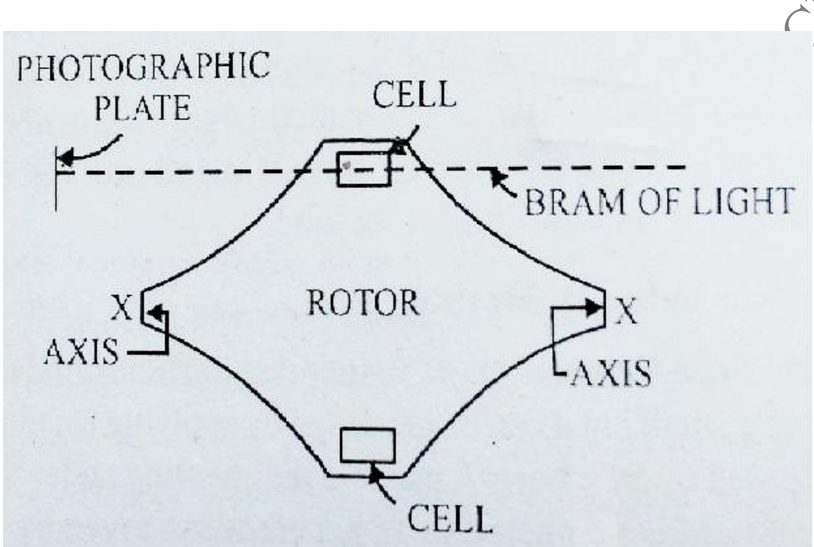
Q.1)What is an ultracentrifuge? Give its principle and construction.What are its advantages?

Ans: An ultracentrifuge is a high speed centrifuge used to determine molecular weight of polymers .It was developed by Svedberg. It is used to determine for both synthetic and biological macromolecules.

Principle.Polymer molecules in solution, when subjected to a very high centrifugal force, settle down. The rate of sedimentation of polymer molecules under the influence of a constant centrifugal force is related to their molecular weights

Diagram:



Construction:

Ultracentrifnge consists of an aluminium rotor several inches in diameter that is rotated at high speed in an evacuated chamber. The solution being centrifuged is taken in a specially designed cell having quartz windows near its periphery. The rotor is usually driven electrically. A beam of light is passed through the system and then allowed to fall on photographic plate. The amount of light absorbed can be estimated from the blackening of the photographic plate. By observing the various level of settling of sedimenting particles at different time intervals, the molecular weight of the polymer can be determined by the relation given by sedimentation velocity method or sedimentation equilibrium method.

Advantages:

i) It requires small quantity of polymeric material.

ii) It is used to determining molecular weights ranging 10^2 to 10^6 g mol^{-1}

Q.2)How is the molecular weight of a polymer determined by sedimentation velocity method?

Ans:

Polymer molecules in solution, when subjected to a very high centrifugal force, settle down at higher rate. The rate of sedimentation of polymer molecules under the influence of a constant centrifugal force can be related to find their molecular weights.

<u>Principle:</u> When a polymer solution is subjected to high centrifugal force, the rate of sedimentation of polymer molecules increases. The movement of the polymers molecules in solution is opposed by the frictional force of the solvent molecules.When the magnitude of the frictional force becomes equal to the centrifugal force, the layer of polymer molecules move with a uniform velocity. By observing the position of molecules at different time intervals, the molecular weight of the polymer can be determined.

Consider a spherical particle of radius r and density d subjected to a centrifugal field $\omega^2.x$ where ω is the angular velocity of rotation in radians per second at a distance x from the axis of rotation.The centrifugal force acting on the particle is then given by

$$f = 4/3\ \pi\ r^3\ (d - d_m)\ \omega^2.x \qquad \text{---------------I}$$

This downward force is opposed by the upward frictional force and eventually a constant speed will be attained when the frictional force becomes equal to the centrifugal force.

