Experiment No. 6. Name : Visco siby Avesage Metod

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DETERMINATION OF MOLECULAR WEIGHT OF A POLYMER BY VISCOSITY AVERAGE METHOD

AIM:-

To determine the molecular weight of a polymer in solution by using a viscometer

APPARATUS REQUIRED:

Ostwald's Viscometer, Volumetric Flask, Stop Watch, Standard Flask,

REAGENTS REQUIRED:

Polymer, suitable solvents

PRINCIPLE:-

If a polymer is soluble in a suitable solvent. measurement of solution viscosity provides a simple and convinient method of molecular weight determination in a capillary viscometer the viscosity of a liquid is proportional to the time taken by a known volume of liquid to flow through a capillary under a specified hydrostatic pressure at a fixed temprature. The conditions of flow should ensure that the

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flow is laminar. Using Poiseville's equation it is possible to show that if t, η & ρ are the flow time, viscosity & density of a solution respectively; and t_0, η_0 & ρ_0 are that of pure solvent then

$$\frac{\eta}{\eta_0} = \frac{\rho}{\rho_0} \cdot \frac{t}{t_0}$$

The value of η/η_0 is known as relative viscosity. In dilute solutions, which are often employed for molecular weight determination, ρ is not much different from ρ_0 & hence

$$\eta_{rel} = \frac{\eta}{\eta_0} = \frac{t}{t_0}$$

The specific viscosity η_{sp} is defined as

$$\eta_{sp} = \eta_{rel} - 1$$

A plot of η_{sp}/C vs C is a straight line for dilute solution, the intercept

$$\lim_{C \to 0} \frac{\eta_{sp}}{C} = \eta_{int}$$, which is known as intrinsic velocity.

The Staudinger-Mark-Houwink equation which relates η_{int} with molecular weight

$$\eta_{int} = K(M)^{\alpha}$$

where 'K' is an empirical parameter characteristic of a particular solute-solvent pair & "α" is a 'shape' parameter, which can vary from about 0.5 for well-coiled polymers in poor

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about 2 for rigidity extended 'rod' like polymers.
From known values of K & α. Molecular weight can be determined.

PROCEDURE →

Prep. of various conc. of polymers in water:
1% solution of polymer in water will be supplied. We need to prepare at least '5' dilution, viz. 0.1%, 0.2%, 0.3%, 0.4% & 0.5% polymer in water before carrying out the experiment.
Dilution can be done using volumetric expression

$$V_1 N_1 = V_2 N_2$$

Set up the Ostwald viscometer & measure the flow time (t_0) of a fixed volume of the pure solvent. Take an average of 3 readings.
Rinse the viscometer with the most dilute solⁿ, measure the flow time (t_i) keeping the flow volume same. Repeat for other solution.
Calc η_{rel} & η_{sp}. Plot η_{sp}/C vs C, extrapolate to $C=0$ to obtain η_{int}. Calculate the molar weight.

RESULT →
Volume of polymer liquid to be used for each measurement = 12.5 mL
The molecular weight of the given polymer is = 69,726.0066

