

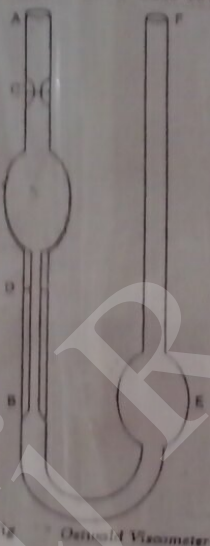
EXPERIMENT NO.

1. Object:

Determine of viscosity of test liquids provided with the help of ostwald viscometer.

2. Introduction:

General Discussion: Viscosity of a liquid may be defined as internal friction of resistance between the two layers of a liquid moving apart one another with different velocities. It is generally denoted by η . The viscosities of different liquids are measured by viscometers and compared in terms of coefficient of viscosity, which is defined as the force in dynes per square centimeter required to maintain a difference in velocity of 1 cm per second between two parallel layers of a liquid held at a distance of 1 cm from each other.



Viscosity is measured by using Ostwald's viscometer method. The time taken by the different liquids to travel from point C to D is measured. This method is based on Poiseuille's law. The rate of flow of a liquid through a capillary tube relates with the coefficient of viscosity of liquid by equation.

$$\eta = \frac{\pi r^4 \Delta P}{8Vt}$$

where η = Coefficient of viscosity (poises)

- r = radius of tube (cm)
- l = length of tube (cm)
- t = time for flow (sec.)
- V = Volume of liquid (ml)
- P = Pressure (dynes/cm²)

The pressure of a liquid column is given by

$$P = h \rho g$$

Where h = height of column
 ρ = density of liquid

$$\eta = \frac{\pi r^4 t h \rho g}{8 V l}$$

It is not necessary to determine all the quantities. The viscosity of water at different temperatures has been measured accurately. In usual practice, the viscosity of given liquid is measured with reference to that of water. This is known as relative viscosity. In actual practice, only the time of flow for equal volumes of water and the liquid under study was measured. Let t_1 and t_2 are the times of flow of the same volume of water and the liquid respectively and η_1 and η_2 are their coefficient of viscosity, then

$$\frac{\eta_1}{\eta_2} = \frac{\pi r^4 t_1 h \rho_1 g}{8 V l} \times \frac{8 V l}{\pi r^4 t_2 h \rho_2 g}$$

value of h is same in both cases, V is same, therefore,

$$\frac{\eta_1}{\eta_2} = \frac{t_1 \rho_1}{t_2 \rho_2}$$

Knowing the coefficient of viscosity of water (η_1) that of other liquid (η_2) can easily be calculated.

3. Requirement

A) Reagents:

- i) Test liquids whose viscosity is to be determined
- ii) Distilled water
- iii) Acetone (for washing the viscometer)

B) Apparatus:

- i) Viscometer
- ii) Specific gravity bottle if density is to be determined
- iii) Rubber Tube & Pinch Cock
- iv) 100 ml beakers 2 Nos.
- v) Pipette (25 ml)
- vi) Stop Watch
- vii) A bottle of distilled water

4. Procedure:

- i) Clean the viscometer with chromic acid mixture and then wash it with water. Finally wash it thoroughly with solvent. Dry the viscometer in electric oven. (40-50°C to 10 minutes)
- ii) Attach a piece of clean rubber tube to the end A and clamp the viscometer exactly in a vertical position.
- iii) Introduce 15ml of distilled water by means of pipette into the large bulb E through the end F.
- iv) Suck the water through the tube at the end A, until it rises 1-2 cm above the mark C. Allow the liquid to flow by releasing the pressure.
- v) Start the stop watch when the meniscus of the liquid passes the mark C and stop the watch when it reaches the mark D. This gives the time of flow of water from mark C to D. Repeat the measurements about four or five times and take the mean value. The readings should not differ by more than 0.2 percent of the mean value of time.
- vi) Clean the viscometer with solvent (alcohol or acetone) and then dry it.
- vii) Fill the viscometer with the given liquid (same volume as in the first reading) and determine the time needed for the liquid meniscus to pass the marks C and D. Take four or five readings and the mean value.
- viii) Determine the specific gravity of liquid at the given temperature by pycnometer or sp. Gravity bottle.

