Experimental studying of factors affecting on viscosity for lubricating oil

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Abstract:

Fluid flow plays a very important part in the processing of materials. Most processes are based on the use of fluid. The behavior of fluid in flow is very much related to two intrinsic properties of the fluid: density and viscosity.

The viscosity is the most important property of lubricating materials which is defined as the time of the lubricate. There are many factors that have negative effects on the viscosity and its value, away from the operating range allowed.

This paper aims to study some of those factors, including heat, pollution and their effects on the kinematic viscosity at atmospheric pressure, and to know the internal structure, and the additives, which could make an increase or decrease in the property of viscosity till the required level.

Some samples of different types of oils were taken such as Q8, TITAN, X Teer and SUHAIL to make comparisons between them by using two viscometers. The first one is called Rezgho viscometer and the other is called Zahn viscometer, where they are completely different from each other in the method of usage.

The first viscometer depends on an operating system to measure the viscosity at some known temperature which is entered by the researchers to test the viscosity at it, wheres the other viscometer depends on a manual operating system, and depends only on the time and the room temperature.

***Keywords** : viscosity, lubricant, viscometers*

1.Introduction:

The purpose of lubrication is to reduce the friction. Lubrication can help prevent corrosion by protecting the surface from water and other corrosive substances. They play an important role in controlling pollution within systems. Lubricants serve as a channel in which contaminants are transported to filters to be removed. These liquids also help to control temperature by absorbing heat from the surfaces and moving them to a lower temperature where they can be dissipated.

For any oil lubrication system, the viscosity is considered the most important parameter. When the oil viscosity is not within the specified viscosity, the condition known as lubrication is not enough will occur, resulting in increased friction, wear and heat. Viscosity determines the measurement of internal resistance fluids for a flow at a specified temperature. There are two ways to measure the viscosity of liquids, which are dynamic (absolute) viscosity and Kinematic Viscosity.

The dynamic viscosity is obtained through the reformulation of Newton's law.

$\tau = \eta.\gamma$

Kinematic viscosity (ν), describes a substance's flow behavior under the influence of Earth's gravity. Dynamic viscosity is divided by density which is defined as mass per volume. The quantity mass carries the gravitational influence.

$$\nu = \frac{\eta}{\rho}\left[\frac{m^2}{s}\right] \qquad \rho = \frac{m}{V}\left[\frac{kg}{m^3}\right]$$

The large-scale kinetic viscosity was created for historical reasons: gravity as a driving force does not require any detailed technical equipment. It is simply available everywhere on Earth. Kinetic viscosity is mostly used to identify petrochemical fluids such as fuel or lubricating oils.

“The viscosity of a lubricant changes with temperature – in almost all cases, as the temperature increases, the viscosity decreases; and – conversely – as the temperature decreases, the viscosity increases. To select the proper lubricant for a given application, the viscosity of the

fluid must be high enough that it provides an adequate lubricating film, but not so high that friction within the lubrication film is excessive. Therefore, when a piece of equipment must be started or operated at either temperature extreme – hot or cold – the proper viscosity must be considered."[1]

2-Types of oils:

Five types of oils were used in this experiments such as :-

TITAN SUPER GT 10W-40:

TITAN SUPER GT is recommended for year round use in passenger cars, light duty trucks and vans with naturally aspirated or turbocharged gasoline engines. It can also be used in light duty diesel engines.

XTeer GASOLINE 10W40:

XTeer gasoline is the most advanced gasoline engine oil designed for premium cars with the latest technology, it meets the requirements of current advanced engine oil grade of API SN. It is optimized to provide outstanding protection and lubricity in all passenger gasoline car engines. It is used for all premium gasoline vehicles (both naturally aspirated and turbocharged engines, it is used also for high performance cars, and finally it is suitable for all seasons(-20°C/-4°F)

Q8 Formula Advanced 10W-40:

This type of oil is used for high quality synthetic based engine oil formulated with Q8 hydro-cracked components. And it is recommended for passenger cars and vans equipped with modern gasoline or LPG

engines with catalysts. Eventually it is suitable for normally aspirated or turbocharged diesel engines with or without direct injection.