For a spherical particle falling with constant uniform velocity, the force of friction is given by Stokes law as ,

----------------II

Where is the coefficient of viscosity of the medium.

and **v i**s the uniform velocity of the moving particle

Equating the two forces,

$$\mathbf{4/3\ \pi\ r^3\ (d - d_m)\ \omega^2 . x =}$$

The velocity *v* of the particle, at a point x from the top of the colloidal dispersion, which is identified as *dx*/dt the rate at which the colloidal particles sediment with time.

Or

Integrating the equation between the limits x_1 at t_1 and x_2 at t_2.

Or

The quantity ——— is known as Sedimentation co-efficient, S

Thus ,

By passing a beam of light through the cell containing the polymer solution and allowing it to fall on a photographic plate, the position **x** of the upper boundary of the particles is noted after various intervals of time **t.** Thus knowing x and t at two stages of sedimentation and also ω, the speed of rotation of the ultracentrifuge, the radius of particles r can be derived from the above equation. This value of r can then be used to determine the mass of a single particle,

and hence the molecular weight of the particles can be calculated from the equation, **M=mN**, where N is Avogadro number.

Q.3)What are light emitting polymers? Describe their construction and working

Ans:

Light emitting polymer is a polymer that emits light when a potential difference is applied to it. These are special plastic materials that convert electrical power into visible light

Electrical power ⟹ Light emitting polymer ⟹ visible light

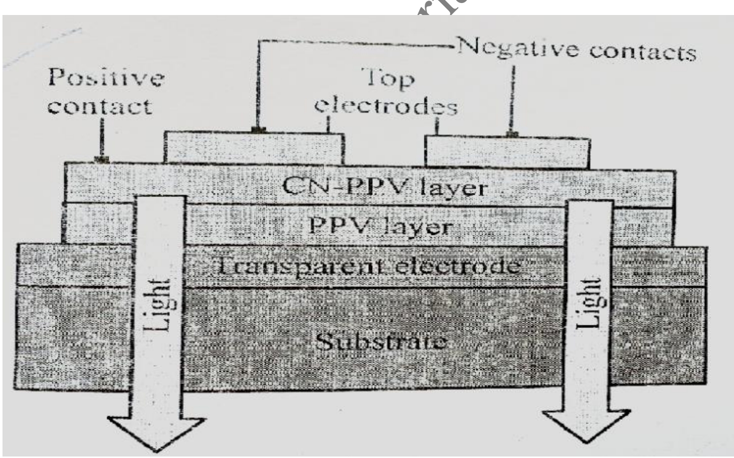
A polymer needs to show fluorescence to conduct electricity to the light emitting polymer. A number of polymers have been shown to emit light under the application of electric field, the property is called electroluminescence.

<u>Construction of light emitting polymer device</u>

The structure of LEP consists of a thin film of semiconducting polymer sandwiched between two electrodes (anode and cathode). LEP uses a two-layer polymer – a hole-transporting layer of poly (p- phenylene vinylene) (PPV) and an emissive layer of a cyano-substituted PPV derivative (CN-PPV) to achieve the same effect.

Working:

When electrons and holes are injected from the electrodes, the recombination of these charge carriers takes place forming a particle called exciton. These excitons are in excited state and go back to their initial state by emitting energy that escapes through glass substrate.



Q.4)What are the advantages of light emitting polymers over other displays?

Ans:

1.It can be viewed from any angle.

2. It requires only 3.3 volts and have lifetime of more than 30000 hours.
3. Its power efficiency than all other flat panel displays like LCDs (Liquid crystal displays).
4. It has no directional or blurring effects.
5. Display fast moving images with optimum clarity.
6.The cost of manufacturing is much less because the active material is polymer.
7. LEPs can range from tiny devices millimeters in dimension to high definition devices upto 5.1 meters in diameter.
8. Fast switching speed.

Q.5) Give the applications of light emitting polymers

Ans:

1)The flexible LEP's are used to laminate helmet face shields, military uniforms, shirtsleeves and aircraft cockpit instruments panel or automotive wind shields for navigation and warning systems.

