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Full Length Research Article

MEASUREMENTS OF POUR POINTS, FLASH POINTS, WATER CONTENTS AND VISCOSITY OF SOME SELECTED AUTOMOBILE OILS USED AS LUBRICANTS IN NIGERIA

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ABSTRACT
The aims of this paper is to determine the viscosity of the automobile lubricating oils at 0^0 C to 100^0C, and some of the lubricant's specifications(flash point and pour point) obtained with a rapid evaluation device and the standardized method using DV-E viscometer. The study material comprised 5 fresh engine oils, all of which are commercially available. ASTM D5949 was the method implored for determining the pour point of the samples. It was found that all the multi-grades oil coincide at 100^0C, which is approximately engine operating temperature. That is they have almost the same viscosity at 100^0C (43.2cst and 51.2cst (centistokes)). However, some are desirable than others. Therefore, one has to be careful when choosing these oils. The study fills an important gap in empirical research in the context of the reliability of measurement results using various research techniques.

Keywords— Viscosity, Temperature, pour point, flash point, DV-E viscometer.

INTRODUCTION

Viscosity is the property of all fluids which distinguishes them from ideal (non-viscous) fluids. The viscosity of a fluid is a measure of its resistance to flow and therefore, the knowledge on the pattern of their flow and the forces causing these flow are of great importance (Markova *et al*. 2010). Each fluid has its own unique characteristics and with these characteristics we can define the meaning and the physical properties of fluids at a given temperature (Markova *et al*. 2010; Lorefice & Saba, 2017; Myshkin & Markova, 2018; Gayle, 2020). Therefore viscosity is an important property of fluids which requires greater understanding (Gayle, T. 2020).

The measure of internal friction in lubricating oils has widely increased as a result of internal velocity gradient in a fluid largely constitute to viscosity (Markova *et al*. 2010; Lorefice & Saba, 2017; Myshkin & Markova, 2018). In liquids, the viscosity decrease with increase in temperature while for gases the reverse is the case (Toledo *et al* 2016; Sariyerli Sakarya & Akcadag 2018; Gayle 2020). The viscosity of gas increases with increase in temperature because of the greater molecular activity as the temperature increase (Toledo *et al* 2016; Wolak & Zaja 2017; Yanaseko *et al* 2019). The kinetic theory of gases (no inter-molecular forces are considered) show that as gas molecules move in random direction superimposed on the mean fluid motion. They collide with other molecules in adjacent fluid layers. The collision will increase their mean fluid with velocity or motion depending on whether they collide with faster or slower molecules. This interchange of molecular momentum is manifested as fluid viscosity. Therefore measurement of gas viscosity and liquid viscosity or viscosity property of liquid is very important to the field of science and engineers, it enables the scientist and engineers to know the type of fluid they are handling during its research or industrial work and with these properties, the researchers make a wide variety of choices upon which fluid can be used at an ambient condition to serve as his lubricating oil with competition in technology, pioneering chemist scheduled by introducing and developing a range of oils to match the dynamic technology of engine development (Wolak & Zaja 2017; Zhu, Zhong & Zhe 2017; Yanaseko *et al* 2019; Gayle 2020; Kobayashi & Kondoh 2020).

The monitoring of oil viscosity in determining the changes in viscosity during the operation compared to the viscosity of fresh oil, i.e., the initial viscosity when yet to be used, while the critical values for the decrease and increase in viscosity are established (Markova *et al*. 2010). It is, however, worth noting that the viscosity of fresh oil, as given in the standards, i.e SAE 20W-50 (W means winter and SAE stands for Society For Automobile Engineers) may differ from its nominal value by up to 20%, while a change in viscosity of 10% during which the operation may often be considered critical (Markova *et al*. 2010). Therefore, it is essential to use data from freshly obtained oil as a control experiment.

AUTOMOBILE ENGINE OIL IN NIGERIA

An Engine oil is also known as lubricating oil, motor oil (Kobayashi & Kondoh 2020). It guarantees a friction-free operation of the different parts of your car. Engine oil also works as a coolant to cool down the heated-up component of the cars. It is because engine oil very vital to your cars smooth functioning (Kawatra & Bakshi 1996; Syarifah Yunus 2013; Zadorozhnaya, Levanov & Oskina 2016; Kobayashi & Kondoh 2020). There are several Engine oils available in the Nigerian markets that are also suitable for Nigerian cars. The article gathers a sample of 5 Engine oil brands in Nigeria.

The objectives of the study are to investigate some Nigerian made engine oils. As well as, see how good these lubricants are under practical application in automobile. The investigation will be restricted to only test of lubricants most important properties, viscosity, pour point, flash point and water content.

METHODOLOGY

The research used five (5) engine oils from various producers. All

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of the samples tested were synthetic oils of 20w-50 viscosity grade, recommended for passenger cars. The oils were numbered from A to E. The brand names of the engine oils and their quality specifications were not disclosed, as the purpose of the study was to determine the important properties of the sample tested. The materials used in measurement of viscosity for the purpose of this research are; DV-E viscometer, flashpoint tester Heating mantle, Refrigerator, Thermometer and Beakers, CPV Receiver Design.