SUHAIL 15W40:

It is an extra high performance diesel engine oil that provides excellent lubrication of today's diesel engines promoting extended engine life. This extra high performance has been proven in the field in a wide variety of industries, applications, and mixed fleets.

The advanced chemistry of this product provides outstanding performance in both modern, demanding low-emission diesel engines and older diesel engines operating on low or high sulphur fuel. Mobil Suhail 15W-40 combines a blend of high performance base stocks with a progressive additive system to provide superior control of oil thickening due to soot build-up and high temperatures as well as outstanding resistance to oxidation, corrosion, and high temperature deposits.

3-Technical processes

Many different experiments were done, with two different viscometers, and each experiment has its own device (viscometer) and its own type of testing oil, which means that each experiment has its own results independently from the other experiments.

The Herzog Multi-Range Viscometer (HVM 472)

Zahn Cup Viscometer

4-Calculation:

For calculating a couple of determined kinematic viscosity values, $v_1$and v_2, from the measured flow times, t_1 and t_2, and the viscometer constant, *C*, the following equation will be needed:

$$v_{1,2} = C \cdot t_{1,2} \qquad (1)$$

Where:

$v_{1,2}$ = determined kinematic viscosity values for v_1 and v_2, respectively, mm^2/s.

C = calibration constant of the viscometer, mm^2/s^2,

$t_{1,2}$ = measured flow times for t_1 and t_2, respectively, s,

Calculate the kinematic viscosity result , as an average of v_1, v_2.

Calculate the dynamic viscosity η from the calculated kinematic viscosity, *v*, and the density, ρ, by means of the following equation:

$$\eta = v * \rho * 10^{-3} \qquad (2)$$

Where:

η = dynamitic viscosity mPa·s,

ρ = density, Kg /m^3 at the same temperature used for the determination of the kinematic viscosity and,

v = kinematic viscosity mm^2 /s.

5-Results:

The tables below show the experiments results by using **Herzog Viscometer** to test four types of oil versus different temperatures.

Q8 Oil	
Temp	kinematic viscosity
0	988.74
20	264.81
40	96.88
60	44.25
80	23.73
100	14.33
120	9.45
140	6.67

Table 1: The kinematic viscosity of Q8 oil at different temperatures.

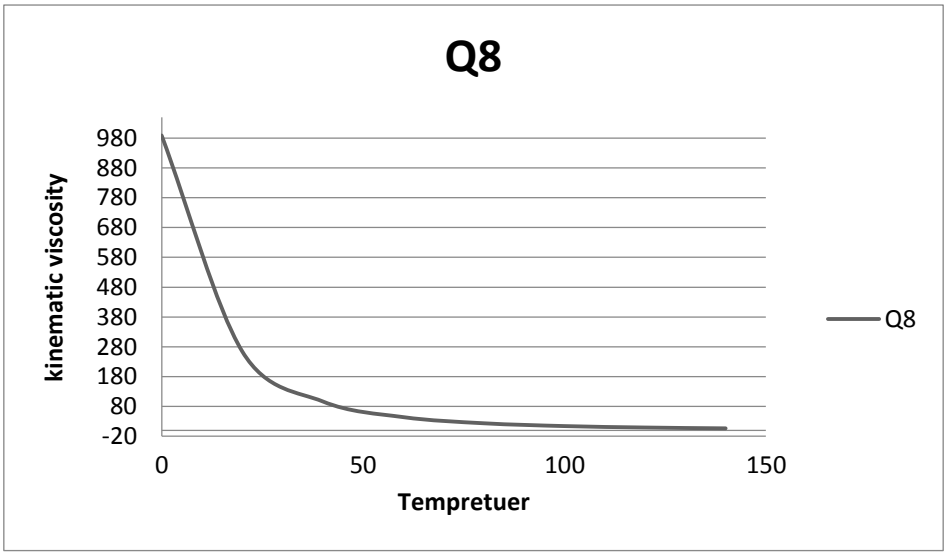

Figure 1: Relation between kinematic viscosity and temperature

TITAN Oil	
temp	kinematic viscosity
0	921.09
20	251.07
40	93.02
60	42.87
80	23.15
100	14.047
120	9.3
140	6.59

Table.2: The kinematic viscosity of Titan oil at different temperatures.

