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Research Paper

Study on the Comparative Assessment of Motor Engine Oil Viscosities in Ijebuland, Ogun State, Nigeria

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ABSTRACT

This study importance is to determine the relation of motor engine oil with changes in temperature and its effects on fuel system. Although other factors that affect viscosity of motor engine oil are mentioned, we have dwelt more on the factor of temperature, and we have taken into consideration that the temperature can be affected both by the environment and the engine system. This is a localized study of the monograde, multigrade and local oil of Ijebu-ode, Ago-Iwoye and environs.

In this study we have adopted the “Falling ball” method. Temperature readings were done by thermometers and timing was done using a stopwatch. The oils were placed in graduated cylinders and balls were dropped in the cylinder. This was done three times at 20°C, 0°C, and 70°C. The different variables that were used to solve for viscosity are density, volume, and velocity.

Results shows that as the temperature increases to higher degree, the change in the kinematic viscosity becomes very small especially for local oils A, B and C. These oils have been most used for generators and motorcycles, this research further shows that this is in fact a reason for high rate of malfunction of motor engines in these areas as Nigeria is already a hot region. The SAE 20W-50 was found to be most adjustable to temperature. The implication of this study is to give an informed opinion on the use of proper motor oil as indicated by manufacturer with regards to temperature and confirm the integrity of monograde, multigrade and local oils in Ijebu-Ode, Ago-Iwoye and Environs.

Keywords: Viscosity, Motor Engine, Oil, SAE, Monograde, Multigrade, Ijebu

INTRODUCTION

Background Information

The effects of friction and viscosity in diminishing the velocity of running water were noticed in the Principia of Sir Isaac Newton. The term viscosity is commonly used in the description of fluid flow to characterize the degree of internal friction in the fluid. This internal friction, or viscous force, is associated with the resistance that two adjacent layers of fluid must move relative to each other. Viscosity causes part of the kinetic energy of a fluid to be converted to internal energy [1].

Motor oil, or engine oil, is oil used for lubrication of various internal combustion engines. While the main function is to lubricate moving parts, motor oil also cleans, inhibits corrosion, improves sealing cools engine by carrying heat away from the moving parts.

SAE viscosity grade motor oil: 5W-30 (W stands for winter); Temperature conditions: Below -18°C; Description: Provides excellent fuel economy and low temperature performance in most late–model engines. It is especially recommended for new car engines.

SAE viscosity grade motor oil: 10W-30; Temperature conditions: Above -18°C; Description: Most frequently recommended motor oil viscosity grade for most automobile engines, including high performance multivalve engines and turbo charged engines.

SAE viscosity grade motor oil: 10W-40; Temperature conditions: Above -18°C; Description: The first multigrade introduced. That is a good choice for controlling engine wear and preventing oil breakdown resulting from oxidation.

SAE viscosity grade motor oil: 20W-50; Temperature conditions: Above -7°C; Description: Provides maximum protection for high–performance, high–RPM (Revolution per Minute) racing engines. It is an excellent choice for high temperature and heavy loads such as driving in the desert or towing a trailer at high speeds for long periods of time.

SAE viscosity grade motor oil: SAE 30 & SAE 40; Temperature conditions: Above 5°C & above 16°C; Description: For cars and light trucks, where recommended by manufacturers. Not recommended when cold temperature starting is required [2].

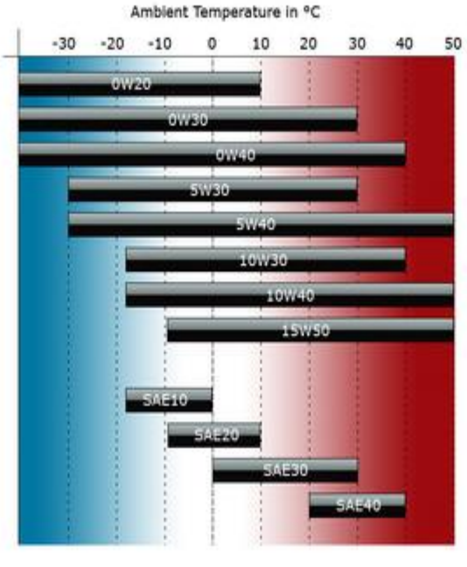

Figure 1.1: Chart illustrating a rough guide to ambient temperatures vs. oil viscosity performance in both multi-grade (top half) and mono-grade (lower half) oils.[3]

Problem Statement and Justification

When the kinematic viscosity of lubricant oil is too low, heat will generate due to insufficient film thickness and metal-to-metal contact will occur. Conversely, if the viscosity is too high, heat will again be generated but, due to the internal fluid friction created within the oil [4,5]. The engine of a vehicle can completely knock down when the wrong type of oil is being used. Choosing the best motor oil was observed to come up frequently in discussion between motor heads either on motorcycle or cars [6]. There are various brands and types of automobile oils in the markets, the choice of which is left to the users' discretion. When temperature is too low, fluid viscosity is high. At low temperatures, the fluid often reaches the point where it congeals and will no longer flow (pour point). High temperature also accelerates wear, destroys hydrodynamic lubrication regimes, increases the oxidation rate, fosters additive depletion, and affects other critical aspects of the machine [7].

Moving to energy efficient lubricants is cost effective compared to hardware modifications and direct engine measurements demonstrate that moving to lower viscosity engine lubricants results in lower engine friction [8].

Aims and Objectives

The specific objectives are:

i. To calculate the density of the different motor oils.
ii. To record the temperature and how it affects the viscosity of the motor oils.

Others are:

i. To understand what viscosity is.
ii. To understand what factors, govern viscosity.
iii. To understand the importance of viscosity in relation to a fuel system.
iv. The aim of this experiment is to find out how fluid bath oils really are by measuring its viscosity.
v. Collect and record data from their experiments.

vi. Analyse the data by graphing it.

Scope and Limitation

There are oils with different grade but in this study five different oils were used. Two have known viscosity grade 20W-50, SAE 40 and three others without a known viscosity grade were used (A, B & C). Viscosities of these oils were calculated at 10°C, room temperature (28°C), 50°C and 70°C. This study is to measure how the kinematic viscosity of engine oil changes with temperature. Such knowledge is critical for description of processes running in the combustion engines.