2) The ultrathin and light weight polymer films will significantly reduce the weight of flat panel displays in cell phones, portable computers, large screen on the wall TVs.

3)The transparent organic LEDs are used in dynamic credit cards.

4) Transparent organic LEDs may be fabricated on windows for home entertainment and teleconferencing purpose.

5)LEDs are promising, low cost solutions for today's flat panel displays.

6)They may find applications in full colour high resolution personal digital assistants, light weight wristwatches that double as high definition TCs, roll up daily-refreshable electronic newspapers, automobile light system without bulbs, office windows/walls/partitions that double as computer screen etc.

Q.6) Give the basic principle of light emitting polymer
Ans:

The basic principle of operation for polymer Organic Light Emitting Diodes (P-OLEDs) is the following:

1. A thin film of LEP material is stacked between two electrodes, one of which is transparent, typically the anode.

2. Electronic charges are injected into the LEP layer, with the cathode providing electrons and the anode providing holes.

3. Light is produced through radiative recombination of bound electrons and hole pairs in the,LEP layer at a wavelength characteristic of the LEP structure.

Q.7) Give the different type of organic light emitting device available in the market.

Ans:

There are three types of light emitting device available in the market

i) Flexible Organic Light. emitting Diodes (FOLEDs)

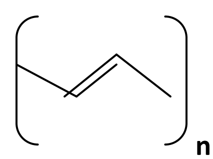
ii) Stacked LEDs

iii) Transparent. TOLEDs

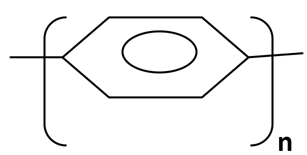
Q.8) Give examples of light emitting polymers

Ans:

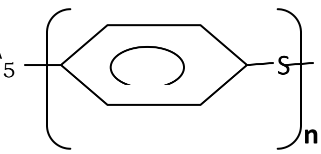
1)Polyacetylene doped with iodine or bromine or Li or AsF_3



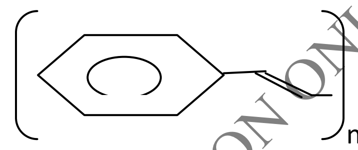
2)Poly(p-phenylene) doped with Li,K,AsF_5



3) Poly(p-phenylene sulphide) doped with AsF_5



4)Poly(p-phenylene vinylene) doped with AsF_5



Q.9) Define i)relative viscosity ii) specific viscosity iii) reduced viscosity.Write the Mark-Houwink equation and explain the terms involved in it.

Ans:

i) **<u>Relative viscosity</u>**:It is defined as the ratio of viscosity of pure solvent to that of the solution of a given polymer .

Rel*ative viscosity* $\eta_r = \eta/\eta_0$.

i.e. —

where η is the viscosity of the polymer solution and η_0 is the viscosity of the pure solvent.

2)**Specific viscosity** is the relative increase in viscosity and is given by,

—— —

3)**Reduced viscosity**: The ratio /C, ie. the relative increase in specific viscosity per unit concentration of the polymer, is known as *reduced Viscosity*

4)**Intrinsic viscosity**: The viscosity obtained by extrapolating from the graph plot of /C against **C** to zero concentration. This extrapolated value is known as *intrinsic viscosity* ,Thus

= /C

= —

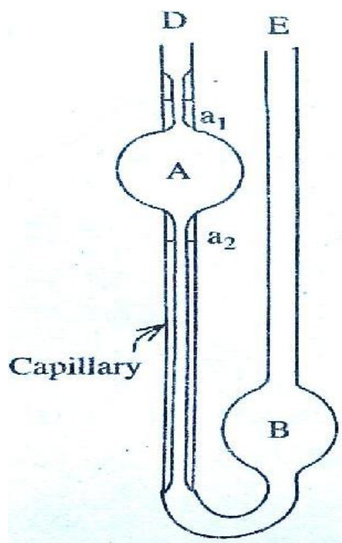
Where, C is the concentration of the polymer in g/dl.