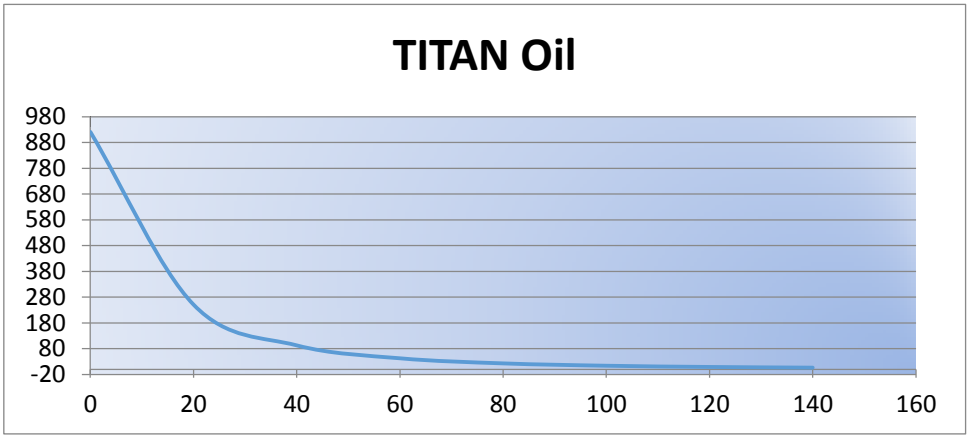

Figure 2: Relation between kinematic viscosity and temperature

XTeer Oil	
temp	kinematic viscosity
0	989.16
20	264.69
40	96.78
60	44.19
80	23.7
100	14.3
120	9.44
140	6.66

Table 3: The kinematic viscosity of XTeer oil at different temperatures.

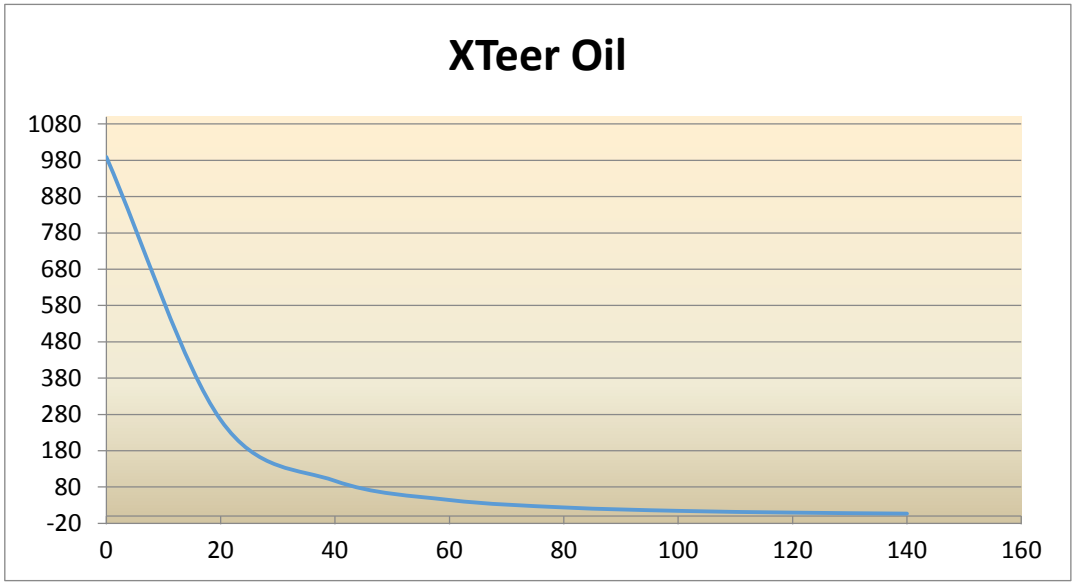

Figure 3: Relation between kinematic viscosity and temperature

Sohail oil	
Temp	kinematic viscosity
0	1333.18
20	318.83
40	108.12
60	46.9
80	24.28
100	14.3
120	9.27
140	6.46

Table 4: The kinematic viscosity of Sohail oil at different temperatures.