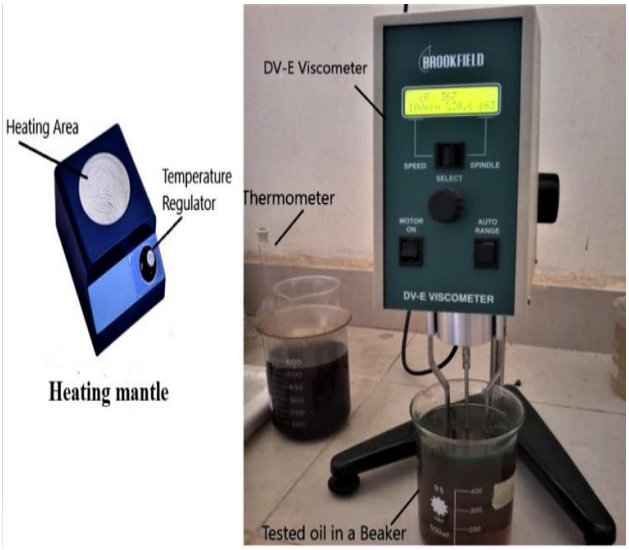

Figure 1. Experimental set up with DV-E viscometer and heating Mantle

As shown in **Error! Reference source not found.**, the sample for various oils A, B, C, D and E were refrigerated to obtain the sample at 0°C temperature for initial test (viscosity). After which the DV-E viscometer is set up with guard leg mounted on the DV-E viscometer and the spindle selected was attached. Then the center spindle is immersed into the sample and the reading was recorded and the subsequent samples were subjected to heat using the heating mantle along with thermometer to measure the temperature. And the same procedure is carried out at different temperature for each of the oil sample.

Water Content of Oil
To determine the water content, we use the Crackle method using the following apparatus; 100ml burette, measuring cylinder.
Hot plate and thermometer. The unit for the water content is parts per millions (ppm).

Flash Points (Cleveland) is determined using the method ASTM D-92, IP-36, ISO-2592 using the Cleveland open cup flash point tester
Unit is Degrees Centigrade (°C).

RESULTS
This research find out the properties of different engine oils used in Nigeria and worth of the products of different companies under study. Table 1 shows the Flash points (FP), pour points (PP), and water content (WC) of the oil samples tested.

Table 1. Measurement of Flash point, pour point, and water content of engine sample A-E

Samples	A	B	C	D	E
Flashpoints(^{0}C)	240	228	235	230	220
Pour point(^{0}C)	-46	-39	-35	-38	-37
Water contents(ppm)	Negative	Negative	Negative	Negative	Negative

It was observed that sample A has a highest FP while sample E has a lowest FP. These shows that at higher temperature sample A is safer to be used in automobile with less hazard of fire or explosion compare to sample B,C,D, and E. However, all the samples A,B,C,D and E have a PP less than 0°C, meaning that all sample will remain in liquid form up to -46°C -39°C -35°C -38°C and -37°C respectively. This shows all sample are suitable to be used in Nigeria based on the weather and daily temperature. The measurement of the WC shows negative for all the samples. This shows that the oils are suitable for use and has lower risk of premature aging of the oil during operation in automobile.
Fig.2. shows a combined plot of oil samples A, B, C, D and E for the dynamic viscosity against temperature.

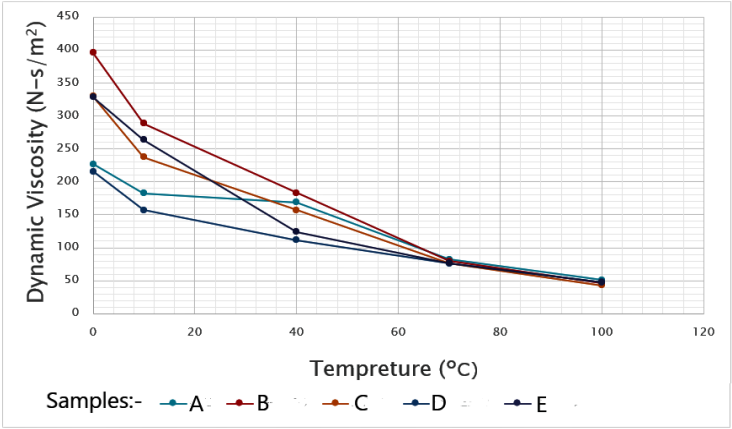

Figure 2. Plot of dynamic viscosity against temperature for Sample oils A, B, C, D and E

It was found that all the multi-grades oil coincide at 100^{O}C, which is approximately engine operating temperature. That is they have almost the same viscosity at 100°C (43.2centiStokes and 51.2cSt). However, some are more desirable than others. This because at a very low temperature of about 0°C, sample B (395.6cSt) is the highest followed by sample C (330.0cSt), the third is sample E (328.4cSt) and the lowest is sample D with 215.9cSt. At 10°C and 40°C sample B is still the highest while sample D is the lowest except at 70°C where sample A is the highest, but sample D still the lowest. Therefore, it has shown that sample B, C and E fall drastically which implies that with continuous heating they will be undesirable quality. For this reason sample A and D are more desirable compared to B, C and E.

Conclusion

Conclusively, this research determines the properties of five automobile engine oil to grading system and importantly described the behavior with respect to temperature of various Nigerian made oils (viscosity variations) and will go a long way in helping the users to choose particular oil for their use, depending on their requirements. However, this research findings will provide guide on which oil product one can wisely choose.

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