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BTX -Petrochemical Examination In Asphaltene Fraction Generated From Nigerian Escravos Crude Oil

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ABSTRACT

This research work evaluated the operational process products during combustion of the heavy fuel Escravos Asphaltene. Analytical analysis emphasis was given to the Petrochemical moieties of the Escravos Asphaltenes. This Research revealed that, UV-Vis (230nm, 259nm, 295nm, and 238nm etc.), FTIR and XRD instrumentations demonstrated potentials for this examination. The results designate that, several Petrochemicals derivatives (UV-Vis Specs) of the Escravos Asphaltene composition are generated. Further identification of the functional group proves the composition of the material such as the FTIR spectrum of E-asphaltene reveled properties in the range of 650-4000cm^{-1}nm demonstrated by figure above. It can be deduced that, absorbance peak at 754$cm^{-1}$is original C-H wagging vibration. Additionally, absorption peak observed APO at 29188cm^{-1} is presume to be $–CH_3$ consistent with the asymmetric stretching vibration while the APO at 1459 and 2855 are attributes related to $–CH_2$- symmetric bending $–CH_2$- symmetric stretching respectively. Additionally, these functional groups are linked to the parent structure of Escravos Asphaltene. XRD instrumentation have been employed to demonstrate the heavy fuel fractions profiles and other non-organic fraction as about six elements have been identified and all have the connection to the Escravos Asphaltene structure. Whilst the physical proximate combustion parameters showed high FCC up to 55% and presented 13.8% AC, and with VOCs of up to 36% accounting for the presence of OPAHs and other Oxygenates, including alkanes and Oxyhalogens while lower MC have been detected. In general, the Heavy Fuel Escravos Asphaltene have presented some potentials as heavy fuel fraction for Nigerian Energy Content.

Keywords*:* Asphaltene Petrochemicals, Escravos Asphaltene, Heavy fuel Fractions, Heavy fuel Energy, and Fuel Combustion

1.0 **INTRODUCTION**

Asphaltene are heavy fuel compounds with many domestic and industrial applications. Generally, this fraction is obtained from heavy fuel oil HFO or Petroleum. The asphaltene fractions can be use directly as fuel in boilers and furnaces, and for power and marine engines applications. Additionally, clean chemicals from these fractions will make a great impact on petrochemical domain, such as benzene, toluene and xylene. These components play role as a major source of petrochemicals organic materials with high value applications. (Bengtsson, 2011).Crude oil components are grouped into four main chemical classes, based on differences in solubility and polarity: saturates aromatics, resins, and asphaltenes (i.e., the so-called SARA classification). When dealing with solubility aspects of crude oils, most of the studies are focused on resins and asphaltenes. Asphaltenes encompass the heaviest and most aromatic constituents of the oil and are defined in terms of their insolubility when an excess of low molecular weight paraffin is added to the oil. Resins are considered as homologous to asphaltenes but with lower molecular weights and fewer and smaller condensed aromatic structures, and therefore are soluble in solvents in which asphaltenes precipitate(Acevedo, 1985).

1.2 Heavy Fuel Oil (HFO)

Heavy fuel oil (HFO) is a category of fuel oils of a tar-like consistency. This is also known as a bunker fuel, or residual fuel oil, HFO is the result or remnant from the distillation and cracking process of petroleum. For this reason, HFO is contaminated with several different compounds including aromatics, sulfur and nitrogen, making emission upon combustion more polluting compared to other fuel oils(McKee, 2013). HFO is predominantly used as a fuel source for marine vessel propulsion due to its relatively low cost compared to cleaner fuel sources such as distillates(Bengtsson, 2011). Heavy fuel oils consist of a blend of middle distillates, mainly diesel fuel, and heavy oil residuals. Varying the fraction of the mixture changes the weight percentage of the asphaltene in the heavy fuel oil (HFO) sample (DeCola, 2018).

1.3 **Asphaltenes**

According to Kobayisi, 1955 and Mullins 2000, Asphaltene is a very high molecular weight complex component in the fuel which increases the fuel viscosity, surface tension, and chemical reaction rate. Heavy fuel asphaltenes are defined as the nonpolar and nonvolatile components of crude oil they are in soluble in alkanes (normal pentane and normal heptane) but soluble in aromatics (benzene and toluene) (Speight, 2004).Mullins, 2013, indicated that, Asphaltenes are dark-brown-to-black friable solids that have no definite melting point, and usually form and swell upon heating, leaving a carbonaceous residue (Mullins, 2013). However, the molecular weight of asphaltenes span a wide rangefrom hundreds to millions, leading to speculations of about self-aggregations (Badre, 2006). The phenomenological definition of the asphaltene class leads to a complex mixture of compounds including a broad range of molecular weights and aromaticity factors, mainly related to precipitation, high viscosity or formation of water-in-crude oil emulsions(Artok, 1999). The propensity of asphaltenes to flocculate is a complex function of the crude oil composition. No simple theory relating flocculation with the concentration of asphaltenes, resins, or aromatics is generally valid, and the reasons underlying the marked propensity of asphaltenes to precipitate remain to date largely unclear(Bouhadda, 2000).

As the demand for hydrocarbon fuels continues to increase rapidly, oil production industries and consumers are paying considerable attention to the dynamic performance and reliability of the combustion process of these fuels. Asphaltene are heavy fuel compounds with many domestic and industrial applications. Generally, this fraction is obtained from heavy fuel oil HFO or Petroleum. The asphaltene fractions can be used directly as fuel in boilers and furnaces, and for power and marine engines applications. Additionally, clean chemicals from these fractions will make a great impact on petrochemical domain, such as benzene, toluene and xylene. These components play role as a major source of petrochemicals organic materials with high value applications. (Atiku, 2015)

1.4 **Asphaltene Composition, Structure And Molecular Weight**

Barde stated in 2002 that the organic and elemental composition of asphaltenes constituted the building of the structure asphaltene leading to a larger chemical structure with many aromatic branches linked together (Badre, 2006). Carbon and hydrogen are the most abundant elements in asphaltenes, and the content of carbon and hydrogen are usually greater than 90 wt%. Other elements such as sulfur, nitrogen and oxygen are also found in asphaltenes. Sulfur contents vary from 0.5 to 7.0 wt%(Mullins, 2007).On the other hand, the nitrogen content of asphaltene constituents has a somewhat lesser degree of variation (0.05-0.5 wt%), and oxygen contents generally less than 1.0 wt% (Sheu, 1995).

1.5 Chemical composition of asphaltene

According to Damirbas, 2002; asphaltenes are constituted by the some of the components as follows: Aromatic rings composing alkyl chains up to C_{30}. Depending on the type of asphaltene, sulphur as Benzothiophene rings and nitrogen is contained in the pyrole and pyridine, such as ketones, phenols, and carboxylic acids. In addition, organometallic such as Nickel, Vanadium, complexes with pyrole nitrogen atoms in Porpyrinic rings.

1.6 Structural Composition

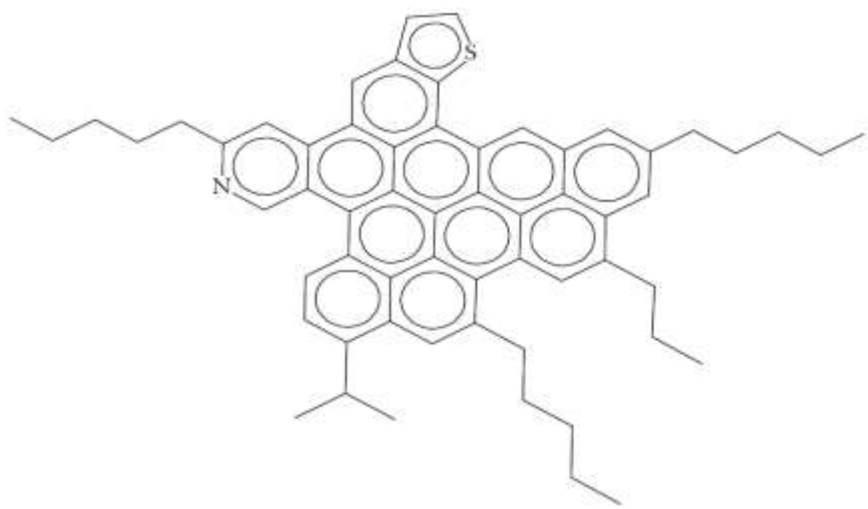


Figure1.1: Molecular Hypothetical Structure of Asphaltenes Constituted by an Aromatic core, Alkylchains, and Hetroatoms (Groenzin,)

