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Effect of Temperature on Selected Motors Oils

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Abstract: The present study contains investigation of the viscosity of different selected motors oils. The viscosity of the selected motors oils has been studied at different temperatures. We studied the behaviour of those oils using rotating viscometer. It was found that the viscosity decreases with increasing temperature. The present study has studying the activation energy for the motors oils. It was found that the activation energy for the best oil less than the others oils.

Key words: Viscosity, motors oils, temperature, activation energy, viscometer, behaviour

INTRODUCTION

Viscosity is the property that describes a real fluids resistance to flow. When real fluids flow in a pipe, a frictional force parallel to the surface in the direction of flow has to be overcome in order to move the fluid through the pipe. The layers of fluid in contact with the inside wall of the pipe are at rest due to adhesive forces between the liquid molecules and molecules of the wall material whereas the fluid in the centre of the pipe moves with maximum velocity. Each successive layer of fluid between the pipe wall and the centre moves with distance across the tube is called the velocity gradient. (Gradient is measure of how a certain parameter changes with distance).

If a shearing stress is applied to any portion of a confined fluid, the fluid move and velocity gradient will be set up within the fluid with a maximum velocity at the point where the stress is applied. If the shear stress per unit area at any point is divided by the velocity gradient, the ratio obtained is defined as the (viscosity) of the medium.

It can be seen, therefore, that viscosity is a measure of the internal fluid friction which tends to oppose any dynamic change in the fluid motion. If the friction between layers of fluid is small (low viscosity) an applied shearing force will result in large velocity gradient. As the viscosity increase, each fluid layer exerts a larger friction drag on adjacent layers and the velocity gradient decreases (Serway, 1996; Schaschke, 2014; Viswanath *et al*., 2007; Grass, 1971).

MATERIALS AND METHODS

Experimental work: In this study, the material examined is a selected motors oils for contrast the noticed consequences. The objective of the research is to investigate the viscosity properties of motors oils at different temperatures.

Measurements of viscosity: Most viscometers monitor the ease with which fluid flow through capillary tubing. Let us now derive an expression relating the viscosity of liquid (η) to the experimental methods for measuring the viscosity of liquid for the following methods: Poiseulles method, Stokes method, Ostwald viscometer and using rotating cylinder viscometer.

We use the rotating cylinder viscometer shown in Fig. 1. We can produce slow shearing a thin fluid film between two large flat plates or between the surfaces of coaxial cylinders. If these plates have the same surface area, the shear stress on their surface is equal, as are the velocity gradients there. The rotational viscometer which generally consists of two concentric cylinders one rotate with respect to one another, the space between them is filled with liquid whose viscosity is to be measured.

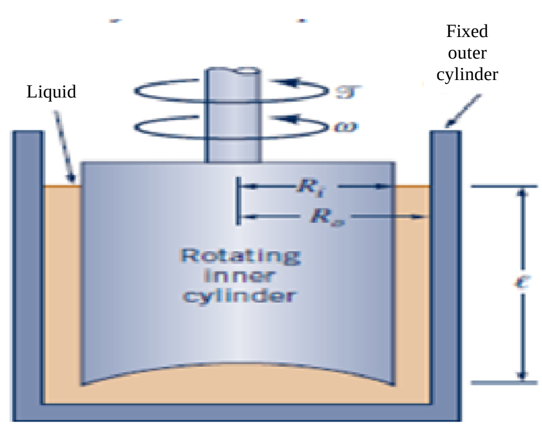

Fig. 1: The rotating cylinder viscometer

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The rate of rotation under the influence of a given torque is indicative of the velocity of the liquid. If a cylinder is suspended inside a coaxial cylinder and it is allowed to rotate about the common axis with constant angular velocity and the space between the two cylinders is filled with a viscous fluid a measurement of the viscosity may be obtained from the couple produced on the stationary cylinder (Napolitano *et al*., 1965; Hibberd, 1952).

A portable Viscometer (VT-04) using a certain rotator that covers the range (0.3-13) poise. And Viscometer (VT-03) using other rotator to cover the range (1.5-33) cm poise.

