International Journal of Engineering and Technology Research
Vol. 2, No. 7, July 2014, pp. 1 - 7, ISSN: 2327 - 0349 (Online)
Available online at www.ijeatr.org

Research article

Effect of Additives on the Metal Content and Viscosity Index of Blended Engine Oil.

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Abstract.

This research work was basically carried out to investigate the effect of additives on the metal content and viscosity index of blended engine oil. This effect is a function of the additives on the metal content and viscosity index of the blended engine oil. The additives whose effects were investigated in this research work were B023233 (comprising of anti-oxidant, detergent, dispersant, pour point depressant, and anti-rust additives) and B23333 which is the viscosity modifier additive. All the laboratory tests carried out were in accordance with the specification of the American Society for testing and materials (ASTM). This study utilized graphic and statistical illustrations to highlight the effect of the additives on the aforementioned properties.

The results of the tests obtained from the blend show that the properties- metal content and viscosity index increases as the concentration of the additive increases.

Key words: Engine oil, Additives, metal, Viscosity

Introduction

In modern society where the use of automobiles is a life saving technology, the care and preservation of these automobiles are very important. Engine oil for automobiles are therefore very important, the manufacturing of the right type of engine oil that helps in preventing wears in our automobile engine is important not only for automobiles but also for aircrafts and ships[1].

An important step in the refinery process of the petroleum industry is the vacuum distillation, which is the process where the atmospheric residue (residue from the atmospheric distillation) is heated in a furnace at a temperature of about 400^0C and introduced in a furnace where distillation takes place at a mean effective pressure of between 100 – 120 mmHg[2]. This process gives various grades of base oil, diesel fuel, asphalt and bitumen. It is these base oils that are used as engine oil since they can provide a slippery coating to relatively moving parts in the automobile engine, and can also transfer heat away from the hot engine parts such as cylinder walls, pistons and values. However today's automobile engine ask for more of the above functions, as a result, chemicals called additives are carefully chosen and blended into the base oil to impact new properties and/or improves the existing properties of the base oil[3].

This research studies the physical properties of an engine oli with varing additive concentrations.. This is achieved through laboratory tests according to American Society of Testing Materials (ASTM) and American Petroleum Institute (API) specifications.

Properties necessary for the engine oil performance.

Some of the important properties necessary for satisfactory engine performance are**:**

a) Low viscosity under operating condition: Since volatile characteristics are essential inherent in the choice of the base oil for the particular type of service and cannot be improved by the use of additive materials.

b) Satisfactory flow characteristics in the temperature range of use: Flow characteristics largely depend on the choice of base oil; However, they can be improved through the use of pour point depressants and viscosity modifiers. The formal improve low-temperature flow properties while the latter enhances high-temperature viscosity characteristics,

c) Superior stability or ability to maintain desirable characteristics for a reasonable period of use. While these characteristics depend to some extent on the base oil, they are primarily associated with additive materials, which enhance base fluid properties in this araa. Engine oil stability is also affected by the environment in which it operates, such factors as temperature, oxidation potential and contamination with water, unburnt fuel fragments, and corrosive acids limit the useful life of engine oil. This is the area where additives have made a major contribution in improving the performance characteristics and extending the useful life of engine oils.

d) Compatibility with other materials in the system: Compatibility of engine oil with seals, bearings, clutch plates, etc, may also be partially associated with the base oil. However, additive chemistry can have a major influence on such characteristics.

Origin of Engine Oil Additives.

The manufacturing of engine oil by conventional refining methods is almost entirely subtractive in its effect. The process is all about removal of certain components thereby concentrating the more desirable hydrocarbons. The method of improving the properties of a substance by adding a small quantity of a foreign material is an old art in many industries[6]. Therefore, it is natural that almost as soon as petroleum oils were used as lubricants, attempts were made to improve their properties by the addition of various other materials.

In 1855 English patent 2668 were issued covering, the addition of small amount of rubber to petroleum oils to improve the lubricating properties[5]. This was followed by a number of other patents taken out in different countries and covering the mixture of various types of material to petroleum products to improve their properties in one way or the other. However, it has only been in the last five to six decades that any systematic study has been made on this subject.

In 1922 Mourea and Dufraisse published the first of a series of papers describing the study of oxidation of organic compounds and its inhibition[6]. During the course of the study of the properties of acrolein, they discovered that adding traces of certain other materials could inhibit the oxidation of this very unstable compound. This made them to extend their investigation to petroleum oils and discovered that it could be stabilized against oxidation by addition of small amount of other compounds.

