EXP.NO. (3)

Falling ball viscometer

The aim of experiment

-To determine the viscosity of glycerin

-To determine how the viscosity of a liquid varies with temperature

Theory

Viscosity is resistance to flow. For liquids, typically the larger the intermolecular forces the higher the viscosity. The other factors that affect viscosity are temperature and the shape of the molecule. The viscosity of liquids decreases when the temperature increases, while the viscosity of gases increases with the increase of temperature. This is due to reason that the viscous forces in a fluid are due to cohesive forces and molecular momentum transfer. Dynamic viscosity is the force needed by a fluid to overcome its own internal molecular friction so that the fluid will flow.

A body that moves in a fluid is affected by a fractional force in the opposite direction of its velocity. The magnitude of this force depends on the geometry of the body, velocity and the internal fraction of the fluid .**The dynamic viscosity (η)** is calculated using the following equation:

$$\eta = K\,(\rho_1 - \rho_2).\,t \quad \text{------------(1)}$$

Where: K= Ball constant =0.007 mpa.cm^3/g

ρ_1= Density of ball=2.2 g/cm^3

ρ_2 = Density of glycerin is 1258.6 Kg/ m^3

t = Falling time of the ball in seconds

The kinematic viscosity (**ν**) of a fluid is the ratio of the viscosity of the fluid to the density. Mathematically, it is expressed as:

$$\nu = \frac{\eta}{\rho} \quad \text{-------------(2)}$$

ν= Kinematic viscosity [cm^2/s]

η = Dynamic viscosity [mpa.s]

ρ = Density of the liquid sample [g/cm^3]

Dynamic viscosity for some common liquids at temperature 37° are indicated below:

Fluid	Absolute Viscosity (Ns/m^{2}, Pas)
Glycerine	0.950
Heptane	0.000376
Mercury	0.0015
Distal water	0.00089
Blood	0.003-0.004

Apparatus

- Cylindrical measuring tube, spherical glass ball .

-The measuring tube is positioned slightly inclined about 10^{0} to the vertical position surrounded by outer glass tube which can be filled with temperature controlled water. The assemblies is pivoted can be turned upside down as shown in Figure 1

-Water bath and stop watch.

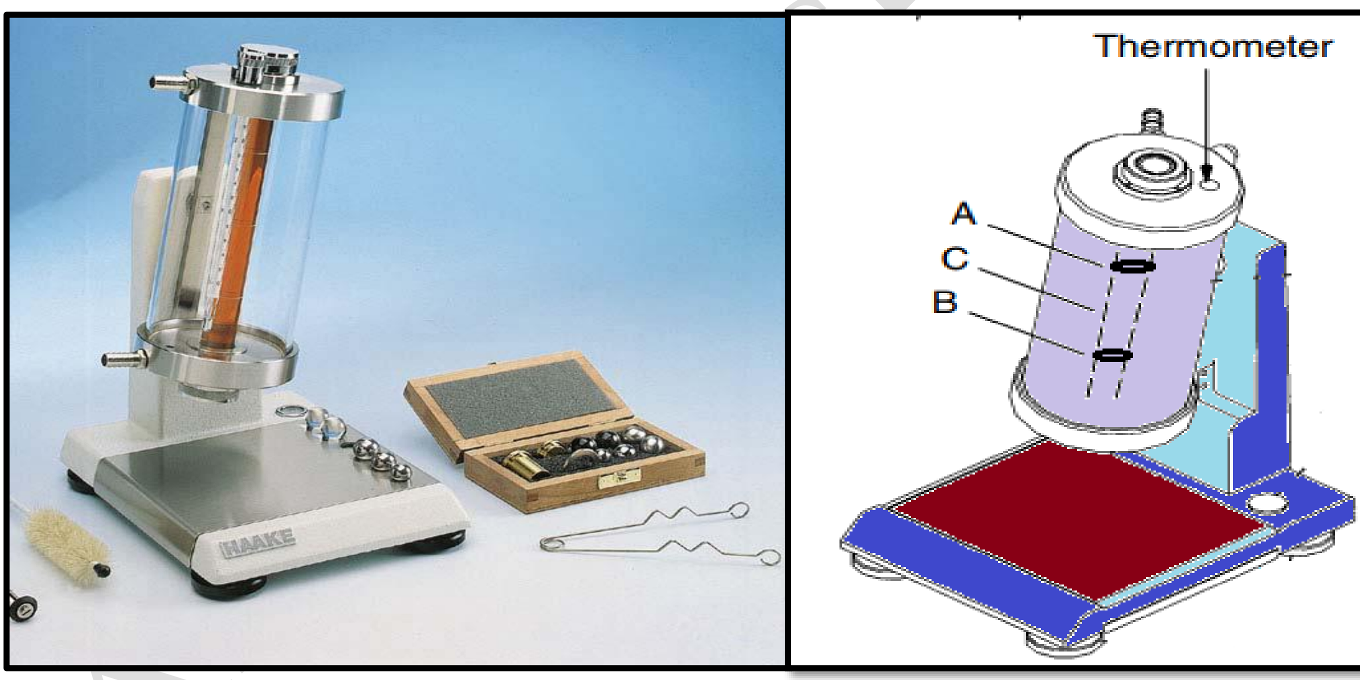

Figure (1): a. Viscometer instrument b. Schematic viscometer measuring tube

Methodology

1- Determine the viscosity of the glycerin

* Fill the measuring tube with glycerin
*Put down the ball in the measuring tube
*Determine the falling time of the ball from ring A to ring B by using stop watch
*The time period starts when the lower periphery of the ball touch the ring A, and the falling time end when the lower periphery of the ball touch ring B.
*Turn the tube 180^0 again the ball return to its start position.
*Falling time repeated three time at room temperature and then determine the average value of measuring results.
*Find the viscosity of glycerin from the equation (1 and 2).

2- Change the viscosity of a liquid according to various temperatures

*Switch on the thermostat and set temperature at 40^0c
*Wait until temperature stabilizes then measure the ball falling time
*Repeat the previous step at different temperature and then write results as shown in table 1
*After completing the experiment, set the temperature on the thermostat near the room temperature and turn off the power supply.
*Tabulate the reading

Table 1: the relation between temperature and falling time

T.C^0	**t/sec**

*Plot a graph between the temperature and the time.
*Discuss the result.

Medical application

Viscosity is of critical importance in medicine as fluids are introduced into the body intravenously:
1-measurement of blood viscosity before and after dialysis.
2-Plasma viscosity measurement , amniotic and synovial fluid .
3-measuring the viscosity of bile .
4-Determining the sedimentation rate of RBC_s (ESR) .