Getting engine oils with SAE 5W-30 and 10W-40 viscosity grade in Nigeria is very difficult due to scarcity in the supply of such oil, this has caused the experiment to be carried out latter than as expected thereby, resulting in inadequate time for observation during the experiment. The unavailability of instruments needed for the lab experiment has also caused disturbance in carrying out experiment effectively, with composure and optimally.

The graduated cylinder was having greater mass, so I used the mass of the beaker instead. Also, the triple beam balance was not able to get the mass of liquid up to 500 ml in the beaker, so I measured for 250 ml liquid in beaker, multiplied my result by two and then I subtracted the mass of the beaker to get mass of 500 ml liquid plus beaker.

Study area: Oils used were gotten from supplier at Ago-Iwoye and Ijebu-Ode Ogun State.

The most common unit of measure for viscosity is the Kinematic viscosity and this is usually quoted in data sheets at 40°C (104°F) and 100°C (212°F). The commonly used unit of measure is centistokes, but the correct SI unit of measure is mm^2/s [9].

SAE Viscosity Grade	Maximum CCS Viscosity 10^{-3}Pa.s at (°C)	KV 100°C mm^2/s minimum	KV 100°C mm^2/s maximum
5W	3500 (-25)	3.8	-
10W	3500 (-20)	4.1	-
15W	3500 (-15)	5.6	-
20W	4500 (-10)	5.6	-
25W	6000 (-5)	9.3	-
20	-	5.6	<9.3
30	-	9.3	<12.5
40	-	12.5	<16.3
50	-	16.3	<21.9
60	-	21.9	<26.1

Table 2.1: SAE J300 Viscosity Grades for Engine Lubricants

KV- Kinematic Viscosity, CCS - Cold Cranking Simulator

How Oil viscosity Affects Motor Engine

At the low-temperature end, oil must be resistant to thickening so that it flows more easily to all the moving parts in your engine. Also, if the oil is too thick the engine requires more energy to turn the crankshaft, which is partly submerged in a bath of oil. Lower-viscosity grades of oil such as Shell Helix Ultra make it easier for your engine to start from cold because they present less resistance to moving parts and hence take less power from your engine. This also means that you get enhanced fuel economy (Shell South Africa). 5W oil is typically what's recommended for winter use. However, synthetic oils can be formulated to flow even more easily when cold, so they are able to pass tests that meet the 0W rating.

Once the engine is running, the oil heats up. The second number in the viscosity rating--the "40" in 10W-40, for example--tells you that the oil will stay thicker at high temperatures than one with a lower second number--the "30" in 10W-30, for example. What's important is that you use the oil viscosity your car owner's manual recommends.

MATERIALS & METHODOLOGY

Method

Temperature readings were done by thermometers and timing was done using a stopwatch. The oils were placed in graduated cylinders and balls were dropped in the cylinder. This was done three times at 20°C, 0°C, and 70°C. The different variables that were used to solve for viscosity are density, volume, and velocity.

Plan

The first thing that will be done is to measure the spheres volume by first measuring its radius with the micrometer screw gauge. Then by calculating the spheres masses, it'll be easy to calculate the density of the ball. This will be used later when calculating the viscosity of the bath oil. The density of the bath oil also will be gotten for calculations later. Next a graduated cylinder will be filled with oil about 500 mL from the top. This will be left to allow any air bubbles caught during pouring to escape. A metre rule will be used to mark a starting point to start measuring from, on the cylinder, below the surface of the liquid, (this will allow the sphere to reach terminal velocity before taking measurements).

An ending point would be marked also with a metre rule on the cylinder. After marking two points the distance between the two points has to be measured with a metre rule at a steady position (meter rule can be held by a retort stand), to find my "fall distance" used later in calculations. The sphere should be held so that it is just touching the liquid while ready with a stop-clock to measure the time. Then the ball will be released, and timing starts immediately when the sphere crosses the top mark and stopped the clock when it crosses the lower mark. This would be repeated for three different sizes of spheres and the whole experiment would be repeated for each sphere three times. The spheres to be used are sand-cemented balls and to retrieve them from the liquid each time, a long spoon would be used to guide them out after emptying the liquid in the graduated cylinder to reasonable amount.

The only thing that will vary in this experiment is the size of the balls. As I am only trying to find out the viscosity of the fluid there is no real need for me to vary any variable, but this will give me a wider range of results to make sure that I can calculate the viscosity correctly. Different oils would be used during my experiment for comparing between data and result gotten. To make the experiment a fair test the ball bearings should be dropped from the same height each time making sure that they will all be just touching the surface of the liquid before releasing with no added force. Before re-dropping the spheres, make sure that they are dry so that the test is kept in the same conditions for each repeat. This is to make sure that all the tests are fair and that there is no difference between each repeat.

Hypothesis

As the oil begins to heat up to higher temperatures, each type of motor oil will become thinner and thinner, making it quicker for the ball to fall through and hit the bottom of the graduated cylinder.

Materials

- 500 mL (glass) graduated cylinder
- 500 mL sample of one of the following
  - SAE 20W-50
  - SAE 40
  - Three engine oil with unknown viscosity grade: labelled A, B and C.
- Hot plate
- Thermometer
- 1000 mL Cylindrical Beaker
- Balls (5/16” diameter) funnel
- Stopwatch
- Stirring Rod
- Marker
- Triple beam balance
- Meter-rule
- Micrometer screw gauge

Material Description

Engine Oil Samples

The oil samples used were of the SAE viscosity grades 20W-50, SAE 40, A, B and C (indicates the popular roadside mixed oil). Engine oil is viscous liquid that is used to reduce wear on moving parts; they also clean, inhibit corrosion, improve sealing, and cool the engine by carrying heat away from moving parts. Motor oils used are derived from petroleum based chemical compounds.