Between 1930 to 1940, there was at least one stabilized turbine oil in the market, additives for depressing the pour point of lubricating oil was also introduced commercially at this time[7]. This was also followed by special additive for prevention of bearing corrosion by motor oils. Since 1935, there has been progressive development in the use of chemical additives to enhance engine oil performance.

Materials and Methods.

Base oils, NS 150 with lighter viscosity (60.68%wt), NS 500 with heavier viscosity (21.32%wt) were blended with some additives B023232 (14.2%wt) comprising anti oxidant, detergent, pour point depressant) as well as a viscosity modifier B23333 (3.8%wt).

Note: NS – Neutral solvent, BSS – Bright stock solvent.

Determination of the metal content (zinc) on the blended oil sample by chemical method.

The test method is applicable for determining the mass percent of barium from 0.003 to 15, calcium and magnesium from 0.002 – to 1.3% of the engine oil. Some engine oils are formulated with metal containing additives that act as detergents, antioxidants, anti-wear agents etc. Some of these additives contain one or more of these metals: barium, calcium, zinc and magnesium. Zinc content is determined by chemical method by adding a buffer solution of 5.5 pH. This is because at the pH, only zinc in the oil can react with the EDTA (ethylene diamine tetra acetic acid) used for the titration. All other metals in the sample do not react, but when the total content is to be analysed, a buffer solution of 10 pH is used.

An empty beaker was weighed, 1.5g of the engine oil sample was measured and poured into the beaker. An organic solvent- toluene of about 10ml was added to dissolve the lubricant. Propan-2-ol was also added to increase the volume of the sample in the beaker. This is because it has no effect on the chemistry of the test sample. A buffer solution of 5.5 pH was also added. This buffer solution makes it possible for zinc to react. The solution was then heated in a fume cupboard to increase the reaction temperature. At this stage, methyl thymol blue complex indicator was added and this mixture was titrated against EDTA. When the colour of the mixture changed, the volume of the EDTA used was read from the burette. The zinc content in PPM was calculated using:

Zn content = molarity of EDTA x volume of EDTA used in titration x 65.4 x 1000/weight of oil sample used.

Determination of the viscosity index on the blended oil sample.

An important property of lubricating oil is the rate of at which its viscosity changes as a function of temperature. This property generally referred to as viscosity index (VI). This can be determined by the use of tables specially made for viscosity index of petroleum product when their kinematic viscosity at 40^0C and 100^0C as well as the additive concentrations in the oil blend are known, But when the table is not available, equations are provided for the calculation of the viscosity indices.

Results and Discussion.

Zinc content in blended oil enters through the additives and it plays a positive impact on the property of the oil. Zinc content indicates the presence of oxidation inhibitor, detergent/dispersant, anti-wear and antirust in the additive. The ASTM specification for zinc content falls within the range of 920 – 1130 ppm. Table 1.1 below shows the experimental result of the effect of additive on the zinc content of the blended engine oil. The table shows a little conformation with the range. The little variation could be as a result of experimental error. It was observed the more the additive, the more the zinc content in the oil. Fig 1.1 which is a plot of zinc content against additive concentration went further to explain that the higher the additive, the more the zinc content, and this goes to improve the quality and effectiveness of the engine oil when in use in the automobiles, aircraft as well as ships. It was a linear relationship between the two variables

Viscosity index is the rate at which lubricating oil changes with a rise or drop in temperature. A comparative number designates this rate. Table 1.2 shows the experimental result, and it was partly gotten from the table specially made for viscosity index of petroleum products at various temperatures when the concentrations are known.. The table goes to show that the higher the additive concentration the more the viscosity index. Fig 1.2 which is a plot of viscosity index against additive concentration in the oil further illustrates that there is a proportional increase in viscosity index as the additive concentration increases. The relationship between the two variables was observed to be linear. However, it was observed that the higher the viscosity index, the smaller a change in temperature affects the kinematic viscosity of the engine oil. However, this increase in viscosity index as additive concentration increases plays a positive role in the performance of the engine oil when used.

Fig 1.3 is also a plot of viscosities observed at 40^0C against the additive concentrations, (see table 1.2 below) at this particular temperature, it was observed that the higher the concentration of the additive, the lower the viscosity. The relationship between the dependent and independent variable was found to be linear though it was a negative plot. This goes to show that the decrease in viscosity at this temperature does not really favour the performance of the engine oil to some extent when applied on the automobiles or aircraft as the case may be because the oil was found to be light.

