coal in a way that is robust and flexible.

3. In addition, further studies should be carried out using a real pilot scale combuster; coal exploitation, processing and productions in other to meet in the energy demands of the Nation.
4. In order to reinforce Nigeria's economic and social development and to compete with the developed countries, the integration of clean coal power generation (CCPG) in the nation electricity mix is imperative.

ABBREVIATIONS

AC	-	Ash Content
ASTM	-	American Society for Testing Materials
CCS	-	Carbon capture sequestration
CCT	-	Clean Coal Technology
CDM	-	Clean Development Mechanism
CPE	-	Coal Power Electricity
FBR	-	Fluidized Bed Reactor
GDP	-	Gross Domestic Products
GHG	-	Green House Gases
IGCC	-	Integrated Gasification Combined Cycle
IRP	-	Installation Restoration Program
MC	-	Moisture Content
NEPG	-	National Electric Power Grid
NMA	-	Nigeria Metallurgical Agency
NSRMEA	-	National Steel Raw Materials Exploration Agency
ODS	-	Ozone Depletion Substances
SCR	-	Selective Catalytic Reduction
VM	-	Volatile Matter

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