RESULTS AND DISCUSSION

Effects of temperature on viscosity of liquid: The viscosity of liquids varies markedly with temperature but more importantly, it decreases with increasing temperature. The value of viscosity for water at 20°C is 1 mPa.sec or 1 CP. Most ordinary liquids have viscosities on the order of 1-1000 mPa.sec. Generally, the viscosity of liquids decreases with increasing temperature (and vice versa). As temperature increases, the average speed of the molecules in liquid increases and the amount of time they spend (in contact) with their nearest neighbours decreases. Thus, as temperature increase, the average intermolecular forces decrease and the variation is non-linear.

In this study, we studied the behaviour of motor oils under low and high temperature conditions, the first number describes the effect of temperature of (A oil), (B oil) and (C oil) using rotating viscometer.

It is clearly seen from the results obtain in the laboratory that the viscosity of liquid depends on temperature to very marked extent in which the viscosity of liquids decrease with increasing temperature following an exponential form.

It was first shown empirically by the Spanish physical chemist J. de Guzman that the viscosity obeys the law of the Arrhenius type in which the viscosity expressed as:

$$\eta = A_{vis} \exp\text{-}(bK_B T) \quad (1)$$

Where:

b = The constant for each liquid
A_{vis} = Pre-exponential factor which is constant for give liquid
K_B = Boltzmann's factor
T = Temperature (K)

According to the discussion of A_{vis} it could be expressed in the above equation as (η_o) and (b) is related the activation energy:

$$\eta = \eta_o\left(e\text{-}\frac{\Delta\xi}{K_B T}\right) \quad (2)$$

Arrhenius equation provides us with a mean of determining the value of activation energy from measurement of viscosity of such fluid at two different temperatures (Munson *et al*., 2012).

The activation energy: Express the minimum kinetic energy that the molecules must possess to overcome the repulsion between their electron clouds when they collide (Rao, 2013).

The viscosities of liquids decrease with increasing temperature either under isobaric conditions or as saturated liquids. It is often a good approximation to assume Ln(ηL) is linear in reciprocal absolute temperature, i.e:

$$\text{Ln}(\eta_L) = A+\frac{B}{T} \quad (3)$$

This simple form was apparently first proposed by de Guzman in 1913, another variation involves the use of a third constant to obtain Vogel equation:

$$\text{Ln}(\eta_L) = A+\frac{B}{T+C} \quad (4)$$

Goletz and Tassios have used this form (for the kinematic viscosity) and report values of A-C for many pure liquids.

Equation 4 requires at least two viscosities temperature datum point to determine the two constant. If only one datum point is available, one of the few ways to extrapolate this value is to employ the approximate Lewis Squires chart which is based on the empirical fact that the sensitivity of viscosity to temperature variations appears to depend primarily upon the value of the viscosity. Liquid viscosity can be expressed in an equation form as:

$$\eta_L^{-0.2661} = \eta_K^{-0.2661} + \frac{T\text{-}T_K}{233} \quad (5)$$

Where:

η_L = Liquid viscosity at T, CP
η_K = Known value of liquid viscosity at T_K CP
T and T_K = May be expressed in either °C or K°

Thus, given value of η_L at T_K, one can estimate value of η_L at other temperature.

Data and data analysis: The change in the viscosity of the motors oils versus temperature is shown in Fig. 2. For