Fig 1.4 is also a plot of viscosities observed at 100^0C against same additive concentrations. Here the reverse was the case. At this particular temperature, the oil was already too light and the addition of the additive was observed to have a slight positive impact on the viscosity by increasing the weight of the oil. An increase in weight favours a slight increase in the viscosity. The plot was a linear one showing there is a strong relationship between the dependent and independent variables. Under the conditions, the oil will perform better when used in the automobile, aircraft or in the ship as the case may be.

Fig 1.1: plot of zinc content (ppm) against additive concentration (%wt)

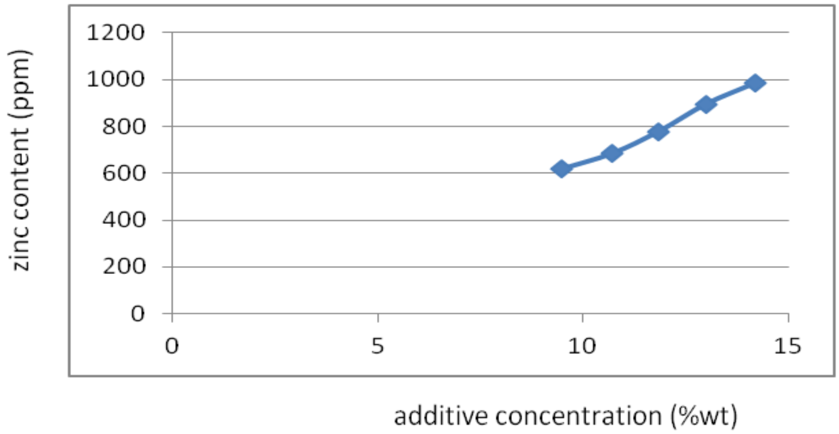

Fig 1.2: plot of viscosity index against additive concentration (%wt)

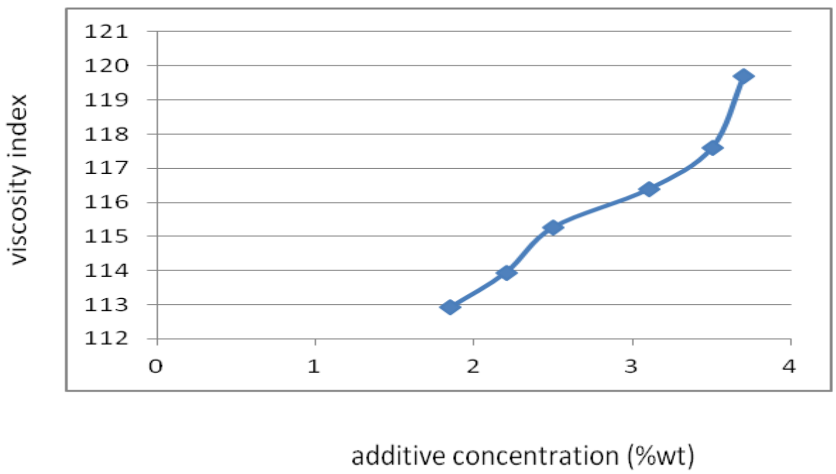

Fig 1.3: plot of viscosity @ 40^0C against additive concentration (%wt)

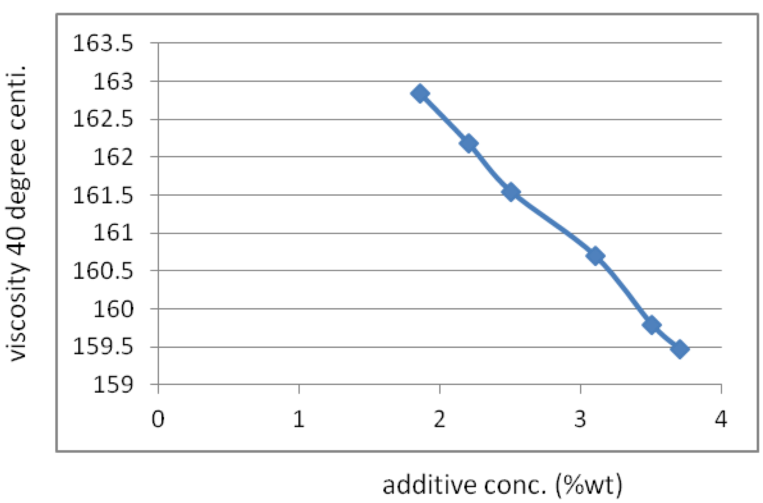

Fig 1.4: plot of viscosity @ 100^{0}C against additive concentration (%wt)

