Experiment 1

Determination of Absolute and Relative Density of Ethanol

Objective:

- Accuracy of the determination of the weight (mass) by different balance
- Determination of absolute density of a liquid and relative density

Introduction

Density of the liquid or solution is defined as the mass of unit volume, density is also termed specific gravity. The relative density of liquid or solution is defined as the ratio of weight of a given volume of that liquid to the weight of an equal volume of water at the same temperature.

d= W/V

Where

m = Mass V = Volume D= Density

The relative density for solution 1 &2 is:

$$d_1 = w_1 / v_1 \qquad d_2 = w_2 / v_2$$

$$d_1 \backslash d_2 = (w_1 / v_1) \backslash (w_2 / v_2)$$

$$d_1 \backslash d_2 = w_1 / w_2$$

Equipment and Chemicals:

Density bottle, balance, ethyl alcohol, dist. Water.

Procedure:

1. Clean the density bottle with dist. water then alcohol and dry it using stream of air from suction pumb.

2. Weight the empty bottle and record the weight (w_1).

3. Fill the bottle to the mark with dist.water. Warm it to 25 ^{0}C and weight the bottle with water, record the weight (w_2).

4. Calculate the weight of water (W_{H2O}).

5. Repeat step 3 at 30 ^{0}C, 35 ^{0}C, 40 ^{0}C.

6. Refill the bottle with ethanol up to the same mark as in step 3, then weight the bottle, records the weight (w_3).

7. Calculate the weight of ethanol (W_{EtOH}).

8. Repeat step 6 at 30 ^{0}C, 35 ^{0}C, 40 ^{0}C.

9. Find out the density of water d_2 and the density of ethanol d_1 this called the absolute density.

10. We can calculate the density of liquid by using relative density.

Data and Calculation

T ^{0}C	**d_2 water**	**W ethanol**	**W water**	**$d_1 \backslash d_2 = W_{ethanol} / W_{water}$**	**$d_1 = (W_{ethanol} / W_{water}) x d_2$**
25	**0.99707**				
30	**0.99567**				
35	**0.99406**				
40	**0.99224**				

Questions:

1- Liquid water has a density of 1000 kgm^{-3}, while ice has density of 920 kgm^{-3}.

Calculate the volume occupied by 0.25kg of each.

2- Osmium is a very dense metal. What is its density in g/cm3 if 50.00 g of the metal occupies a volume of 2.22 cm^3?

3- The density of octane, a component of gasoline, is 0.702 g/mL. What is the mass, in kg, of 875 mL of octane?

Experiment 2

Determination of Absolute and Relative viscosities of ethanol as a Function of Temperature

Introduction

Viscosity is the frictional forces acting between the different layers of the liquid. The coefficient of viscosity (η) is the force required per unit area to maintain unit difference of velocity between two parallel planes in the fluid, 1 cm apart. The unit of viscosity is called poise. (1 poise = 0.1 Pa s).

The viscosity of a liquid may be determined by measuring its rate of flow through a capillary tube. For a liquid flowing through a capillary tube of radius "r", for a time "t", under a constant pressure "P" the volume "V" of liquid issuing from the tube is given by Poiseuille's equation :

$$V = \frac{\Pi r^4 P t}{8 L \eta} \qquad (1)$$

Where, L is the length of the tube.

The viscosity coefficient is given from equation (1) as

$$\eta = \frac{\Pi r^4 P t}{8 L V} \qquad (2)$$

If the dimensions of the capillary and the volume of the liquid flowing through it are constant, equation (2) reduced to

$$\eta = kPt \qquad (3)$$

Where

$$k = \frac{\Pi r^4}{8LV}$$

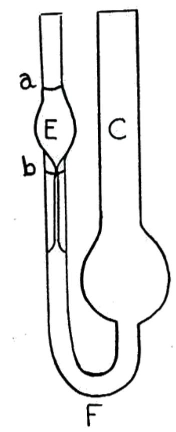
Thus, although the determination of absolute viscosity is a matter of some difficulty, the ratio of the viscosities of two liquids may be readily determined using a viscometer. The pressure P at any instant driving the liquid of density d through the capillary of a viscometer is equal to "hdg", where "h" is the difference in height between the levels in each limb of the instrument and "g" is the acceleration of gravity. Although "h" varies throughout the experiment the initial and final values are same in every case, hence P is proportional to the density.

The relationship between the viscosities η_1 and η_2 of two liquids 1 and 2 having a densities d_1 and d_2 is

$$\frac{\eta_1}{\eta_2} = \frac{d_1 t_1}{d_2 t_2} \qquad (4)$$

Where, t_1 and t_2 are the times of flow. The viscometer must therefore be calibrated by using a liquid of known viscosity and density ,e.g water.

The above method based on Oswald viscometer



However Rotational viscometer is now being used widely to measure the viscosity of any solutions based on the resistance of the liquid against the rotational probe

The viscosities of most liquids decrease, with increasing temperature, According to the "hole theory", there are vacancies in a liquid, and molecules are continually moving into these vacancies so that the vacancies move around. This process permits flow, but requires energy because a molecule must surmount an activation barrier to move into a vacancy. The variation of the coefficient of viscosity with temperature may be represented by

$$\frac{1}{\eta} = Ae^{\left(\frac{-E_a}{RT}\right)} \qquad (5)$$

Where, E_a *is* the activation energy of the fluidity, Equation 5 can be written in the form

$$\ln\left(\frac{1}{\eta}\right) = \ln(A) - \frac{E_a}{RT} \qquad (6)$$

This is a straight line relation, the plot of ln(1/η) versus (1/T) fives a straight line of slope equals ($-E_a/R$)

Where, R is the universal gas constant (R= 8.314 J/mol. K)

Apparatus and Chemicals

1. Bohlin Viscometer
2. Viscous liquid or solution

Procedure:

1- Put 17 ml of a given liquid on the cuvette of liquid of Bohlin visometer

2- Use the computer interface and Thermostat circulating unit to adjust the temperature of the measure to 25^{o}C.

3- Begin measurement and record the viscosity of the liquid

4- Repeat steps 2 and 3 at temperatures 30, 35, and 40 ^{o}C.

5- Plot ln $(1/\eta)$ against 1/T

6- Verify that this relation could be a straight line from the slope $(-E_a/R)$ calculate E_a

Data and Calculation

T	d_1	d_2	η_2	t_1	t_2	$\eta_1 \backslash \eta_2 = d_1\ t_1 / d_2\ t_2$	$\eta_1 = \eta_2\ x(d_1\ t_1 / d_2\ t_2)$
25			0.8937				
30			0.8007				
35			0.7225				
40			0.6540				