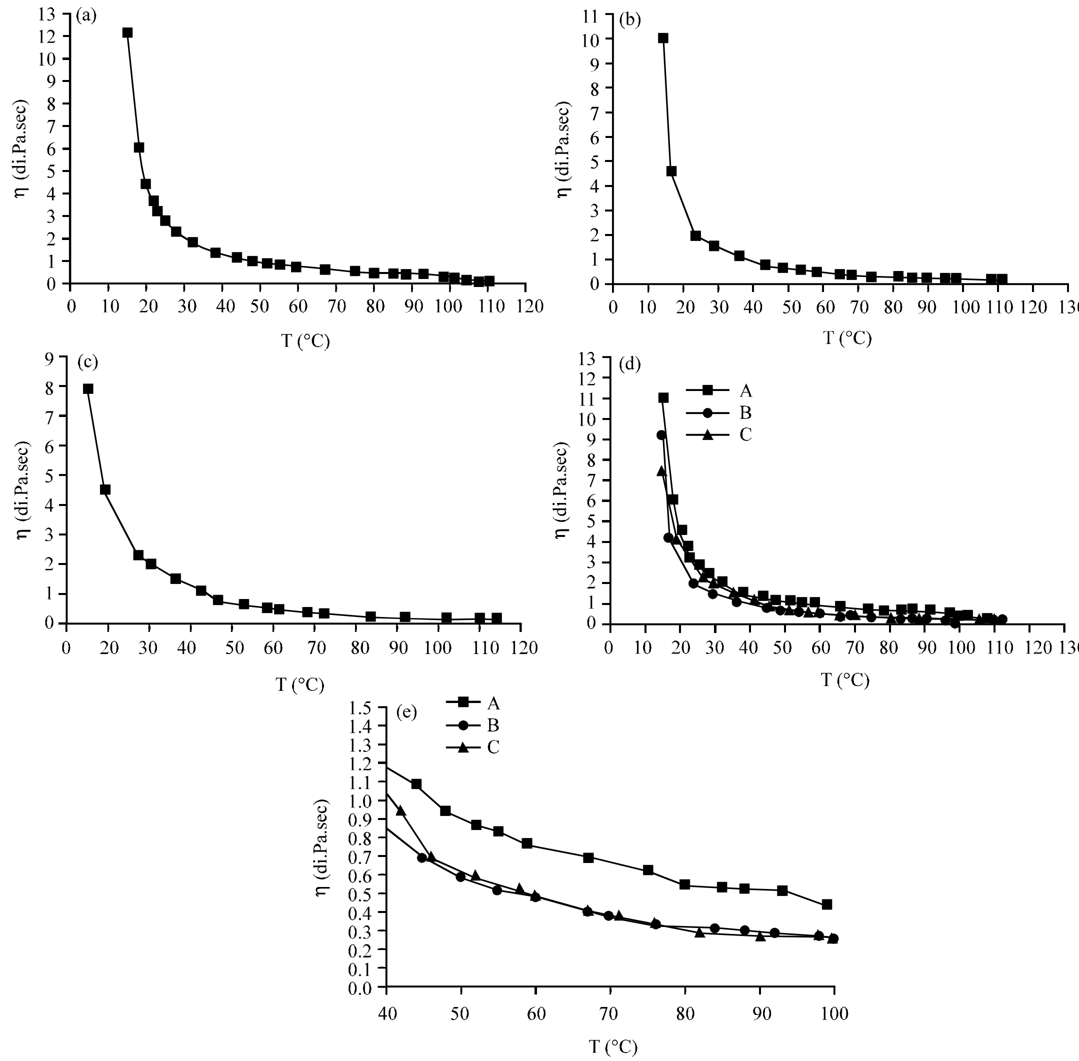

Fig. 2: a) The viscosity at different temperatures for motor oil (A); b) The viscosity at different temperatures for motor oil (B); c) The viscosity at different temperatures for motor oil (C); d) Comparison the viscosity at different temperatures for motor oils (A-C) and e) Comparison the viscosity at high temperatures for motor oils (A-C)

motors oils (A-C) at different temperatures. It can be clearly seen that the values of viscosity decrease with temperature dissimilar. An increase in temperature leads to a decrease in values of (η). The coefficient of viscosity (η) decrease with increase in temperature for all motors oils as shown in Fig. 2.

Finally, coefficient of viscosity (η) decrease with increase in temperature for motors oil (A) less than motor oil (B) and motor oil (C) as shown in Fig. 2-c.

In this paper, we study effect of temperature on viscosity of different oils. And we have this data as shown in Table 1.

The viscosity of motor oil, like most fluids, varies with temperature. At high temperature of the oil (60-100)°C after the engine has been running for some time, we can compare between different oils. The change in the viscosity of the motors oils versus temperature is shown in Fig. 2d for motors oils (A-C) at high temperatures (60-100)°C after the engine has been running for some time, we can compare between different oils. Note that, the viscosity for (A) oil less than the others oils.