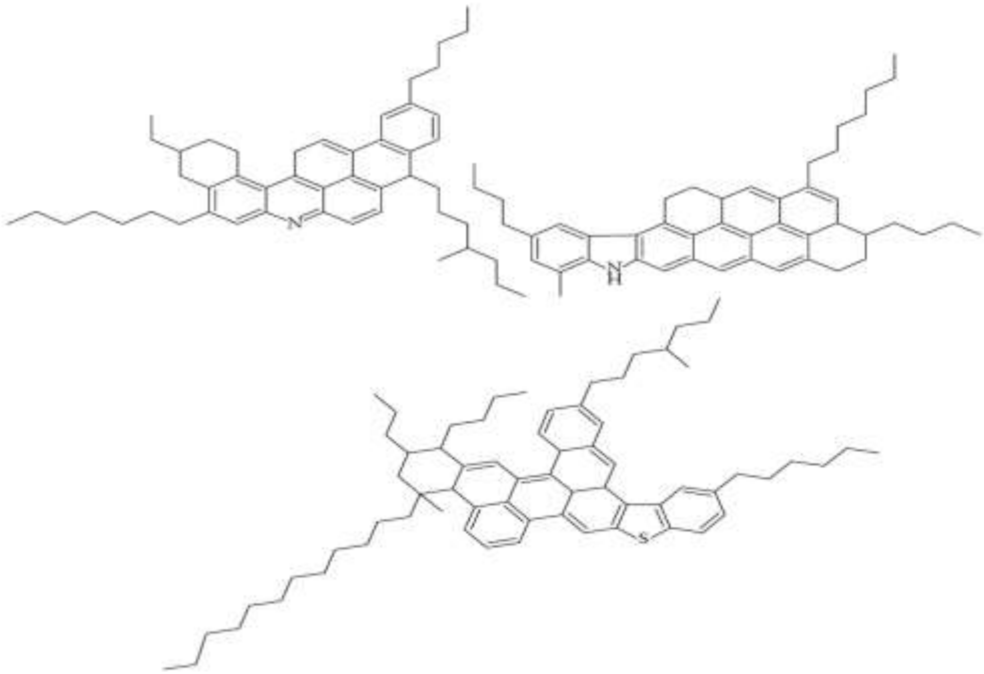


Figure 1.2: Idealized Molecular Structure of Asphaltenes Constituents with Molecular Size Aromatic Ring System and Chemical Composition (Groenzin, and Mullins, 2000).

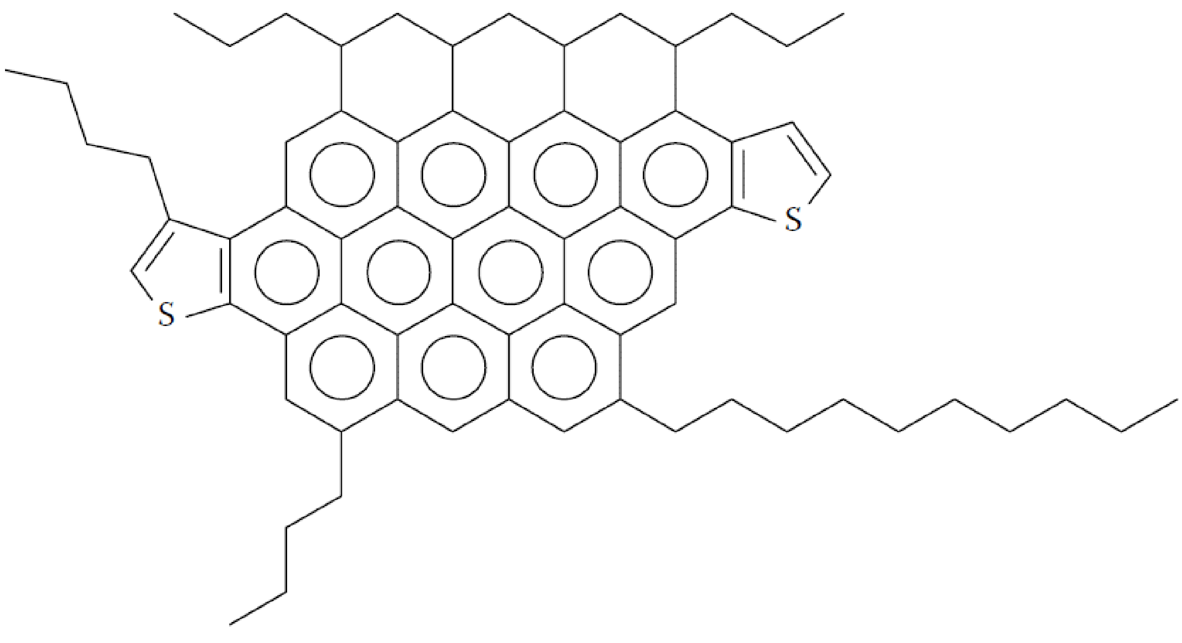


Figure 1.3: Average Structure of Continental-type Asphaltenes for Hydrocracked Residue (Zhao et al 2004).

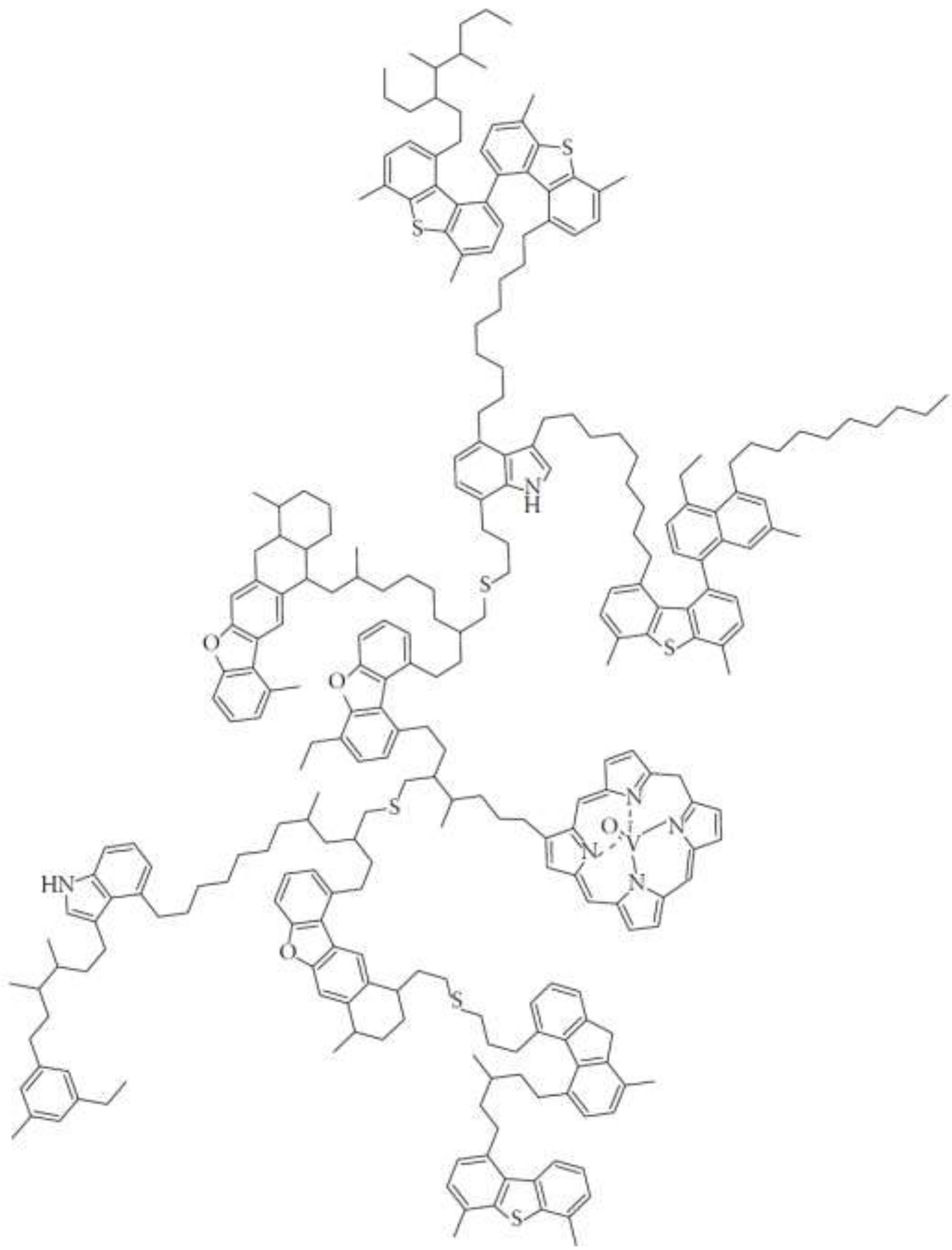


Figure 1.4: This Structure Obtained from Chemical Transformation during Hydro-processing, and an Archipelogo –Type Asphaltene Generated by Monte Carlo Simulation (Sharemata et al, 2004)

1.7 Asphaltenes Petrochemical

A petrochemical is any chemical manufactured from crude oil and natural gas as distinct from fuel and other products (Speight, 2014, 2019a), derived from crude oil and natural gas, and used for a variety of commercial purposes. The definition has been broadened to include the whole range of organic chemicals in many instances; a specific chemical included among the petrochemicals may also be obtained from other sources, such as coal, coke or vegetable products. For example, materials such as coal, benzene and naphthalene can be made from either crude oil or coal, while ethyl alcohol may be of petrochemical or vegetable origin (Speight, 2004). However, in the current content, petrochemicals can be conveniently divided into two groups, primary petrochemicals and intermediates and derivatives.