Figure 3.1: Oil samples with known viscosity

Graduated Cylinder

A graduated cylinder is a common piece of laboratory equipment used to measure the volume of a liquid. It has a narrow cylindrical shape. Each marked line on the graduated cylinder represents the amount of liquid that has been measured. When the liquid is poured into the cylinder and reading is done, the value calculated is set to be 100.0 mL. The precise value equates to 100.0 ± 0.1; 100.1 or 99.9 mL.

Figure 3.2: Graduated Cylinder

Hot Plate

The hot plate used is a portable self-contained tabletop small appliance that features one electric heating element. The hot plate as used to heat the oil to the desired temperature.

Thermometer

A thermometer is a device that measures temperature or temperature gradient. The thermometer has two important elements:

i. A temperature sensor, in this case, the bulb of a mercury-in-glass thermometer in which some physical changes occur with temperature.
ii. Some means of converting this physical change into a numerical value this is the visible scale that is marked on a mercury-in-glass thermometer.

Figure 3.3: Mercury in-glass thermometer

Cylindrical Beaker

A beaker is a simple container for stirring, mixing, and heating liquids commonly used in many laboratories. The beaker is cylindrical in shape, with a flat bottom and a small spout to aid pouring. The beaker mark is up to 1000 mL.

Triple beam balance

Triple beam balance is an instrument used to measure mass very precisely. The device has reading error of +/- 0.05 gram. The name refers to the three beams including the middle beam, which is the largest size, the front beam which is the medium size, and the far beam which is the smallest size. The difference in size of the beam indicates the difference in weights and reading scale that each beam carries. The reading scale can be enumerated that the middle beam reads in

100 gram increments, the front beam can read from 0 to 10 grams, and the far beam can read in 10 gram increments. The triple beam balance can be used to measure mass directly from the objects, find mass by difference for liquid, and measure out a substance.

Figure 3.4: Triple Beam Balance

Micrometer Screw Gauge

This is a device incorporating a calibrated screw widely used for precise measurement of components in mechanical engineering and machining as well as most mechanical trades, along with other metrological instruments such as dial, vernier, and digital callipers. (Figure 3.4)

Safety precautions

i. I also made sure that I wore safety goggles so that the fluid does not meet my eyes.
ii. I wore gloves during this experiment because the oil is an irritant.

Experimental Procedure

i. Fill the graduated cylinder with your liquid sample to the 500 mL mark.
ii. Draw two lines on your column with the wax pencil, one near the top of the oil and one near the bottom.
iii. Measure the distance between the two lines in meters and record the length below. You will need this measurement later for your data table.
iv. Take the temperature of the liquid at room temperature (in °C) and record in the data table.
v. Use a stopwatch to time the ball as it drops through the oil. Drop the ball into the oil and measure the time it takes the ball to travel from the top line to the bottom line. Try to drop the ball as close to the liquid's surface as you can. Conduct total of three trials and record the times in seconds in your data table.

Figure 3.5: Micrometer Screw gauge

vi. Pour the liquid from the graduated cylinder into the cylindrical beaker until you have emptied most of the fluid. Use a spoon to remove the balls from the graduated cylinder.
vii. Heat the liquid in the cylindrical beaker on the hot plate to a temperature of 50°C. You can mix the liquid with a stirring rod.
viii. Pour the heated liquid from the beaker into the graduated cylinder up to 500 mL mark (Note: oil may have expanded during heating. If so, take a new height measurement).
ix. Drop a ball into the oil in the cylinder. Using a stopwatch, measure the time it takes the ball to travel from the top line to the bottom line. Try to drop the ball as close to the liquid's surface as you can. Conduct a total of three trials and record the times in seconds in your data table.
x. Do these procedures also for temperature at 70°C and 10°C then record the times in seconds in your data table.
xi. Transfer the heated liquid to the original cylindrical beaker from the beginning and begin your calculations while the liquid cools. Do not clean up the liquid until its temperature have dropped below 50°C.

Observations

I observed that:

i. The oil sample SAE 20W-50 was dark green, SAE 40 was dark brown and A, B & C was darker compared to SAE 40.
ii. Oil sample A, B & C are not as thick as SAE 20W-50 and SAE 40 at room temperature.
iii. The viscosity of the oil reduced as the heated oil increased in temperature.
iv. It became difficult to record the time it took the ball to fall through oil A, B & C at 70

I will also have to measure other, constant, values to be able to calculate this, these include:

- **Radius of sphere (m) -** This is needed in the formula as shown and to calculate the volume of the sphere. To measure this, I will use a micrometer which measures the diameter of the ball and then divide that by two. I will make 3 readings for this and find the average. This is because the ball bearing may not be a perfect sphere.
- **Distance to fall (m) -** This is needed to calculate the velocity of the falling ball. To measure this, I will use a ruler or meter rule.
- **Density of Sphere (Kgm^{-3}) -** This is needed in my analysis later on. To calculate the density, I will divide the mass of the sphere by the volume. The mass will be found by weighing the sphere on some electronic scales. By calculating the density once, it saves me weighing the ball bearings every time. I will assume they have the same density as they are made from the same type of steel.
- **Density of fluid (Kgm^{-3}) -** This is needed to help me work out the mass of fluid displaced by multiplying the density of the fluid by the volume of the sphere which is ultimately used to calculate the upthrust. To calculate the density, I will divide the mass of an amount of the fluid by the same volume.
- **Volume of sphere (m^3) -** This is needed to help me work out the mass of the sphere. To calculate the volume, I will use this formula: Volume of sphere $= \frac{4}{3}\pi r^3$.
- **Mass of sphere (kg) -** This is used to find the density of the sphere and ultimately the viscous drag force. It is calculated by multiplying the volume of the sphere by the density of the sphere.
- **Velocity (ms^{-1}) -** This is used in the viscosity formula and is found by dividing the distance that the ball falls, by the time it takes to fall.

The variables that may affect my experiment

i. **Air bubbles and other materials in the oil:** These would obviously affect the viscosity of the liquid as the descent of the ball would be affected. To try and avoid this I will clean the tube before I pour the oil in and prepare the experiment the day before I conduct it to allow for the air bubbles to escape. If there were air bubbles present, they would pull the ball bearing with them and give a false reading for the viscosity.
ii. **Position of ball bearing in tube:** If the ball bearing is too close to the side of the tube, then it may be attracted to it. This would then affect the motion of the ball as the viscous drag force would increase. To prevent the happening of this I will place the ball bearing in the middle of the tube before releasing and ensure that the tube is vertical.