To calculate the activation energy for different oils, we used Eq. 2. And then plot graph between $L_n(\eta)$ and (1/T) shown in Fig. 3 and we have this data as shown in Table 2. Note that the activation energy for (A) oil less than the others oils because of the minimum kinetic energy of the molecules for oil (A) must possess to overcome the repulsion between their electron clouds when they collide.

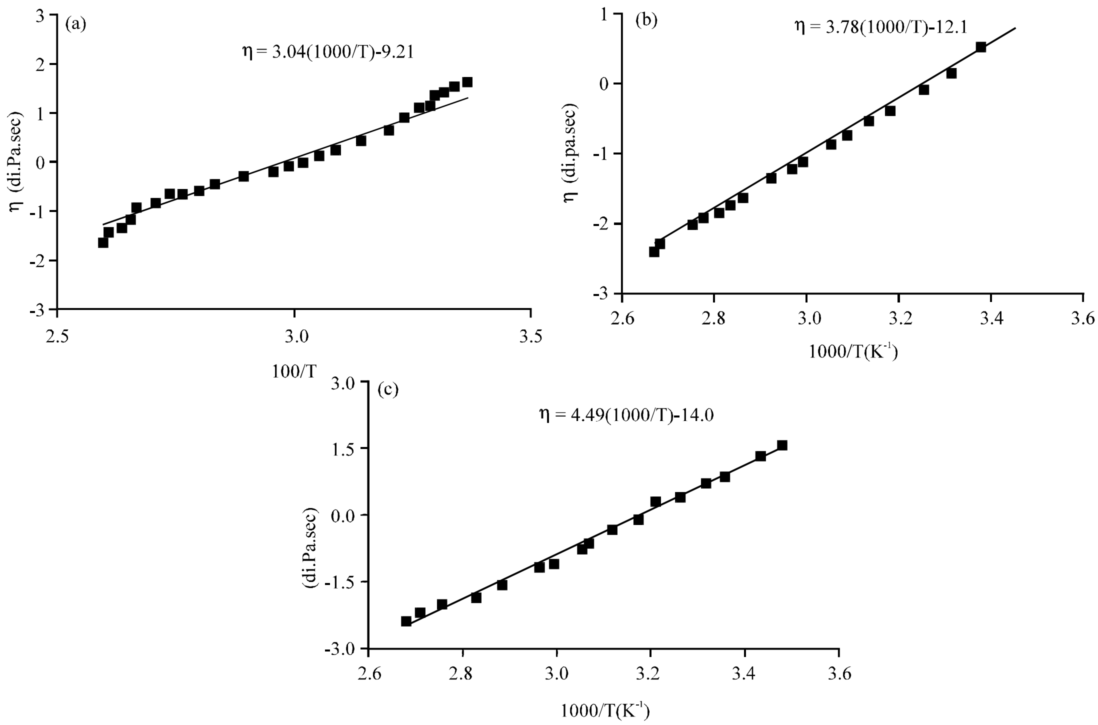

Fig. 3: a) The viscosity as $L_n(\eta)$ at different temperatures as (100/T) for motor oil (A); b) The viscosity as $L_n(\eta)$ at different temperatures as (100/T) for motor oil (B) and c) The viscosity as $L_n(\eta)$ at different temperatures as (100/T) for motor oil (C)

Table 1: The coefficient of viscosity of different oils motors

Types of oil	η (di.Pa.sec) T = 60°C	η (di.Pa.sec) T = 70°C	η (di.Pa.sec) T = 80°C	η (di.Pa.sec) T = 90°C	η (di.Pa.sec) T = 100°C
A	0.85	0.70	0.60	0.500	0.400
B	0.50	0.35	0.20	0.175	0.150
C	0.45	0.33	0.15	0.150	0.125

Table 2: The activation energy for different oils

Types of oil	Slope	Activation energy (J)
A	3.04	4.197×10^{-20}
B	3.78	5.218×10^{-20}
C	4.49	6.198×10^{-20}

CONCLUSION

The viscosity of motors oils were studied. By studying the results, we deduced that:

- The viscosity of the motors oils decrease with temperature
- The activation energy for oil (A) less than the others oils
- The best oils which its viscosity and activation energy is small compare to other oils

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