Primary petrochemicals include;

i. Olefin derivatives: Such as ethylene, propylene and butadiene. Ethylene and propylene are the major part of olefin derivatives. They are the basic source in the preparation of several industrial chemicals and plastic products whereas butadiene is used to prepare synthetic rubber.
ii. Aromatic derivatives: Such as benzene, toluene, and the xylene isomers. They are the major components of aromatic chemicals. These aromatic petrochemicals are used in the manufacturing of secondary products like synthetic detergents, polyurethanes, plastic and synthetic fibres,
iii. Synthetic gas: this comprises of carbon monoxide and hydrogen which are basically used to produce ammonia and methanol which are further used to produce other chemical and synthetic substances.

Petrochemical intermediates and derivatives

Petrochemical intermediates are generally produced by chemical conversion of primary petrochemicals to form more complicated derivative products. Petrochemical derivative product can be made in a variety of ways: directly from primary petrochemicals through intermediate products, which still contain only carbon and hydrogen; and through intermediates that in corporate chlorine, nitrogen or oxygen in the finished derivative in some cases, they are finished products; in others, more steps were needed to arrive at the derived composition (Speight, 2019).

1.8 Upstream, midstream and downstream petrochemicals

Upstream Petrochemicals

The upstream market stage in the petrochemical industry refers to the exploration and production of natural gas and crude oil. It's the first process in the industry and it focuses on finding economically viable sources of petroleum products. Exploration drilling is most often associated with the upstream process of the petrochemical industry. This is when companies drill into the earth to locate underwater and underground sources of natural gas and crude oil. Exploration drilling is performed both onshore and offshore and is usually paired with geological and geophysical surveys to help company's better find viable sources.

Midstream Petrochemicals

Once petroleum products are recovered in the upstream sector, they move into the midstream sector of the petrochemical industry. The midstream sectors focus on the transportation and storage of natural gas and crude oils.

Companies will gather recovered petroleum products and store them until they are ready to be transported. When they can be moved, natural gas and crude oil are normally transported using pipelines, tanker trucks and rail lines to the final market stage of the petrochemical industry.

Downstream Petrochemicals

The final market stage of the petrochemical industry is downstream. Processes for this sector are dedicated to turning natural gas and oil into marketable petroleum products. However, the most important part of the downstream market stage is refining, processing and purifying crude oil and natural gas. When crude oil and natural gas arrives at refineries, they are turned into the petroleum products we use daily such as gasoline, kerosene, diesel oil, lubricants, waxes and liquefied petroleum gas.

1.9 Energy And Economic Impact Of Petrochemicals

Petrochemicals are a large group of chemicals derived from natural gas and petroleum. They are an essential part of the chemical industry as the demand for synthetic materials grows continually and play a major part in today`s economy and society (Speight, 2009)

Petrochemicals are used to manufacture thousands of products that people use daily, including plastics, medicine, cosmetics, furniture, appliances, electronics, solar power panels and wind turbines. Other important petrochemicals include:

i. Ethylene: Used in paper, consumer electronics, detergents, footwear and adhesives.
ii. Propylene: Used in paints, furniture, textiles, pharmaceuticals and food packaging.
iii. Benzene: Creates pharmaceuticals, furniture, electronics, and food packaging.
iv. Toluene: Creates inks and sport equipment.
v. Methanol: Used in thermal insulation and building construction.

For the past 50 or more years, society has been increasingly reliant on the products of the organic chemical industry to supply the cloths we wear, the food we eat, our health, housing transportation, security and other commodities. Approximately 92% of organic chemical products are produced from petroleum that is fossil or mineral, oil and gas.

Petrochemicals are used in a huge range of consumer products such as lubrication of large machines in industries and vehicles, cosmetics, herbicides and fertilizers, synthetic rubber, detergents, plastics etc. As a result; demand for petrochemicals is strongly correlated to global economic activity. Industrial prices are highly cyclical moving from peaks to troughs largely in phase with variations in general business cycle. This is why there is need to diversify many ways of generating chemical base raw materials especially in domestic and industrial applications.

Today, the world`s economy is largely dependent on fossil fuels such as crude oil, and the demand for these resources often sparks political unrest, as results, a small number of countries control the largest reservoirs. Like any industry, supply and demand heavily affect the prices and profitability of crude oil. Therefore, as the demand for light oil cuts increases, HFOs will be blended with a lower fraction of light oils, which, in turn, would increase the percentage of the concentration of asphaltene, and conversely the petrochemical-asphaltenes. Consequently, in compliance with the future economic demand in both light and heavy fuel oils, HFO with higher content of asphaltene is expected to be used in power generation systems.

Due to inflation problems, and a lot of importation of petrochemicals, we require many ways to develop our own petrochemicals from our own crude oil. There is a need to focus on the generation of these raw materials for pharmaceutical, agricultural industrial applications. Thus, this research is designed to study the nature and composition of these heavy fuels generated from our locally available Escravos crude oils. This research work aimed at Identifying the petrochemical base compositions of asphaltenes from Escravos crude oil. With the view to identify possible petrochemical fraction of escravos asphaltene using UV-Vis. In addition, this research evaluates the elemental profile of Escravos Asphaltene- using MP- AES and the volume quantity of the ash using combustion proximate parameters. Additionally, to generate the organic petrochemicals profile in the extracted Asphaltene using XRD and FTIR Instrumentation for functional group profile of the generated escravos asphaltene petrochemicals, including heavy fraction asphaltene generated.

1.10 Scope and limitation

2.0 METHODOLOGY

2.1 Materials

The materials used in carrying out this research work were listed below in table 3.1 and 3.2 indicating the summary of materials, reagents and equipment.

2.2. Sampling And Sample Preparations

The sample collection was carried out near the Escravos River located in Warri South Local Government Area of Delta State. Escravos River, a distributary of the Niger River in the western Niger Delta, southern Nigeria. It is a 35-miles (56 kilometres) westerly course that traverses' zones of mangrove swamps and coasted sand ridges before entering the Bight of Benin of the Gulf area.

2.3. Extraction of Escravos asphaltene

A method consistent with ASTM D 2007-80 was employed and Asphaltene fraction was extracted from the oil sample (Escravos) by addition of an excess of n-heptane in 40:1 (volume: mass) ratio. The mixture was subjected to heating under reflux with gentle shaking to ensure complete dispersion of the material. The precipitated Asphaltene was then removed by vacuum filtration through a 0.45µm pore size membrane. The solid obtained was thoroughly washed with n-heptane in an extractor in order to remove the co-precipitated maltenes until the washing solvent is colorless. The solid obtained was dissolve in toluene and the solution was filtered. The supernatant evaporated and the asphaltene was finally obtained.

