Determination and Characterization of Crude Oil Properties produced from some selected Oil Fields in Olomoro Community

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ABSTRACT

The research work entails the physio-chemical determination of properties of crude oil produced from ZY- oil fields, in Olomoro community of Delta state. Sample of the crude oil collected from the field was analyzed in the laboratory for the physical and chemical properties such as; Boiling point, ignition point, API gravity (Specific gravity), sulphur content, Nitrogen content, salt content, water content etc. The sample of the crude oil analyzed was found to contain the impurities such as salt, water and some metals (Ni, Va, Fe). Experimental procedures were carried out on the crude oil sample. Comparison was made with the standard method of ASTM-TP. From the result it became obvious that the crude oil is of the medium type. It is asphalt base crude of low viscosity, naphthenic, low sulfur, high nitrogen, low salt content. Effects of the properties of the crude oil determined on the processing methods were looked into and solutions preferred. Refiners are advised to watch carefully for the properties of crude oil for effective processing and the enhancement on the economic and market value of the sample crude.
Keywords: API gravity, Specific gravity, Boiling Point, Sulphur Content, Low Viscosity, ignition point and market value

INTRODUCTION

Crude oil, also known as petroleum is a dark viscous fluid containing complex mixtures of organic compound and primary hydrocarbon. The hydrocarbons are compounds of carbon and hydrogen obtained below the subsurface and from underground rock formation ringing in age from ten to several hundred million years (Adebayo 1999). It is an oily flammable liquid varying in colour from colourless to black. It exists within the void space

of some specific formations. Crude oil is seen in liquid state which can be distilled and refined to make fuels and many valuable products. Petroleum is considered a non-renewable resource, unlike trees that can easily be replaces through planting. It is formed slowly by natural process deep in the subsurface rocks (Ayodele 2003). Crude oil has these characteristic: oily texture, heavy odour (fumes), varying viscosities; varying colour such as yellow to dark brown may sometimes appear black. The analysis in the laboratory revealed the quality of the fractions of crude oil on the physical and chemical properties, among these are: flash point, viscosity, nitrogen content, sulphur content, specific gravity, carbon and hydrogen with natural gas. Crude oil as it is known to be the main primary fuel that occurs naturally, separated or transformed into its various fractions or cut in the refinery. Crude oil differs widely in composition and hence in physical properties e.g. viscosity.

The table below depicts the elemental composition of crude oil by weight percentage.

Table 1: Elemental Composition of Crude Oil by Weight%

ELEMENT	MINIMUM (%)	MAXIMUM (%)
Carbon	82.2	87.1
Hydrogen	11.8	14.7
Sulphur	0.1	5.5
Oxygen	0.1	4.5
Nitrogen	0.1	1.5
Others	Trance	0.1

(Levorsen, 1967).

Comparing this with the analysis of the composition from all parts of the world is generally in these percentages.

Table 2

ELEMENT	PERCENTAGE RANGE COMPOSITION
Carbon	83 – 87
Hydrogen	11 – 15
Nitrogen	2.2
Sulphur	0.1 – 7
Oxygen	0 – 1.5

RESEARCH METHODOLOGY

The sample used for this research work was collected in the study area about the end of raining season (October 2016). The sample was obtained from that ready for (export) and refining. The natural gas and water in the crude oil had been separated at the flow station. The sample was stored inside rubber gallon before the detailed analysis, this to prevent evaporation of the dissolved gasses and further reaction with the environment.

RESULT

The result for the analysis is as shown in table 4.6, while a comparison is made with the standard crude oil general test and analysis, from Nile Blend crude in Sudan. This is shown in table 4.7

Table 3: Crude Oil Sample from the Study Area

TEST	RESULT	UNIT
Sanple gravity at 15°C	0.9052	
API gravity	25	Degree
Kinematic Viscosity at 26%	10.08/1 x 10^{-5}	Cst/m^2/s
Dynamic viscosity at 26%	9.12/9.12 x 10^{-3}	Cp/Ns/m^2
Boiling point	221.6	^{o}C
Flash point	46.6	^{o}C
Ignition point	293	^{o}C
Refractive index at 26 ^{o}C	1.498	-
Watson characterization	10.63	-
Ash content	98.67	%W
Water Content	0.125	%Vol
Nitrogen Content	1.01	%Wt
Sulphur	0.397	%mol
Salt content	0.24/2.147 x13^{-3}	%Wt/g/cm^3

Table 4: The standard crude oil general test for nile blend crude

TEST	STANDARD METHOD	UNIT	RESULT
Density at 15°C	ASTMD 4051	Kglmc	0.8610
API Gravity	IP table 51	Degree	32.76
Water content	ASTMD 4006	Vol	0.10
Flash point	IP 170	^{o}C	35
Kinematic viscosity at 40°C	ASTMD 445	M^2/s	4.12 x 10^{-5}
Sulphur content	ASTMD 4294	%mol	0.45
Nitrogen content	ASTMD 4629	%wt	0.075
Salt content	IP 265	Mg/I	5002

Ash content	ASTMD 482	%wt	82.82
Characterization factor	UOP 375 – 59	-	120
Dynamic viscosity 40 °C	ASTMD 445	NS/m^3	4.8 x 10^{-3}
Refractive index at 26 °C	ASTMD 1218 – 92	-	1.445