The most important thing that I will measure is the time that the ball bearing takes to fall the set distance down the tube. This will allow me to calculate the viscosity later. The formula for calculating the Viscosity is shown below. To get to this formula I have re-arranged Stokes Law to make viscosity the subject of the equation.

$$F_d = 6\pi\mu r v \qquad 3.1$$

F_d is the stokes drag or frictional force

μ is dynamic viscosity
r is radius of the spherical object
v is flow velocity relative to the object

S.I units, F_d is given in Newton, μ in Pa.s, r in meter and v in ms^{-1}

F_g excess force due to the difference between the weight and buoyancy of the sphere (both caused by gravity) is given by:

$$F_g = (\rho_b - \rho_f)g\frac{4}{3}\pi r^3 \qquad 3.2$$

Requiring the force balance $F_d = F_g$

$$6\pi\mu r v = (\rho_b - \rho_f)g\frac{4}{3}\pi r^3$$

$$9\mu v = (\rho_b - \rho_f)g2r^2$$

$$\mu = \frac{2g(\rho_b - \rho_f)r^2}{9v} \qquad 3.3$$

g is the gravitational acceleration (ms^{-2})
ρ_b is the mass density of the ball (kgm^{-3})
ρ_f is the mass density of the fluid (kgm^{-3})
μ is the dynamic viscosity ($kgm^{-1}s$)

The kinematic viscosity, k, is calculated using the formula:

$$k = \frac{\mu}{\rho_f} \qquad 3.4$$

Kinematic Viscosity: 1 centi-Stoke (cSt) = 1 mm^2/s

RESULTS AND DISCUSSIONS

Tabular and Graphical Representations

In this chapter, the viscosity of each oil at different temperature degrees including at room temperature are represented and discussed.

Density of the Balls

Volume of the ball is given by;

$$V = \frac{4}{3} \times \pi \times r^3 \qquad 4.1$$

$$\text{Density, } \rho = \frac{m}{v} \qquad 4.2$$

Table 4.1: Density of the Balls

	Mass of balls (grams)	Radius of ball (centimetre)	Volume of Balls (cubic centimetres)	Density (gcm^{-3})
Ball 1	6.9000	1.1010	5.5904	1.2343
Ball 2	9.1000	1.2355	7.8996	1.5196
Ball 3	13.4000	1.3633	10.6133	1.2626

Density of the Engine Oil Samples

Mass of empty beaker = 267g
Volume 500 mL = 500 cubic centimetres

Table 4.2: Density of Oil Samples

Sample material	Mass of oil samples (g)	Density ρ (gcm^{-3})
SAE 40	451.8	0.9036
SAE 20W-50	427.2	0.8544
A	213.0	0.4260
B	251.3	0.5026
C	245.7	0.4914

The density of the oil samples was found to be normal and were gotten at the room temperature. The reference temperature for this experiment was 28°C.

Distance of fall- 23m

Table 4.3: Time taken in seconds for the ball to fall

Sample Material	Time of fall (s)			
	28°C	10°C	50°C	70°C
SAE 40 Ball 1	6.06	13.81	1.41	1.10
Ball 2	6.34	13.77	1.58	1.18
Ball 3	7.21	13.62	1.89	1.26
SAE 20W-50 Ball 1	5.61	17.81	1.03	1.23
Ball 2	6.08	16.41	1.34	0.71
Ball 3	7.53	15.89	1.54	0.95

Table 4.3 To Be Continued…				
A Ball 1	1.47	2.97	1.06	0.68
Ball 2	1.57	3.06	1.18	0.82
Ball 3	1.96	3.21	1.29	0.98
B Ball 1	1.63	3.10	1.30	0.95
Ball 2	1.78	3.27	1.37	1.09
Ball 3	1.95	3.42	1.48	1.21
C Ball 1	1.58	3.04	1.07	0.91
Ball 2	1.64	3.15	1.16	1.02
Ball 3	1.89	3.28	1.23	1.15

$$\text{Velocity, } V = \frac{d}{t} \qquad 4.3$$

Table 4.4: Velocity of the ball

Sample Material	**Velocity of the ball (ms^{-2})**			
	28°C	10°C	50°C	70°C
SAE 40 Ball 1	3.80	1.67	16.31	20.91
Ball 2	3.63	1.67	14.57	19.49
Ball 3	3.19	1.69	12.17	18.25
SAE 20W-50 Ball 1	4.10	1.29	22.33	18.70
Ball 2	3.78	1.40	17.16	32.39
Ball 3	3.05	1.45	14.94	24.21
A Ball 1	15.65	7.74	21.70	33.82
Ball 2	14.65	7.52	19.49	30.26
Ball 3	11.73	7.17	17.83	23.47
B Ball 1	14.11	7.42	17.69	24.21
Ball 2	12.92	7.03	16.79	21.10
Ball 3	11.79	6.73	15.54	19.01
C Ball 1	14.56	7.57	21.50	25.27
Ball 2	14.02	7.30	19.83	22.55
Ball 3	12.17	7.01	18.70	20.00

Now to calculate the viscosity for each ball, I used (equation 3.3).
where gravitation due to acceleration g = 9.8 ms^{-2}

Table 4.5: Viscosity of engine oil sample

Sample Material	**Kinematic Viscosity of the Liquid (mm^{2}s^{-1})**			
	28°C	10°C	50°C	70°C
SAE 40 Ball 1	0.00002548	0.00005799	0.00000594	0.00000463
Ball 2	0.00006253	0.00013593	0.00001558	0.00001165
Ball 3	0.00005053	0.00009538	0.00001324	0.00000883
SAE 20W-50 Ball 1	0.00002862	0.00009098	0.00000521	0.00000628
Ball 2	0.00005170	0.00013960	0.00001139	0.00000603
Ball 3	0.00006340	0.00013337	0.00001294	0.00000799
A Ball 1	0.00003200	0.00006470	0.00002308	0.00001481
Ball 2	0.00005802	0.00011304	0.00004261	0.00002745
Ball 3	0.00006777	0.00011086	0.00004458	0.00003309
B Ball 1	0.00002723	0.00005179	0.00002172	0.00001587
Ball 2	0.00005207	0.00009569	0.00004006	0.00003188
Ball 3	0.00005191	0.00009094	0.00003939	0.00003220
C Ball 1	0.00002741	0.00005257	0.00001856	0.00001579
Ball 2	0.00004961	0.00009529	0.00003508	0.00003085
Ball 3	0.00005220	0.00009062	0.00003397	0.00003176