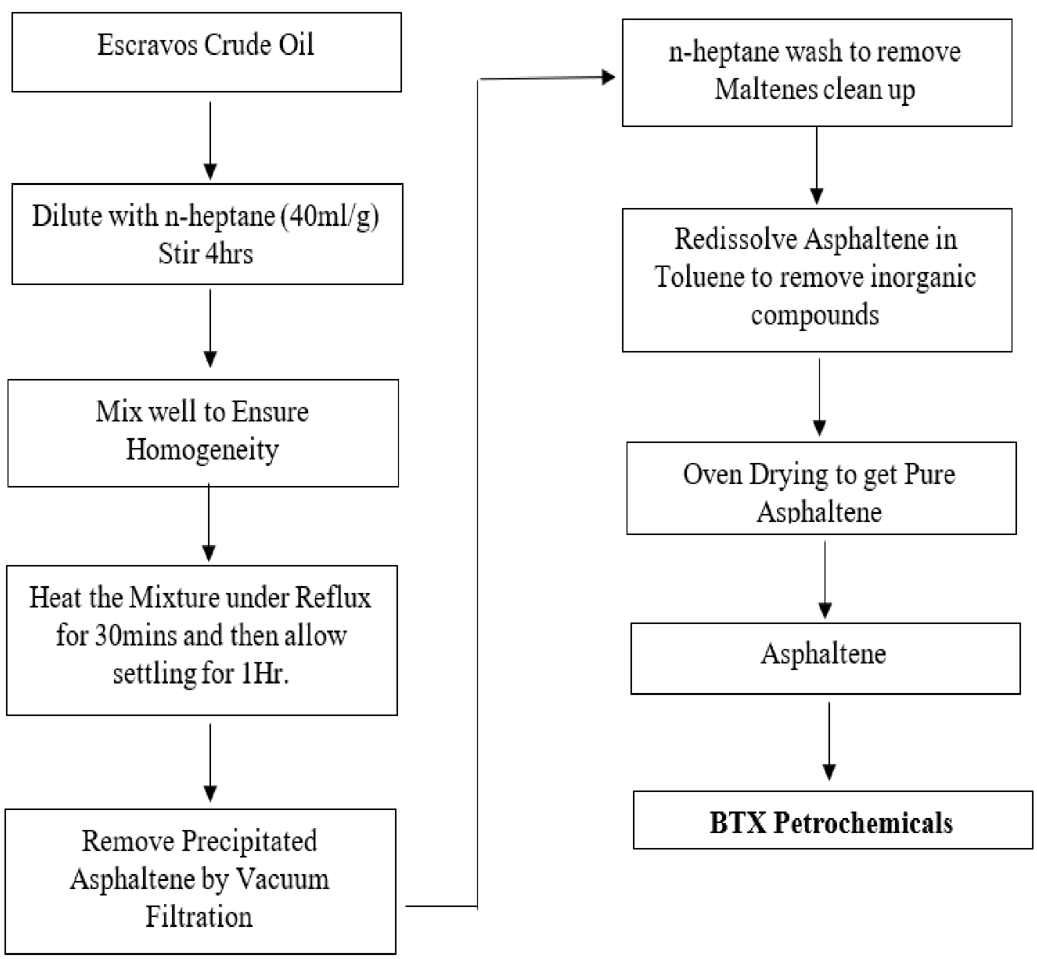


Figure: 2.1: Flow chart Diagram of Asphaltene Extraction (*Atiku, 2015)*

2.3. Combustion Characteristics Investigations

The Proximate analysis indicates the percentage by weight of the fixed carbon, volatile matter, ash and moisture content of the Asphaltene contents. The contents of the moisture in Asphaltene must be exclusively handled, and then store the Asphaltene for use according USPA 1996. Since the water content in the Escravos Asphaltene replaces combustible matter, then this decreases the heat content per kg of the fuel asphaltene. However, the moisture content is investigated according to method consistent with ASTM D2709., and then follows these steps (1) 50 cm3 of both sample and toluene is weighed, (2) mixed in a centrifuge tube (100cm3), followed by centrifuging to allow even distribution of the sample mixtures. (3) The tube is then place in a turning on cup inside an oil test centrifuge such that the tube and sample will be placed and timed for 30 minutes. (4) The setup is subjected to establish a balance position and whirled for agitated speed of 1800rpm after closing the centrifuging machine, this enables homogeneity. (5) Finally, the moisture at the bottom of the tube will be recorded. The typical range is 0.5 to 10%. The loss in weight of the sample is found out and the % of moisture is calculated as:

$$\%\ of\ moisture\ of\ Asphaltene = \frac{loss\ in\ weight\ of\ the\ Asphaltene}{Weight\ of\ air{-}dried\ Asphaltene} \times 100 \ \ldots\ldots (1)$$

2.3.1 Ash Content of Escravos Asphaltene

Ash is an impurity that will not burn(Chen, 1969). The crucible with the residual Asphaltene sample will be heated without lid as 700 ±50ºC for ½ an hour in a muffle furnace. The sample will continue to burn until all carbonaceous materials has disappeared. The loss in weight of the sample will be found out and the % of the ash content will be calculated as:

$$\%\ of\ ash\ content\ in\ Asphaltene = \frac{weight\ of\ ash\ formed}{weight\ of\ air{-}dried\ asphaltene} \times 100 \ldots.(2)$$

2.3.2 Volatile Organic Matter Of Escravos Asphaltenes

The Volatile matters such as methane, hydrocarbons, hydrogen and carbon monoxide and incombustible gases like carbon dioxide and nitrogen found are normally found in Asphaltene (Field M.A., 1967). Thus, the volatile matter is an index of the gaseous fuels present. Typical range of volatile matter is 20 to 35%' the loss in weight of the sample is found out and the % of the volatile matter is calculated as

$$\%\ of\ volatile\ matter\ in\ Asphaltene = \frac{loss\ in\ weight\ of\ the\ Asphaltene}{Weight\ of\ air{-}dried\ Asphaltene} \times 100 \ldots\ldots(3)$$

2.3.3: Escravos Asphaltene Fixed Carbon Content (EAFCC)

The fixed carbon is the solid fuel left in the furnace after volatile matter is distilled off. And it consists mostly of carbon but also contains some hydrogen, oxygen, Sulphur and nitrogen not driven off with the gases. Fixed carbon gives a rough estimate value of Asphaltene.

2.4. Characterization

The Fourier Transform Infrared (FTIR) spectroscopy was used in this research and it provides information on the basis of chemical composition and physical state for the Escravos Asphaltene sample (Cocchi *et al.*, 2004). In this method, the sample was placed in FTIR spectrometer in which the beam of IR from spectrometer will be direct at the sample and measures how much of the beam the infrared light absorbs by sample. The reference database houses thousands of spectra, was then use to identified the molecular identities of the sample.

The Microwave Plasma Atomic Emission Spectroscopy (MP-AES) was used to identify the content, gravity and density of the samples.

Ultraviolet visible (UV-VIS) spectroscopy was used to exploits light in the ultraviolet region, visible and near infra-red range of electromagnetic spectrum has been an important parameter in asphaltene samples investigation quantitatively and qualitatively. Beer Lambert law establishes a linear relationship between absorbance, concentration of absorbers in the solution and the path length. Therefore, UV-VIS spectroscopy can be employed for determining the concentration of the absorbing species, for a fixed path length (l). This is very simple, versatile, fast, accurate and cost-effective technique. Instrument employed for UV-VIS spectroscopy is called UV-VIS-NIR spectrophotometer. Consequently, predetermined wavelengths in these regions have been defined as; UV:300nm – 400nm; VIS: 400-765nm and NIR:765-3200nm.

3.0 RESULTS

The results and discussion of this research is presented below in tables and figures as generated for physical combustion and other characterization by UV-VIS, XRD-EDX, FTIR, and, MPAES Instrumentations

Table 3.1 demonstrated the results of both Crude Escravos and the generated Escravos Asphaltene for Physical Combustion Examination of Carbon content, Moisture Content, Ash, and Volatile organic matter, including Fixed Carbon

	SAMPLES	
Parameter	**Crude Escravos**	**Escravos Asphaltene**
Moisture Content	1.8 ±10	2.5±1.32
Ash Content	1.16±0.5	13.8±0.29
Volatile organic matter	41.24±10	36.0±0.05
Fixed Carbon	47.7±10	55.8±10

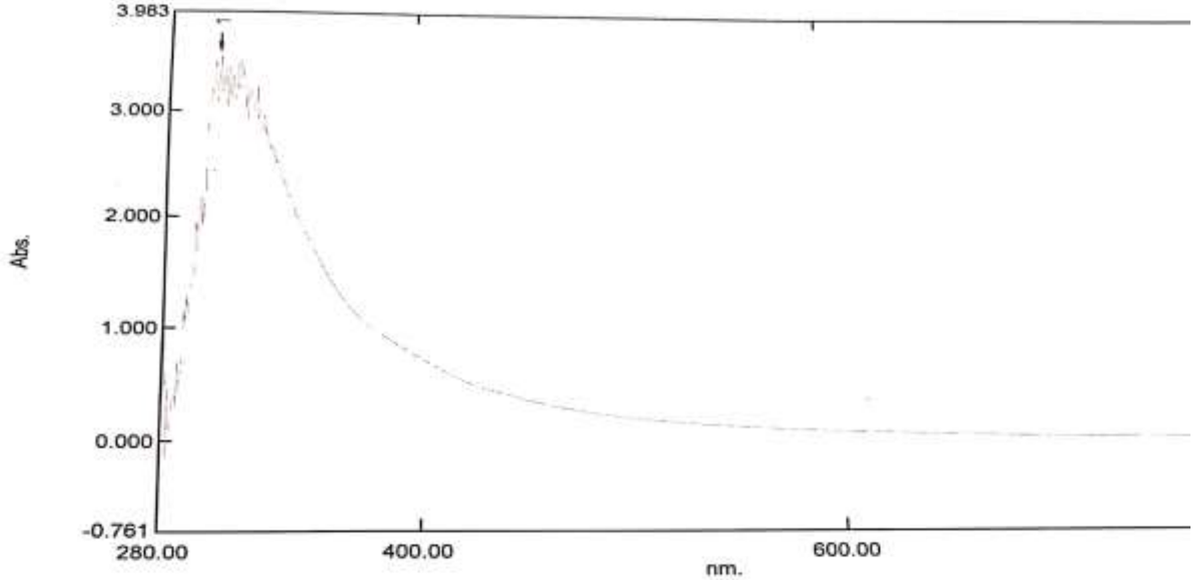


Figure: 3.1. Shows representation of UV-VIS Spectrum peak pick report for Escravos Crude Oil