The intrinsic viscosity of a polymer is related to its molecular weight by Mark-Houwink equation which is,

Where, K and α are constants.

Q.10) How is the molecular weight of a polymer determined by viscometry method?

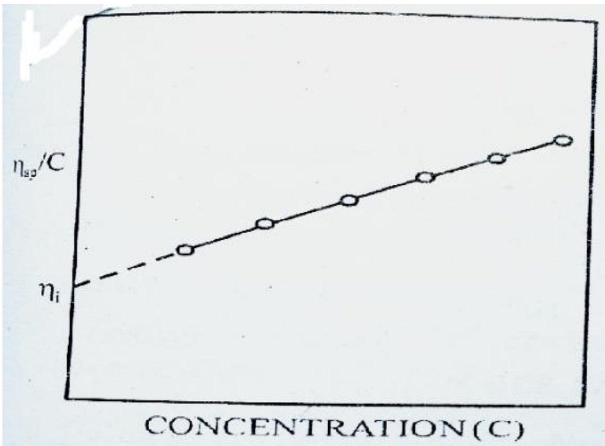
Ans:To determine the molecular weight of a polymer solution by viscometry method, first the intrinsic viscosity of the solution is determined.For this purpose, polymer solutions of different concentrations are prepared. The solvent flow time t_0 and the solution flow times t for different concentrations are measured with the help of a viscometer called the Ostwald Viscometer as follows:



The Ostwald's viscometer as shown consists of a fine capillary tube, a bulb A at the upper end, a u-tube and a bulb B at the lower end. There two marks a_1 and a_2 above and below the bulb A.

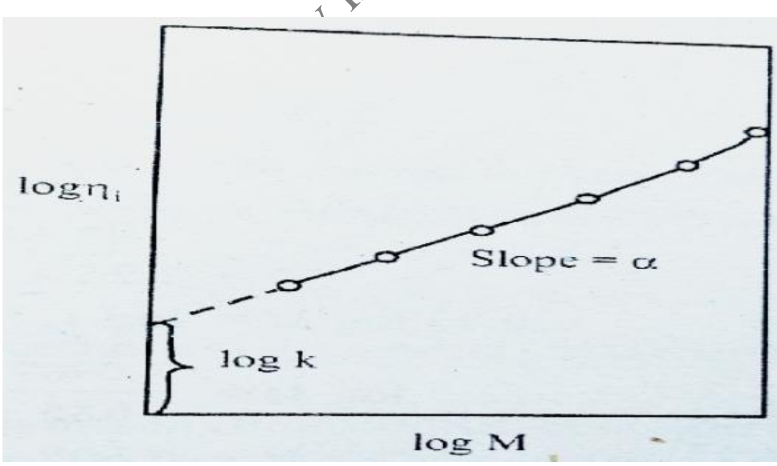
The viscometer is cleaned and dried and clamped vertically in a thermostat. A definite volume of solvent is introduced into the bulb B and is then sucked into the bulb A through a rubber tube attached to D till the level of the liquid is above a_1. The liquid is allowed to flow freely through the capillary and the time t_0 required for the liquid to flow from a_1 to a_2 is determined. The process is repeated at least three times to get constant value of t_0. The viscometer is cleaned , dried and the experiment repeated with the polymer solutions of different concentrations

The specific viscosity of the solutions of the polymer of different concentrations in a given solvent is determined. The ratio of specific viscosity to concentration (/C) is then plotted against concentration and the graph is extrapolated is zero concentration and this value is the required intrinsic viscosity.



The intrinsic viscosity of a polymer is related to its molecular weight by Mark-Houwink equation which is,

Where K and α are constants. Their values can be determined by measuring intrinsic viscosities of a series of samples of polymer the molecular weight of which have been obtained by sedimentation method. The values of log are then plotted against log M, when according to equation (10.33), a straight line of slope α and intercept log K is obtained



----------------------------x-------------------------