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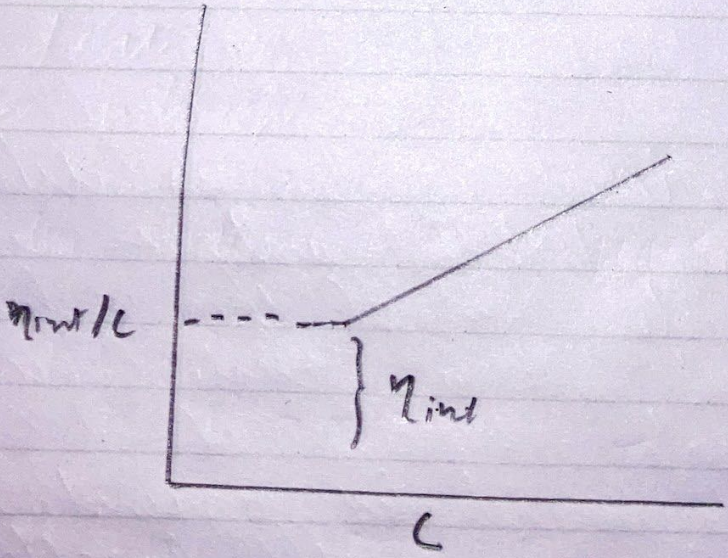
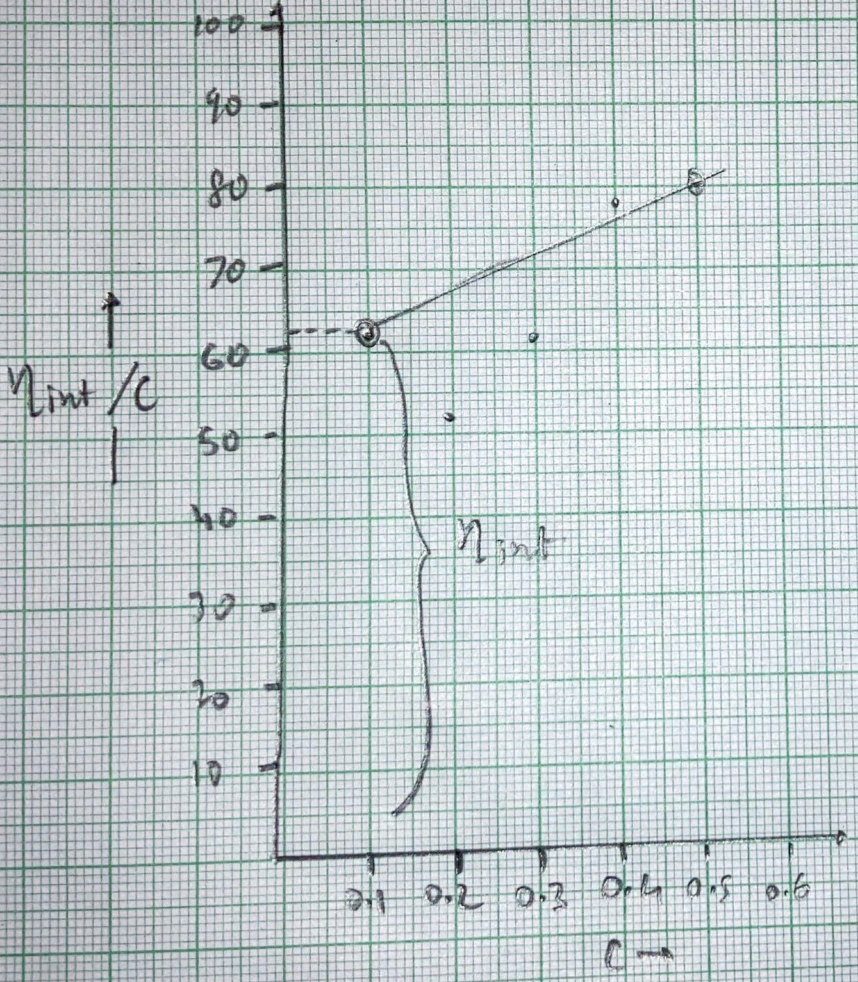
OBSERVATION TABLE →

Sr. No.	Conc. of polymer sol^n	Time of flow (avg).	Relative Viscosity $\eta/\eta_0 = t_s/t_0$	Specific Viscosity $\eta_{sp} = \eta/\eta_0 - 1$	Reduced Viscosity η_{sp}/c
1	Pure Solvent	$t_0 = 48$	1	0	0
2	0.1%	$t_1 = 51$	1.062	0.062	62
3	0.2%	$t_2 = 53$	1.104	0.104	52
4	0.3%	$t_3 = 57$	1.187	0.187	62
5	0.4%	$t_4 = 63$	1.312	0.312	78
6.	0.5%	$t_5 = 67$	1.395	0.395	79

Model Graph.



Plot of η_{sp}/c vs C conc. of polymer solution. to find out intrinsic viscosity



X axis → 1 big Unit = 0.1% C

Y axis → 1 big Unit = 10 unit

CALCULATIONS →

Solvent used → water.

$$\eta_{int} = K \times M^{\alpha}$$

$$\log \eta_{int} = \log K + \alpha \log M.$$

$$\alpha \log M = \log \eta_{int} - \log K$$

$$\log M = \text{anti log} \left[\frac{\log \eta_{int} - \log K}{\alpha} \right]$$

$$= \left(\frac{\eta_{int}}{K} \right)^{1/\alpha}$$

From the η_{sp}/C vs C plot, extrapolate the straight line. Take the intercept is η_{int}.

From the relation, $\eta_{int} = KM^{\alpha}$ where α & K are const.

C for PVA solⁿ,

$K = 45.3 \times 10^{-3}$ $\alpha = 0.64$

$\therefore \eta_{int} = 57$

$M = 69,727.0066$