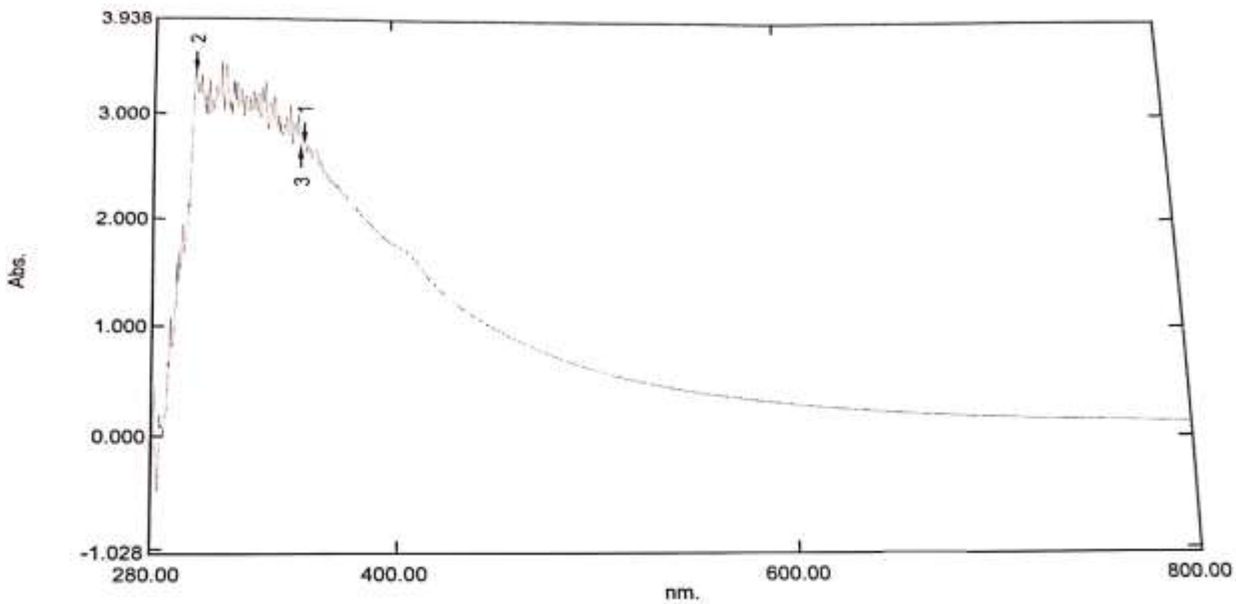


Figure: 3.2. Shows representation of UV-VIS Spectrum peak pick report for Escravos Asphaltene

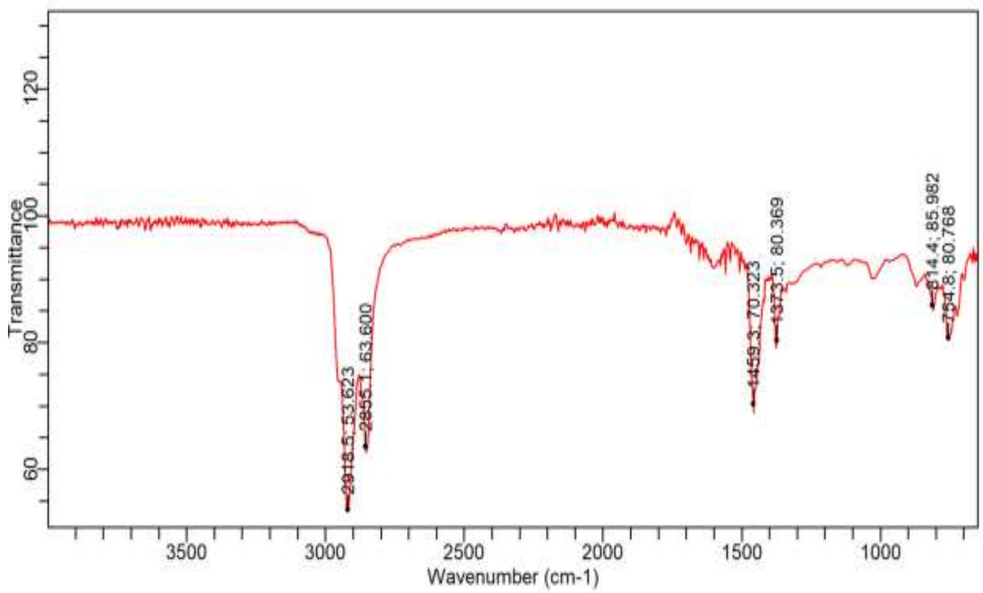


Figure: 3.3. Shows representation of FTIR Spectra peak pick identification report for Escravos Asphaltene

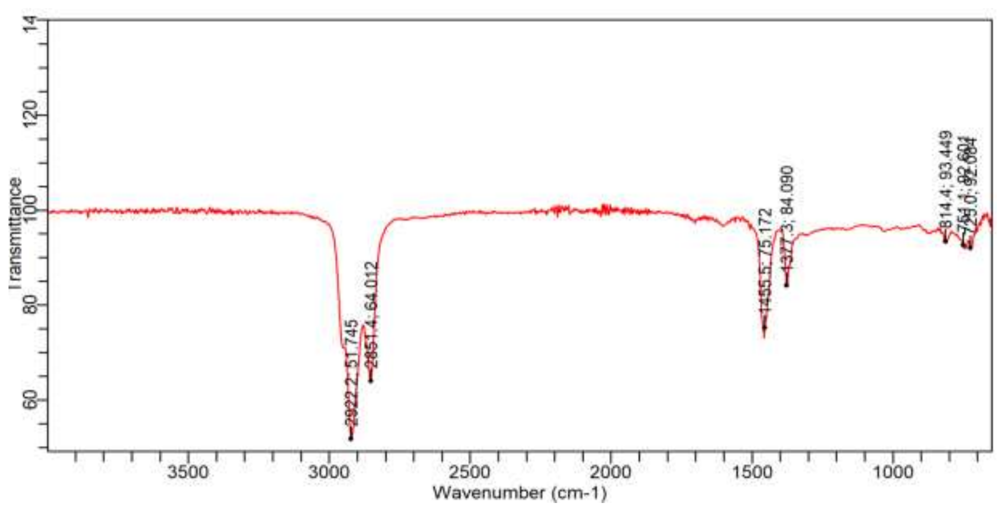
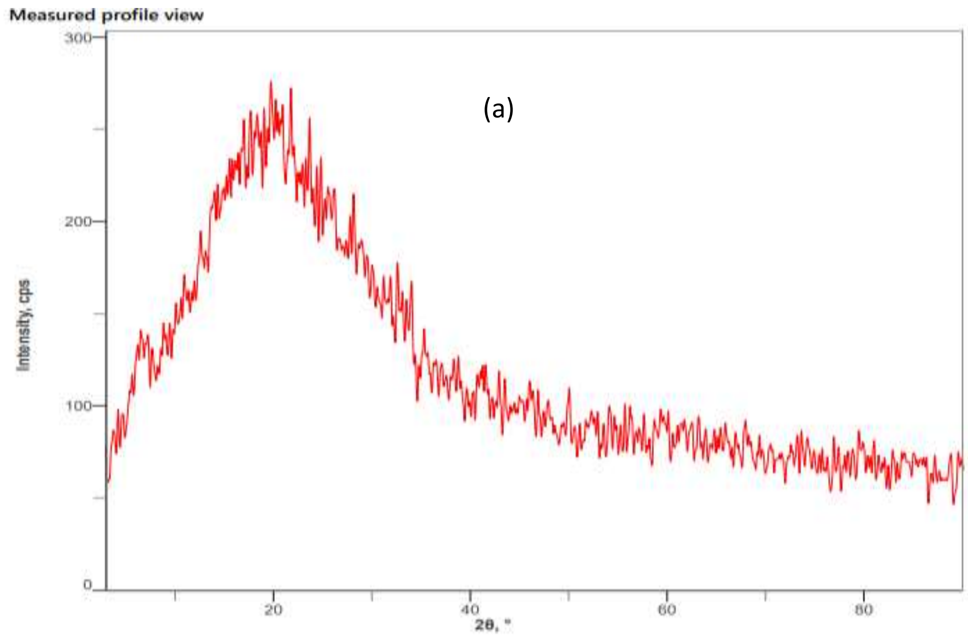