DISCUSSION

The specific gravity value has an average of 0.9062, a value which falls within the standard value and is less dense that water of S.G 1.000. The API gravity has the value ranging from 23.9° to 25.9° API with an average value of 24.9° API. This value falls within the recommended value of medium crude oil with API gravity value between 22.3° and 31.1° API (Wikipedia, 2007). The crude oil sample collected is of economic value based on the API standard. It is therefore acceptable globally. Kinematic viscosity which crude is 10.008 centistokes or 1.007 x 10^{-5} m^2/s indicates that the crude oil has a low viscosity which will allow free flow of the crude oil. The flash point range 45°C to 48°C with a mean value of 46.7°C and ignition point of 293°C, shows that the crude has high ignition point. Ignition point and flash point are used as safety devices in crude oil processing. The refractive index ranges from 1.490 to 1.505 which has an average value of 1.498. This indicates that the refractive index value is in correlation with the API gravity and since refractive index also depends on the density of the oil. The denser the oil, the less the API gravity and lower the refractive index, the more the petroleum fraction in the refinery operation. Watson characterization factor (kw) is 10.64 from the result which indicates that the crude oil is highly naphthenic i.e. contains aromatic and that the crude oil is of the asphalt base type (Bituminous matter). This type of crude is similar to that found in Canada, Venezuela and Brazil. The crude oil is suitable for making high quality gasoline, and asphalt. Ash content ranges from 97% to 98.66% with an average value of 98.65%.

Knowing fully that ash content is used to determine the content of asphalt and the qualities of lubrication fraction of the crude. With this content, the crude oil is affirmed to be of the asphaltic – based type. The water content is between 0.11 and 0.14% by volume. The values are low compared to the standard needed before processing of crude oil. The average value of

0.13% by volume obtained is still very low compared to standard value of 0.2% by volume before processing. Due to the fact that presence of water in crude oil can sharply affect the plant productivity and cause excessive loss of power for evaporation, and condensation of water. The nitrogen content value ranges from 0.98% to 1.04% by weight with a mean value of 0.02% by weight of nitrogen. Although this value does not have effect on distillation of the crude oil during processing but it serves as a poison to catalyst used in catalytic cracking of the crude oil and causes corrosion of pipe problems such as hydrogen blistering. Any crude oil which has above 0.25% by weight of nitrogen is not desirable and must be treated before the crude oil is processed. Sulphur content of the crude oil from the result amount to 0.37% by mole. This value falls between 0.1 – 2% by mole of sulphur for medium sulphur oil by shell standard from their analysis (shell publication 1999). Therefore the crude oil has very low sulphur content and there may be no need for desulphurization before processing of the crude oil.

Levorsen (1967), the minimum sulphur content to be 0.1% by mole.

Nitrogen crude oil from Escravos is about 0.16% by mole of sulphur. These are very low content of sulphur and Bonny is about 0.14% by mole, Obigbo north is about 0.28% by mole of sulphur. These are very low content of sulphur and there may not be need for desulphurization. Salt content has the value of 0.24% be weight / 2.147 x 10^{-3} glcm^3 or 0.75 lb/bbl. This shows that the crude oil contains excess dissolved salt and there would be needed for desalting to meet up with standard of not more than 2mg/l before refining. Excess salt in the crude can cause corrosion, blocking pipes of furnaces and heat exchanges. The asphaltic type (bituminous matter) found in Olomoro, Delta state is similar to the type found in Canada, Venezuela and Brazil. On distillation it leaves less residue content and produces much lighter fractions of gasoline and distillate fuels. Distillation is meant to improve purity of crude oil to obtain fuels and petrochemicals. The effect is felt on heavy fractions of the crude oil on distillation still require further treatment like rectification in order to enhance the separation effectively.

CONCLUSION

Concluding this research work, it is clear that the crude oil sample collected is of medium – grade type with the physical and chemical properties determined shown in the tables. The result obtained confirmed it is a medium type crude.

RECOMMENDATION

From the findings of this research work and analysis, knowing fully well that the various properties of crude oil is determined has various effects on the crude oil processing and the surrounding environment, like the ignition point, nitrogen content, salt content, water content. It also has effect on the economic and market value of the crude oil products. With these trends, recommendations were therefore preferred. With the basic fact that too much salt in crude, in excess of 2mg/litre of salt, leads to corrosion, blocking of pipes of furnaces and heat exchangers. There should be de-emulsifying agent which must be carried out at the earliest stage of the crude oil processing to avert this effect. High ignition will burn prematurely which leads to knocking and may ever result into explosion, this must be averted by the introduction of anti-knock agent known as Ether-Ethyl Lead ($Pb(C_2H_5)_4$). High sulphur content which also cause corrosion in the tailpipe of the exhaust system due to formation of sulphurous/ sulphuric acid and condensation of mixtures need to be desulphurized to eliminate this effect. Water in oil is undesirable in crude oil which could cause knocking engines and flame failure at each outlet of an oil burner by interrupting oil supply or quenching flame by sudden evolution of a mass stream. There is need for removal of this water by either mechanical, chemical, thermo-chemical or electrical methods. The Nigerian Government which is the major stakeholder must be conscious of the revenue that is derived from crude oil products, and work towards improving the quality of the crude oil to meet up with the required standard globally. Refineries must ensure that crude oil meets up with the standard in its properties before processing it into its usable fractions.

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