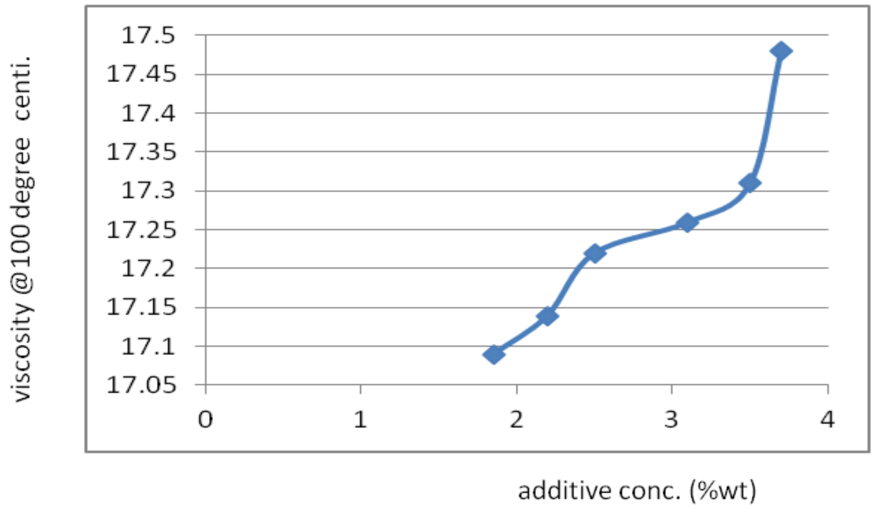

Table 1.1: Effect of additive conc. On the Zinc content

Additive conc. (%wt)	**Zinc content (PPM)**
9.47	619
10.70	685
11.84	779
13.00	897
14.20	986

Table 1.2: Effect of viscosity modifier additives (B233333) on the viscosity index of the oil blends.

Additive conc. (%wt)	Viscosity at 40^{0}C (cst)	Viscosity at 100^{0}C (cst)	Viscosity index.
1.85	162.85	17.09	112.92
2.20	162.18	17.14	113.94
2.50	161.55	17.22	115.27
3.10	160.70	17.26	116.38
3.50	159.80	17.31	117.60
3.70	159.47	17.48	119.69

Conclusion.

This research work was a successful one, and I cannot conclude without stating here that additives used in this research work proved worthwhile when blended with the two neutral solvents (base oils). It is recommended that additives should be used to achieve the desired properties of the engine oil for enhanced automobile, aircraft as well as ship engine performance.

Acknowledgement.

The support of laboratory staff in the department of Chemical Engineering, Enugu State University of Science and Technology, Enugu and that of Petroleum Engineering department of Afe Babalola University Ado-Ekiti, Ekiti State, Nigeria were highly appreciated.

References.

[1] Yanfeng, G., Shenghua, L., Hejun, G., Tiegang, H., Longbao, Z, 2007, “A New Diesel Oxygenate Additive and its Effects on Engine Combustion and Emission”, Applied Thermal Engineering, 27(1), pp 202 – 207.

[2] Li, T., Suzuki, M, 2009, “Effect of Ethyl tert-butyl ether Addition to Diesel Fuel on Characteristics of Combustion and exhaust Emissions of Diesel Engines”, Fuel 88(10), Pp 2017 – 2024.

[3] Elliot, A, Evans. 1963, “Lubricating and Allied Oils”, Chanpmans and Wall Ltd London, 4th Edition.

[4] Kishore, R. A., Nadkarni, 2000, “Guide to ASTM Test Methods for the Analysis of Petroleum Products”, E Lubrizol.

[5] Raymones C., Guather, 1972, “Lubrication”, Bailey Brother and System Ltd, UK.

[6] Lin, C.J., Huagg, J.C., 2003, “An Oxygenating Additive for Improving the Performance and Emission Charateristics of Marine Diesel Engines”, Ocean Engineering, 30, 1699-1715.

[7] Elliot, A, Evans. 1963, “Lubricating and Allied Oils”, Chanpmans and Wall Ltd London, 4th Edition.

[8] Kishore, R. A., Nadkarni, 2000, “Guide to ASTM Test Methods for the Analysis of Petroleum Products”, E Lubrizol.

[9] Raymones C., Guather, 1972, “Lubrication”, Bailey Brother and System Ltd, UK.

[10] Alphore,S, 1968, “Motor Oil Engine Lubricants”, Scientific Publications (GB), UK.