5. Observations:

Room temperature = $t^{\circ}\text{C}$

Density of water at $t^{\circ}\text{C} = d_1$ (from ref. table)

Viscosity of water at $t^{\circ} = \eta_1$ (from table)

Measurement of time of flow of liquids

S.No.	Water	Liquid
	Time of flow in seconds	Time of flow in seconds
1.		
2.		
3.		
4.		
Mean =	t_1	t_2

2. Measurement of density (d_2)

i) Weight of sp. Gravity bottle = x gm

ii) Weight of sp. Gravity bottle and water = y gm

iii) Weight of sp. Gravity bottle and liquid = z gm

Weight of water = $(y - x)$ gm

Weight of liquid = $(z - x)$ gm

$$\text{Relative density of liquid} = \left(\frac{t_2 - t_1}{t_2 - t_1} \right) \frac{d_2}{d_1}$$

Calculation of viscosity

The viscosity of a given liquid is calculated as

$$\frac{\eta_1}{\eta_2} = \frac{t_1}{t_2} \times \frac{d_2}{d_1}$$

$$\eta_2 = \frac{d_2 t_2}{d_1 t_1} \times \eta_1 \text{ poise}$$

6. Result:

The viscosity of given liquid is poise.

7. Precautions:

- i) The viscometer and specific gravity bottle or pycnometer should be thoroughly washed.
- ii) The viscometer should be adjusted in vertical position.

Table I: Surface Tension of some common liquids in dynes/cm

Liquid	20°C	30°C	40°C
Ethyl acetate	23.90	-	-
Acetone	23.70	-	-
Water	72.75	71.28	71.16
Benzene	28.88	27.56	69.56
Toluene	28.44	27.32	26.26
o-Xylene	30.03	28.93	26.13
p-Xylene,	28.63	27.54	27.9
p-Xylene	28.37	27.22	26.7
Ethyl alcohol	22.27	21.43	26.8 at 35°
Carbon tetrachloride	26.77	25.53	20.60
Ether	17.01	15.93	24.41
Chloroform	27.10	-	-
n-Propyl alcohol	28.75	22.89	-
n-Butyl alcohol	24.52	23.18 at 25°C	-
Ethylene glycol	47.7	-	-
Glycerol	63.4	-	-

Table 2: Viscosities of some common liquids in poises

Liquids	20°C	30°C	40°C	50°C
Water	0.010019	0.00890	0.006654	0.0056
Ethyl alcohol	0.01200	0.01033	0.00834	
Benzene	0.00647	0.00561	0.00492	
Chloroform	0.00563	0.00510	0.00464	
CCl ₄	0.00975	0.00841	0.00746	
Toluene	0.00590	0.00525	0.00471	
Acetone	0.00322	0.00293	0.00268	
Carbon disulphide	0.00366	0.00348	0.00319	
Ethyl acetate	0.00449	0.00400	0.00360	
Ethyl ether	0.00243	0.00220	0.00199	
Aniline	0.00427	0.00311	0.00236	
n-Propyl alcohol	0.002256	0.00172		
n-Butyl alcohol	0.002948	0.00230	-	
Ethylene glycol	0.199	0.1335	-	
Glycerol	14.9	6.29	-	

Table 3: Densities of some common liquids at 15°C

Organic Liquid	Density	Organic liquid	Density
Ethyl alcohol	0.7850	Ethyl Acetate	0.9277
Methyl alcohol	0.7960	Methyl acetate	0.8941
Benzene	0.8734	Chloroform	1.4797
Toluene	0.8725	n-Propyl alcohol	0.796
Carbon Tetrachloride	1.05844	n-Butyl alcohol	0.8057
Acetone	1.0524	Ethylene glycol	1.1099
		Glycerol	1.2613 at 20°C