Engine Oil Sample SAE 40

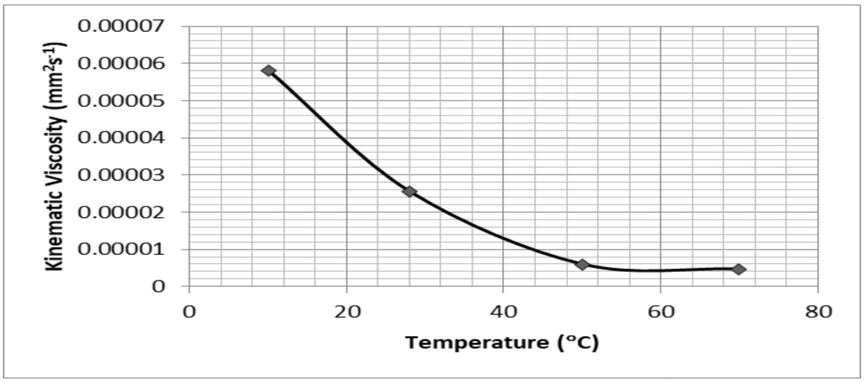

Figure 4.1: SAE 40 Kinematic viscosity against temperature for ball 1

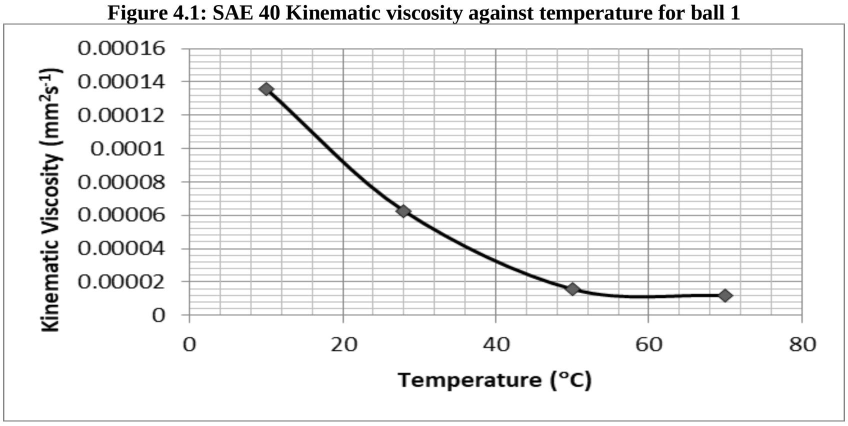

Figure 4.2: SAE 40 Kinematic viscosity against temperature for ball 2

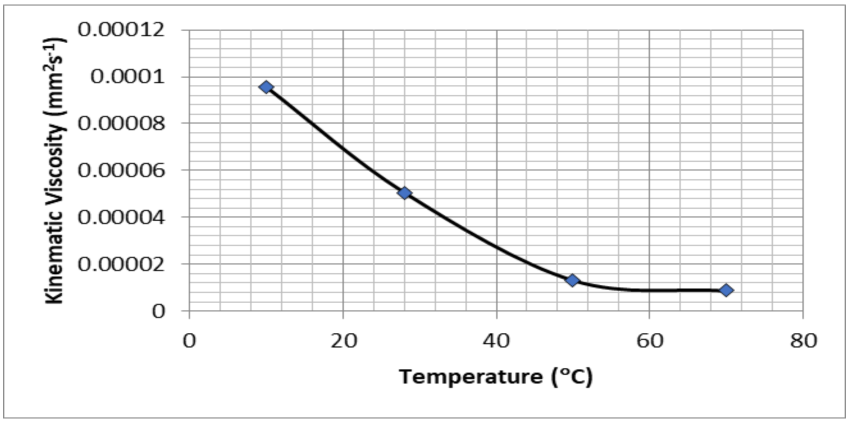

Figure 4.3: SAE40, Kinematic viscosity against temperature for ball 3

Engine Oil Sample SAE 20W-50

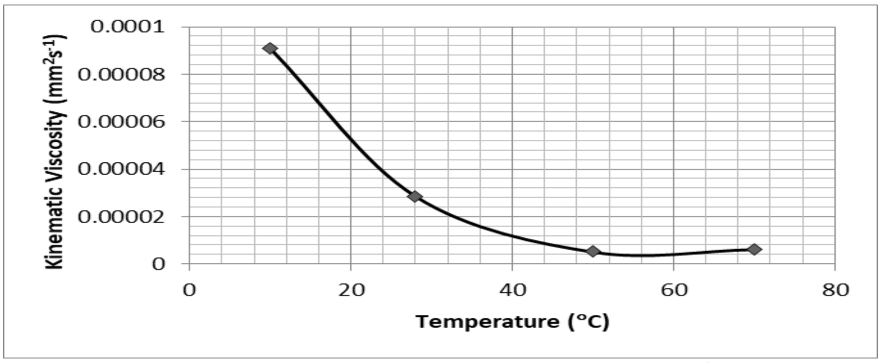

Figure 4.4: SAE 20W-50, Kinematic viscosity against temperature for ball 1

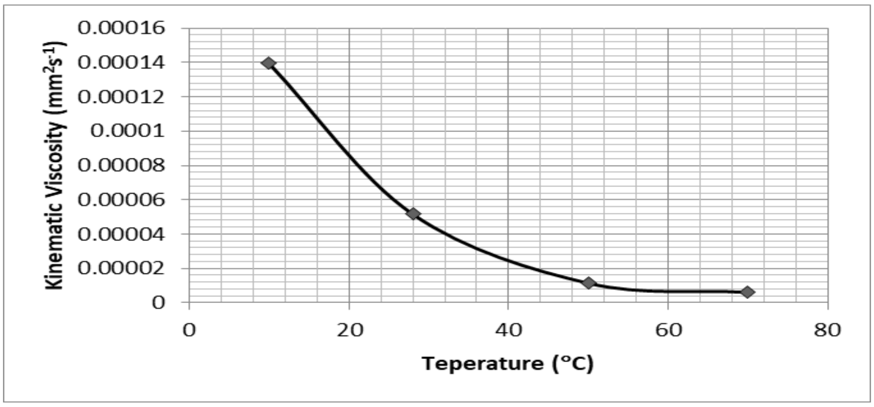

Figure 4.5: SAE 20W-50, Kinematic viscosity against Temperature for ball 2

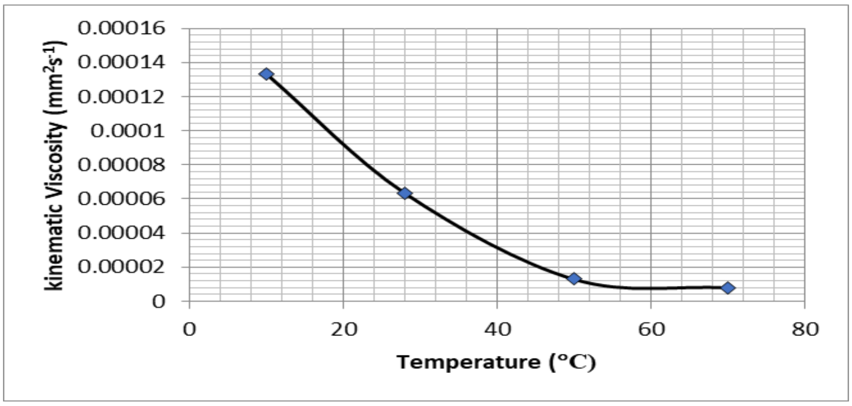

Figure 4.6: SAE 20W-50, Kinematic viscosity against Temperature for ball 3

Engine Oil Sample A

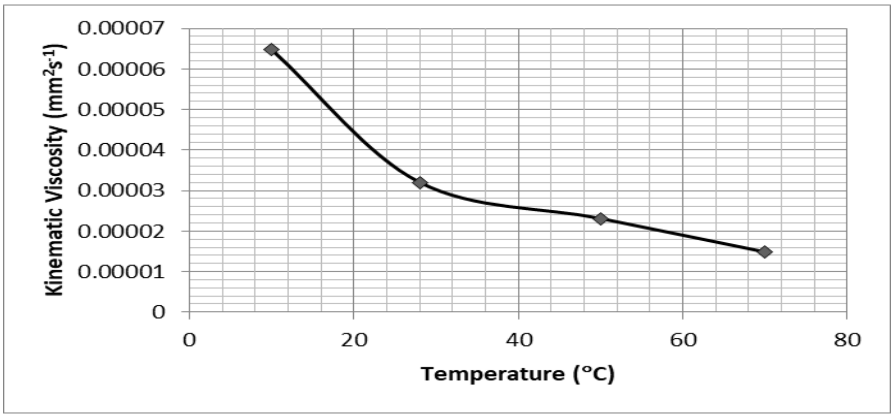

Figure 4.7: A, Kinematic viscosity against Temperature for ball 1

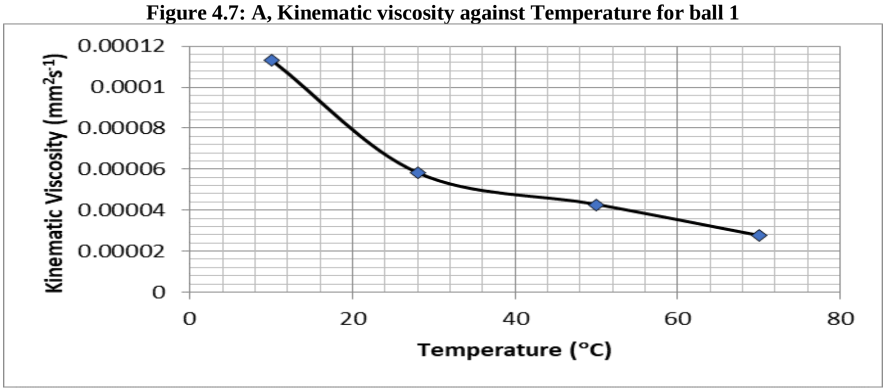

Figure 4.8: A, Kinematic viscosity against Temperature for ball 2

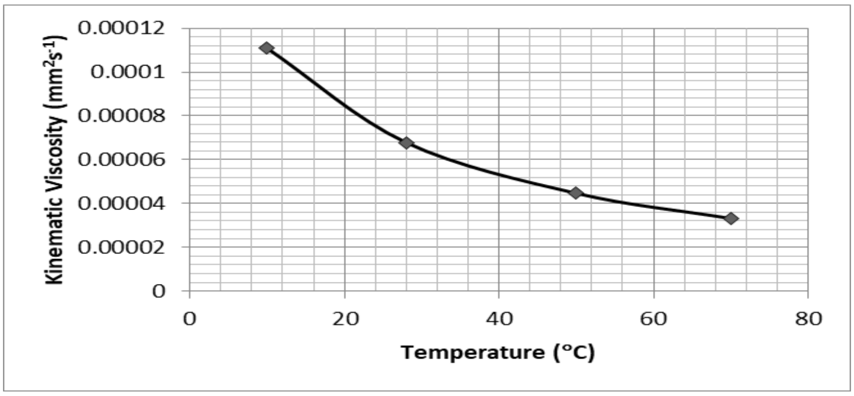

Figure 4.9: A, Kinematic viscosity against Temperature for ball 3

Engine Oil Sample B

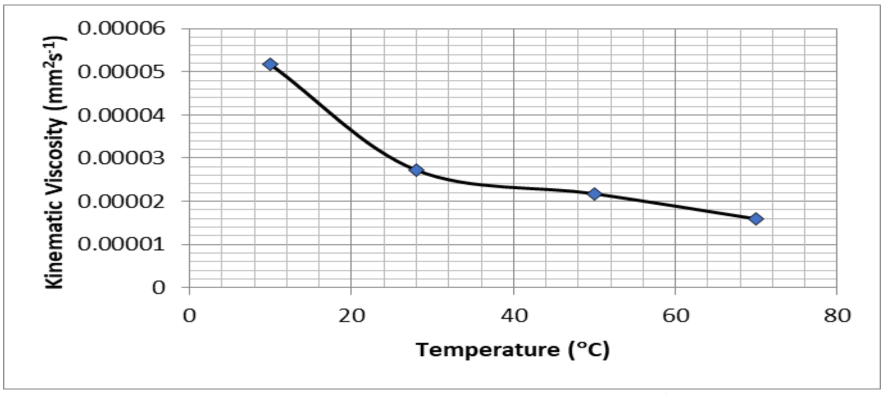

Figure 4.10: B, Kinematic viscosity against Temperature for ball 1

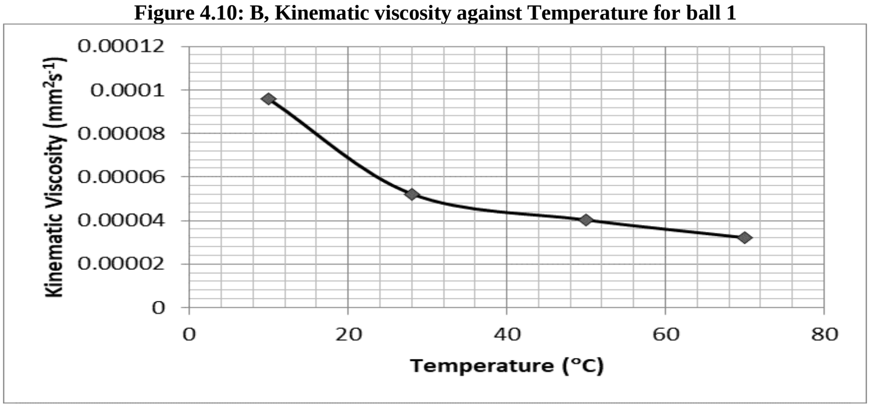

Figure 4.11: B, Kinematic viscosity against Temperature for ball 2

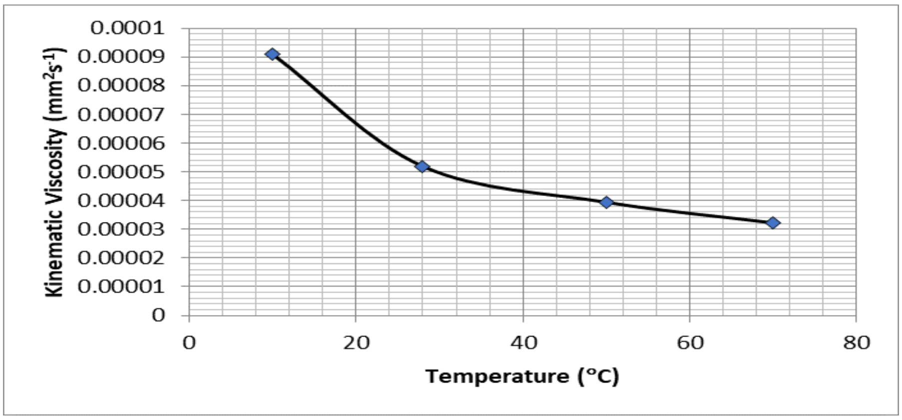

Figure 4.12: B, Kinematic viscosity against Temperature for ball 3

Engine Oil Sample C

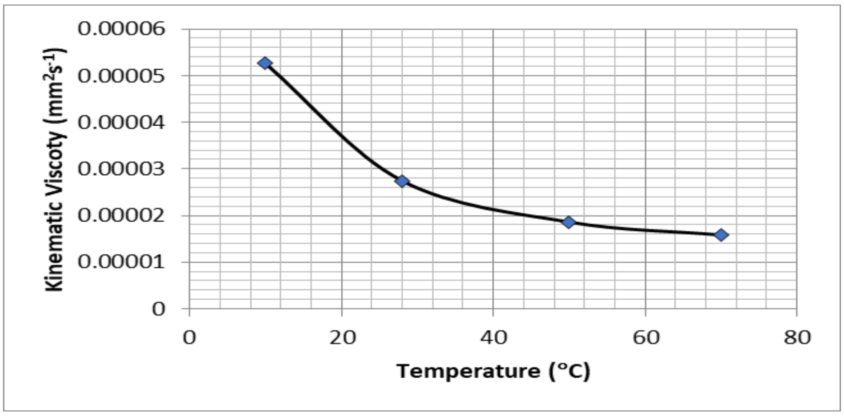

Figure 4.13: C, Kinematic viscosity against Temperature for ball 1

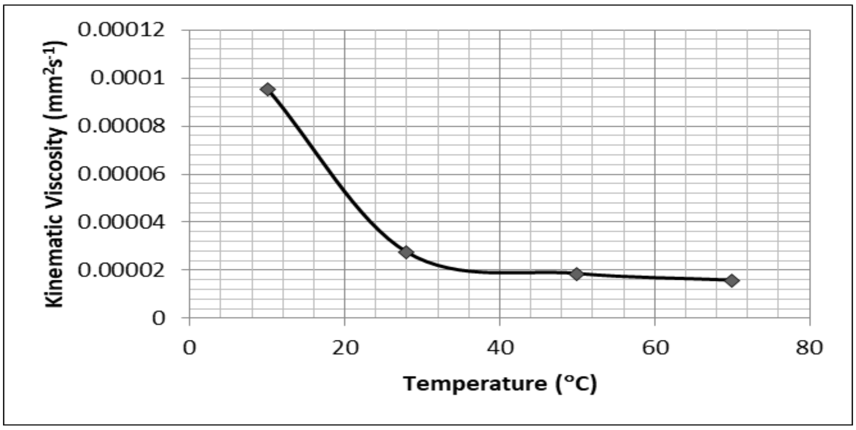

Figure 4.14: C, Kinematic viscosity against Temperature for ball 2

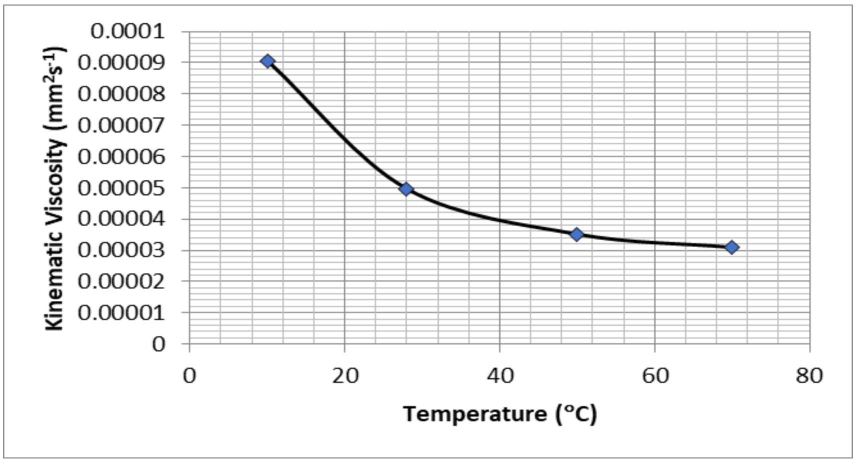

Figure 4.15: C, Kinematic viscosity against Temperature for ball 3