Figure: 3.4. Shows representation of FTIR Spectra peak pick identification report for Escravos Crude Oil



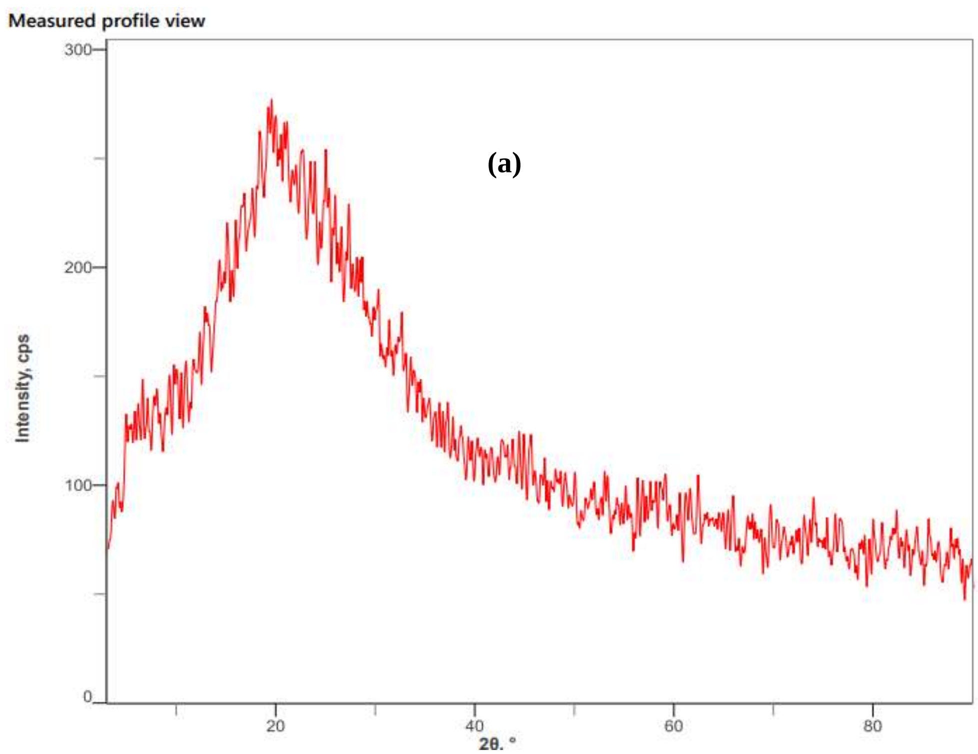
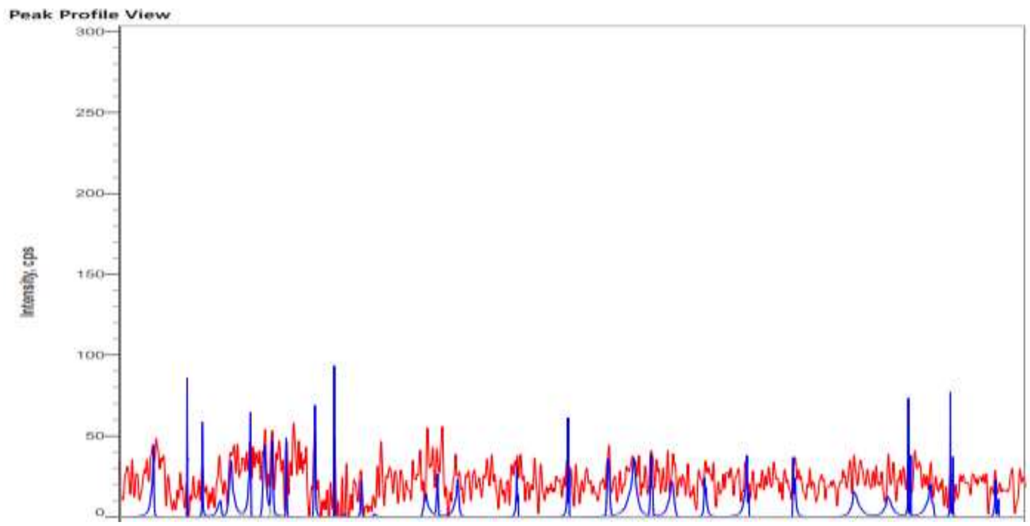


Figure 3.5 (A and B) Shows the XRD Pattern of hydrocarbon Volume Concentration for the Escravos Crude Oil



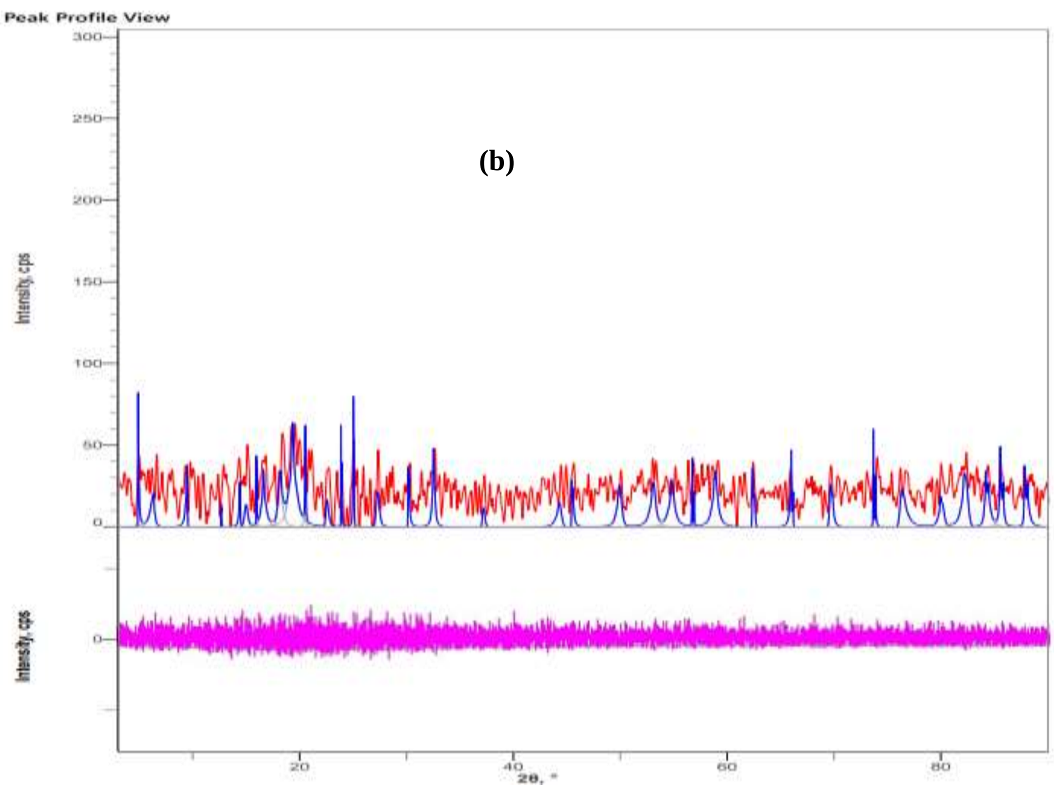


Figure 3.6 (A&B) Shows the XRD Pattern of Hydrocarbon Volume Concentration for the Escravous Asphaltene