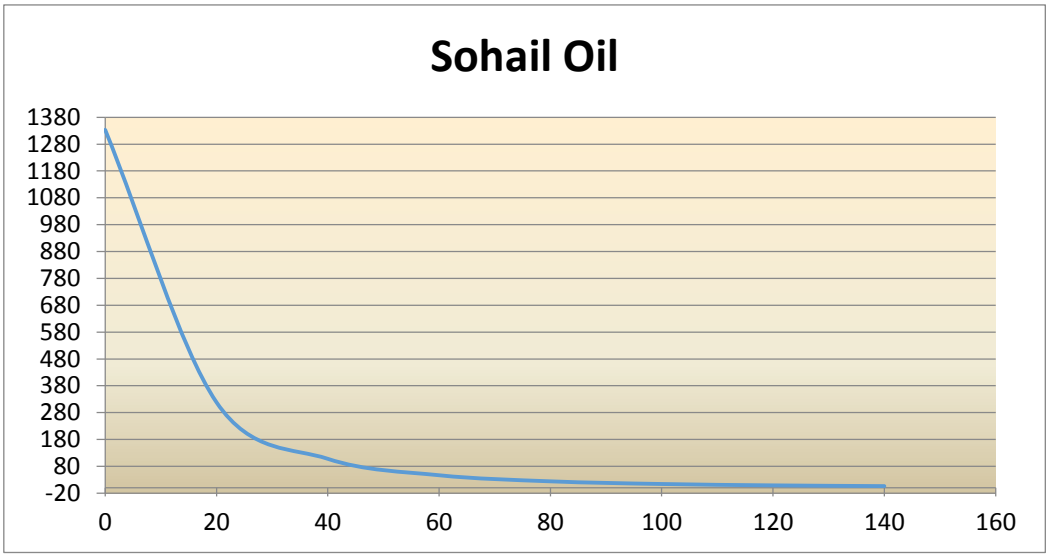

Figure 4: Relation between kinematic viscosity and temperature

The tables and figures below show that the experiments are tested to show how the impurities effect the viscosity, where in the first experiment there was tested a randomly chosen oil with no impurities to check how much time does it require to drain the oil, then 2%, 7% impurities were added to the oil to see if the viscosity gets higher or lower.

Pure Oil		Ave Time
Times	Time (Sec)	34.283
Time 1	34.45	
Time 2	34.1	
Time 3	34.3	

Table 5: Times of draining the oil with no impurities

Impurities of 2%		Ave Time
Times	Time (Sec)	32.423
Time 1	32.71	
Time 2	32.11	
Time 3	32.45	

Table 6: Times of draining the oil with 2% impurities

Impurities of 7%		Ave Time
Times	Time (Sec)	30.533
Time 1	31.1	
Time 2	30.3	
Time 3	30.2	

Table 7: Times of draining the oil with 7% impurities

6- Conclusion:

It was seen that temperature has a negative effect on the viscosity of the lubricants specially those who require certain level, which must not get lower than that level of viscosity that may get the machine stop working which depends on the idea of this manner of working.

We concluded from the previous results that the sohail oil has the largest viscosity, in which for example at $40C^{o}$ the values of viscosity were 108.12, 96.78, 93.02 for sohail oil, XTeer oil and Titan oil respectively.

Impurities also has a negative affection on viscosity but that does not mean that all types of oils have the same affect and properties. for example, there are some types which may get lost at certain temperature. That does not mean temperature should not get lower or higher to keep the required level of viscosity. but there are several ways that may help keeping the required viscosity level and it is called lubricants additives.

A change could be made in the internal construction of the lubricant by adding these additives, and that depends on the reason of adding them. For instance some are added to make the oil resist the extreme temperatures, and some are added to make the oil last with the high pressure, and other with low pressure and other situations.

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