Kinematic viscosity as a function of temperature of 5 mono-grades and multi-grade oils has been considered. It is obvious that density is not the ruling or determinative factor that influence viscosity. The viscosity of oil is highly temperature dependent.

In the figures showing the kinematic viscosity against temperature for SAE 40 and SAE 20W-50 there is an ample fall in viscosity in each temperature up to 50°C which therefore indicates effective flow for lubrication in the temperature value. Whereas, for oil samples A, B & C there is only a little fall in viscosity, and this is due to the result that was shown in Table 4.5, indicating that A, B & C has a low viscosity even at 10°C.

Also, from the graph plot above it shows that as the temperature increases to higher degree, the change in the kinematic viscosity becomes very small which is same as the results gotten by [2] (Figure 2.1). Decrease of oil viscosity with increasing temperature was expected and corresponds with conclusions reported in literature [2]. Multigrade mineral base oil (SAE 20W-50) was observed to show the most adjustable kinematic viscosity with respect to temperature.

Oil samples (A, B & C) as shown in Table 4.5 have a very low difference in viscosity at 50°C and 70°C. During experiment, A, B & C were observed to be as water while pouring at 50°C and 70°C. It is therefore concluded that even if A, B & C could be managed they would cause more harm to recent motorcycle engines. Oil sample B & C were discovered to have closely related viscosity and velocity giving the assumption that they come from the same source. Close value of viscosity was calculated for SAE 40 and SAE 20W-50 at 50°C but different values at 10°C.