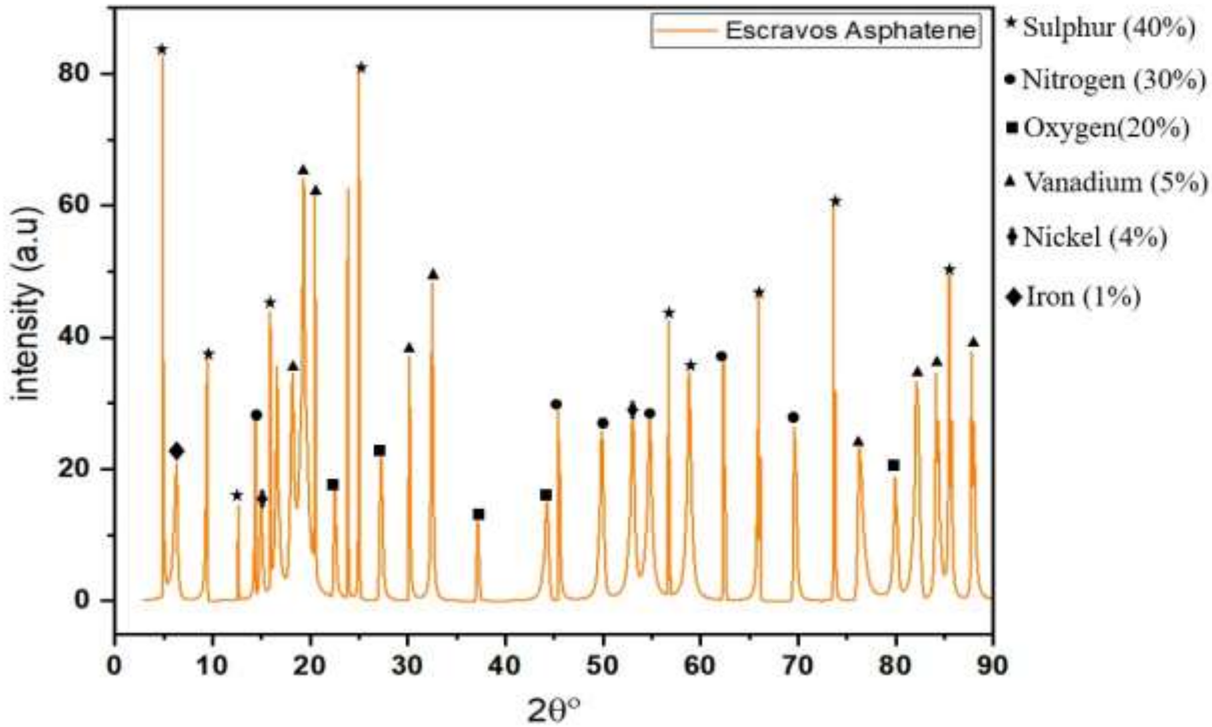


Figure 3.7 Reveal the key Linking Elemental Group Concentration in Percentage for Escravous Asphaltene, Using XRD instrumentation software.

Table: 3.2 Shows the results of Escravos Asphaltene Heavy Metal Composition generated using MPAES Instrumentation

S/N	Heavy metal	Conc. (ppm)	SD
1	Zn	0.24	±0.03
2	Cd	0.07	±0.02
3	Cu	0.22	± 0.03
4	Pb	0.01	± 0.01
5	Fe	0.54	± 0.01
6	As	4.3	± 0.55
7	Ca	4.04	± 0.20
8	Si	0.13	± 0.01
9	Mn	0.13	± 0.02
10	Cr	0.01	± 0.01
11	V	0.58	± 0.02

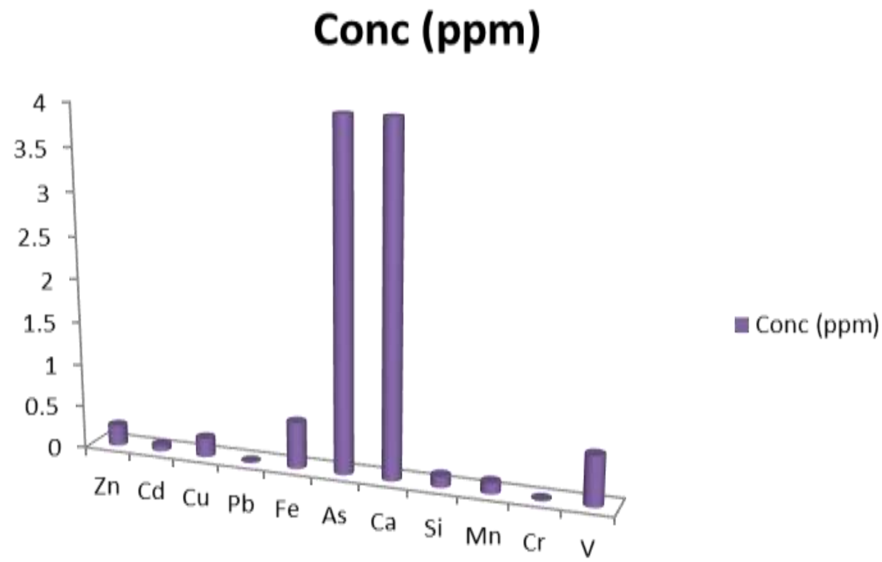


Figure: 3.8 Demonstrates the results of Escravos Asphaltene Heavy Metal Composition

DISCUSSION

In Table 3.1 it can be deduced that, the fixed carbon contents in higher with 55.8% when compared to the main escravos crude oil, this is an indication that, there is strong C-C aromatic bond leading to larger accumulation of heavy structures particularly, asphaltenes. As the ash content reported, the present of 13.8% ash content indicated that there is presence of high inorganic moieties such as vanadium, including nitrogen and some other divalent element that are responsible for strong linking group formation of the heavy fuel escravous asphaltene; due to the accumulation, this analysis also presented lower volatile composition of up to 36% than the escravous crude oil, some in volatile contents only some alkenes and most of oxygenates and oxyhalogens are present with some lower volume of OPAH. However, moisture content MC remarkably higher due to absorption by the concentrated escravous asphaltene.

Figure: 3.1. Shows representation of UV-VIS Spectrum peak pick report for Escravos Crude oil

Figure 3.2 Describe the observance spectral for number of concentrations of asphaltene with wave length from 280nm to 800nm in the raw petroleum crude oil it can be reduce from the result of the measurement properties generated from 280nm up to 480nm to 500nm when it started normalizing as asphaltene concentration in toluene. This is consistent with the explored result by Atiku *et al* who presented absorbance spectral for various concentration (mg/ml) of asphaltene with wavelength ranging from 200nm – 500nm. (shan shan *et al* 2013) this shows that the extraction can be flexible as there is approximate volume to be detected during the separation processes. We can see this instrumentation is the only technique recently that allows characterization of crude oil and its related heavy fraction oil such as asphaltene in petroleum engineering, through dilution in solvent. And this shows no significant variation and that indicate stability of the crude oil and the escravous asphaltene. EE banda-cruz 2021 presented that, in their findings, the maximum derivative of compound observed during their investigation on the spectrum shows different types of compounds in crude oil at approximately 230nm: for benzene compounds, 259nm for naphthalene for pure phenanthrene, 328nm for aromatic chromophores with 3-4 aromatic rings and 401nm for the sort electrical absorbance of vanadyl porphyrins predicted. Though, there is still presence of straight chain hydrocarbons and other non-hydrocarbon materials including the oxygenated components materials

Figure: 3.2 From the UV-VIS 1800 series, this figure describes the absorbance spectral for number of concentrations of escravous asphaltene with wave lengths from 280.00-800. It can be deduced from the result that of the measurements properties generated from 280 up to 392.

The generated asphaltene shows a wide range of accumulated heavy fraction of the decomposition products of the heavy fuel asphaltene particularly the lager aromatic fragmentation ranging from 280 up to 380nm and conservatively at 400nm and 600nm. Additionally, these fragmentations are basically benzene compound at 280, naphthalene and their derivative including pure phenanthrene compound and most importantly the higher heavy fuel fraction leading to petrochemical the 3-4 membered range and largest porphyrins. All there are the fundamental basic fraction of potential petrochemical product such as PCBs, PCDDs dioxins derivative therefore, in this research it can be deduced that the escravos asphaltene has the potentials to generate many petrochemical products and their derivative. This has been reported by (Igor *et al* 2017, and banda cruz *et al* 2020).

Figure 3.3 The FTIR spectrum of E-asphaltene reveled properties in the range of 650-4000cm^{-1}nm demonstrated by figure above. It can be deduced that, absorbance peak at 754cm^{-1}is original C-H wagging vibration. Additionally, absorption peak observed APO at 29188cm^{-1} is presume to be –CH_3 consistent with the asymmetric stretching vibration while the APO at 1459 and 2855 are attributes related to –CH_2-symmetric bending –CH_2- symmetric stretching respectively. The FTIR, characterization reveled the structure and functional group general fragments generated is evidently demonstrated the lower molecular polymers that have been the representation of the higher molecular heavy fraction of the escravos asphaltene, basically. The resultant decomposition of large fraction leading to decomposition products fragmentation of asphaltene or monomers of polymers have been demonstrated in escravos sample as potential products. Figure: 3.4. Shows representation of FTIR Spectra peak pick report for Escravos Crude Oil. The Escravos shows a similar systematic pattern and in the Escravos asphaltene region, however the peak less than 1000cm^{-1} presented highly oxygenated fragmentation with less intensities compare to the Escravos asphaltene.