It can be concluded that knowledge of viscosity behaviour of engine oil as a function of its temperature is of great importance, especially when considering running efficiency and performance of combustion engines. Viscosity influences the ability of oil to flow, which in turn influences the motivating force, or pressure, required to push the oil sufficiently to develop the necessary flow. The rate of oil flow is important to the life of an engine. Previously, engine oil viscosity was of interest only to provide good hydrodynamic lubrication of load–bearing surfaces and to assure adequate flow throughout the engine. With recent advancements in engine controls that use engine oil for precise timing, oil viscosity has become increasingly important. Such advancements include cam phasing, active fuel management, and two-step valve actuation. These are all positive displacement devices that require an oil flow source to develop sufficient pressure which provides hydraulic actuation of components within an engine. Thus, their function can be sensitive to the viscosity characteristics of the oil.

CONCLUSIONSAND RECOMMENDATIONS

Conclusions

This study is primarily focused on quantification of how the viscosity of motor oil changes with temperature.

Most engine oil pumps are of the positive displacement gear type, and assuming the inlet is not starved, they will pump similar volumes of oil at any given rpm, whether the oil is cold or hot. The amount of power required to pump this volume will vary proportionally with temperature. This means the pressurized bearings in the engine will still get oil even at the lowest pumpable temperature. Being cold the oil will be highly viscous, protecting the bearings from wear. The biggest risk with thick, cold oil near the minimum pumping temperature is insufficient ring lubrication, due to the oil being too viscous to splash onto or flow correctly on cold cylinder walls.