The structural fragmentation of the volatile composition at lower wave length less than 1000nm. The moieties where so condense compare with the resultant spectral generated from Escravos asphaltene. This would be due to condensation of the molecular fragment in asphaltene and the other inorganic composition. **Figure 3.5(a and b)** The representation in (a) than high volume of Hydrocarbon materials, this view showed both combination of HCs potential, the compounds containing paraffinic, naphthenic, and aromatic hydrocarbons with traces of impurities including very lower sulpur bond and some higher sulphur related elemental composition as metals. Additionally, the presence of these impurities demonstrates the capabilities of petrochemical materials such as benzene and tolurene as the initial decomposition product in them since in the above view was obtained using N-Heptene that mean its concatratesall the aromaties petrochemical drivers in the crude oil. Figure 3.6 (a and b) shows the peak profile view and a similar systematic pattern and in the escravous asphaltene, however the peak less than 100cm^{-1} presented highly oxygenated fragmentation with less intensive compare to the escravous asphaltene.

The structural fragmentation of the volatile composition at lower wave length less than 1000nm. The moieties where so condense compare with the resultant spectral generated from escravous asphaltene. This would be due to conduction of the molecular fragment in asphaltene and the other inorganic composition. Figure: 4.5. Indicates the representation results from XRD Analyses report for Escravos Crude Oil (a) Measure view and (b) Profile view which produced some important relevant peaks resulting into high concentration of poly aromatic products. Over to bivalency of these elements such as vanadium, the potential possibility of the linking group formation in and aggregation of the individual lower molecular is adhere by the linking group of such element leading to large hydrocarbon. **Figure: 4.6.**

Indicates the representation results from XRD Analyses report for Escravos Asphaltene (a) Measure view and (b) Profile view

It can be seen that from the results range of asphaltene fly ash between 10-30 2θ is observed. Hence the content of the fly ash can be related to glass as in the amorphous phase and can also have non crystalline materials leading to noncombustible materials such as thermoplastic related to petrochemicals. Additionally, the carbon firm tend to be more concentrated the coarse fractions. However, the shape of the peaks tends to be irregular, angular, and tubular. (ICCS 1997 PP1203-1206)

Figure 3.7. Demonstrate the XRD Elemental Peak Identification.

The results analyses showed that, six elements were able to be generated from the analysis software. Although there is low sulphur contents revealed base on the literature here in the crude oil, no doughty it is expected as the escravous asphaltene contains up to 40% sulphur. This is due to the fact that, one of the major linking group of asphaltene, is sulphur and vanadium in some cases while rarely Nikel is demonstrated. Therefore, all the sulphur containing materials were moved to the asphaltene. So, despite this composition escravous asphaltenes is still moderately clean interm of their burning properties compares to the other asphaltenes fractions such as Venuazuala and Saudi Arabian asphaltene.

The result analysis demonstrated that, six elements were generated from the analysis software. Although there is low sulphur content in the crude oil, no doubt it is expected the escravous asphaltene sometimes above 400% sulphur this is due to the fact that one of the major linking group of asphaltene is sulphur and vanadium in some cases. Therefore, all the sulphur containing materials were move to the asphaltene due to its divalent nature in the bondle structure.

So, despite this composition escravous asphaltene is still moderately clean in term of burning properties compare to the other asphaltene such venizeola asphaltene.

From Table 3.2, When the Escravos Asphaltene heats up during combustion, the cell-wall components start to decomposes (pyrolytic products) and or devolatilisation) thus, generates a mixture of gases, vapors, tars and residual solids- the chars and main Asphaltene fuel heavy fractions. The rate of decomposition of the petrochemicals in the Escravos Asphaltene is measured by thermal analysis. The char contents and petrochemical products depends on the O-contents (inversely) and aromaticity (directly) –thus, the high heavy fraction Escravos yield petrochemical materials decomposition products. Additionally, these results into lower molecular poly aromatic hydrocarbons such as BTX based chemicals and other oxygenates, and this implies that, Escravos Asphaltene will have cool nature in terms of its luminosity burning properties.

Again, the volatile proportion of Escravos Asphaltene yield indicates its ease of ignition and the rate of burning. Additionally, a lower low volatile content and high fixed carbon, but for the Escravos Asphaltene moisture content, there is quite appreciable moisture content and its decreasing as the surface area of the of the evaporation and desorption increases. This content, is significantly important since energy must be generated to evaporate the water during combustion and this why the Escravos Asphaltene must be stored under substantial cover so as to reach lower moisture contents under natural evaporation, and also to prevent sides reactions occurrences, as heavy fuel fractions particularly the Asphaltene due its high polynuclie-aromatic hydrocarbons contents such as PAH, O-PAHs PCDs EDCs, Dioxins, PCDDs and Polychlorinated biphenyl. This chemical compounds are highly reactive with ambient air current, and Nitrogen. The contents can only be increase during the thermal conversion processes Asphaltene to decomposition products chemical based petrochemicals. There is much more substantial similitude of the structure of Escravos Asphaltene to that of biomass lignin as the E-Asphaltene content is limited to some certain inorganic heavy metals and even sulphur but with appreciable silicon contents. Traces metals also showed some resemblance such as high calcium content, and iron. Most heavy fuel fractions emanating from coal and petroleum have high ashes contents compares to fuel resources such as biomass. The former, ash is very different chemically from Coal and Petroleum ashes, i.e. they are not aluminous-silicate system, but a mixture of inorganic compounds of Si, K, Ca, P, V, and S etc.

Notably, from Escravos Asphaltene, it has been observed that, there exist appreciable quantity of Silicon and other related heavy metals as detected by MPAES. These composites usually play a significant role as these ashes content can be greater than 15% even in biomass like rape straw and particularly in Grasses you can get up to 18% silicon content with other elements. This silicon content has advantage of not causing lower melting point of ashes composition as this component can resist up to greater than 1200 ^{o}C – 14500 ^{o}C melting temperature.

As a results Escravos Asphaltene does not form much slag and agglomerates during combustion in a fluidized bed, usually, the solution to lower melting point ashes can be improved by the use of additives which rise the melting temperature or use the alternative fluid bed combustors or co-firing i.e. by blending with the fuel who have silicon and other related high melting temperature inorganic materials such as sulphur and iron which can escape through flue gasses the air current or in form of aerosols. However, the petroleum chemistry of Arsenic contents in both natural gas and liquid hydrocarbon is to be taken into consideration by the oil industries. In addition to the health risks due to its toxicity as well as environmental problems, Arsenic is responsible for irreversible poisoning of catalyst and clogging of pipes via accumulation of As –containing precipitates.

CONCLUSION

Asphaltene are heavy fuel compounds with many domestic and industrial applications. Generally, this fraction is obtained from heavy fuel oil HFO or Petroleum. The asphaltene fractions can be use directly as fuel in boilers and furnaces, and for power and marine engines applications. Additionally, clean chemicals from these fractions will make a great impact on petrochemical domain, such as benzene, toluene and xylene. In this research some of the results finding are as follows

The generated asphaltene shows a wide range of accumulated heavy fraction of the decomposition products of the heavy fuel asphaltene particularly the lager aromatic fragmentation ranging from 280 up to 380nm and conservatively at 400nm and 600nm. Additionally, these fragmentations are basically benzene compound at 280, naphthalene and their derivative including pure phenanthrene compound and most importantly the higher heavy fuel fraction leading to petrochemical the 3-4 membered range and largest porphyrins. All there are the fundamental basic fraction of potential petrochemical product such as PCBs, PCDDs dioxins derivative therefore, in this research it can be deduced that the escravous asphaltene has the potentials to generate many petrochemical products and their derivative.

This Research revealed that, UV-Vis (230nm, 259nm, 295nm, and 238nm etc.), FTIR and XRD instrumentations demonstrated potentials for this examination. The results designate that, several Petrochemicals derivatives (UV-Vis Specs) of the Escravous Asphaltene composition are generated. Further identification of the functional group proves the composition of the material such as the FTIR spectrum of E-asphaltene reveled properties in the range of 650-4000cm^{-1}nm demonstrated by figure above. It can be deduced that, absorbance peak at 754cm^{-1}is original C-H wagging vibration. Additionally, absorption peak observed APO at 29188cm^{-1} is presume to be $–CH_3$ consistent with the asymmetric stretching vibration while the APO at 1459 and 2855 are attributes related to $–CH_2$- symmetric bending – CH_2- symmetric stretching respectively.

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