The primary factor to consider when choosing engine oil is the manufacturer’s recommendations for the normal (non-W) viscosity and thermostat temperature. The combination of the two establishes an operating viscosity which is a critical design criterion for many engine systems. Changing the operating viscosity is not advisable! Of course, heavy-duty, Arctic or other operation not covered under the original design of the vehicle may dictate a different approach.

If your vehicle/motorcycle was designed to use 10W-30 oil, the use of 0W-30 oil will give similar oil viscosity at operating temperatures but allow for superior lubrication on start and warm-up. Many older cars were made before the recent development of multi-viscosity oils with a 0W or 5W rating but can greatly benefit from their use. This principle applies even more strongly to cars which were specified with 20W-50 oils. The use of 0W-50 oil will give similar viscosity at operating temperatures. At extreme cold temperatures 0W-50 will be as little as one eighth as viscous as 20W-50. This will assure superior lubrication until the engine is warmed up.

Although some of the imperfections of oil samples A, B & C can still be managed by motorcycles but not a car engine. However, it is advisable to purchase automobile consumable oils from registered companies or fuel stations.

Recommendations

Although some conclusions have been made, but the data gotten from the experiment can still be subjected to further processing to give full understanding of how viscosity changes with temperature as compared to density. If the experiment would be carried out again, I suggest that a falling ball viscometer be used for a more accurate result.

The reference temperature in this experiment if one is to conduct it, I advise should be 40°C to get more workable values for the kinematic viscosity according to SAE and ISO.

Conflict of Interest: None

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