B.Sc. (Honours) Part-I

Paper-IA

Topic: Properties of Colloids

UG

Subject-Chemistry

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Properties of Colloids

In general of colloids have the following properties (**Brief**):

1. The particles of the dispersed phase are relatively large, however they pass through ordinary filter media.
2. The dispersed phase doesn't dissolve in the dispersion medium.
3. They scatter light (Tyndal effect).
4. Particles show random motion (Brownian motion), due to collision with molecules of the dispersion medium.
5. Particles adsorb ions (its own ions in preference to others).
6. Particles may have an electrical charge which leads to repulsive forces which stabilize the colloid dispersion and prevent its coagulation.
7. When the particles of the dispersion phase join together, they coagulate and separate due to gravity.
8. Particles have large surface area.
9. Colloidal suspensions have negligible effects on colligative properties.

The main characteristic properties of colloidal solutions are as follows:

(1) Physical properties

(i) Heterogeneous nature: Colloidal sols are heterogeneous in nature. They consists of two phases; the dispersed phase and the dispersion medium.

(ii) Stable nature: The colloidal solutions are quite stable. Their particles are in a state of motion and do not settle down at the bottom of the container.

(iii) Filterability: Colloidal particles are readily passed through the ordinary filter papers. However they can be retained by special filters known as ultrafilters (parchment paper).

(2) Colligative properties

(i) Due to formation of associated molecules, observed values of colligative properties like relative decrease in vapour pressure, elevation in boiling point, depression in freezing point, osmotic pressure are smaller than expected.

(ii) For a given colloidal sol the number of particles will be very small as compared to the true solution.

(3) Mechanical properties

(i) Brownian movement

(a) Robert Brown**,** a botanist discovered in 1827 that the pollen grains suspended in water do not remain at rest but move about continuously and randomly in all directions.

(b) Later on, it was observed that the colloidal particles are moving at random in a zig – zag motion. This type of motion is called Brownian movement.

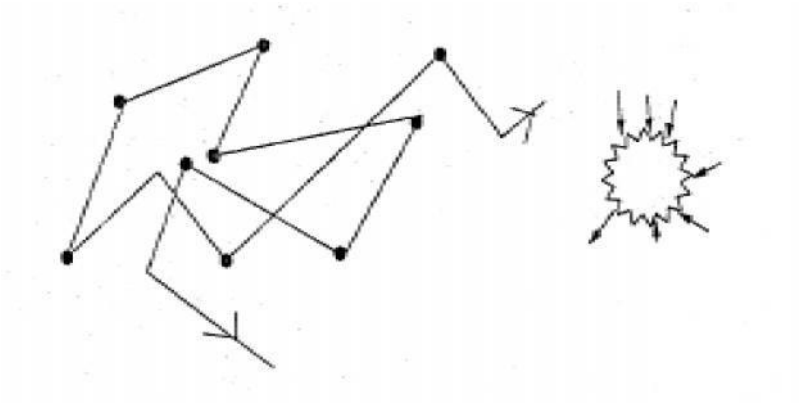

Fig. Brownian Movement

(c) The molecules of the dispersion medium are constantly colloiding with the particles of the dispersed phase. It was stated by Wiener in 1863 that the impacts of the dispersion medium particles are unequal, thus causing a zig-zag motion of the dispersed phase particles.

(d) The Brownian movement explains the force of gravity acting on colloidal particles. This helps in providing stability to colloidal sols by not allowing them to settle down.

(ii) Diffusion: The sol particles diffuse from higher concentration to lower concentration region. However, due to bigger size, they diffuse at a lesser speed.

(iii) Sedimentation: The colloidal particles settle down under the influence of gravity at a very slow rate. This phenomenon is used for determining the molecular mass of the macromolecules.

(4) Optical properties: Tyandall effect

(i) When light passes through a sol, its path becomes visible because of scattering of light by particles. It is called Tyndall effect**.** This phenomenon was studied for the first time by Tyndall. The illuminated path of the beam is called Tyndall cone.

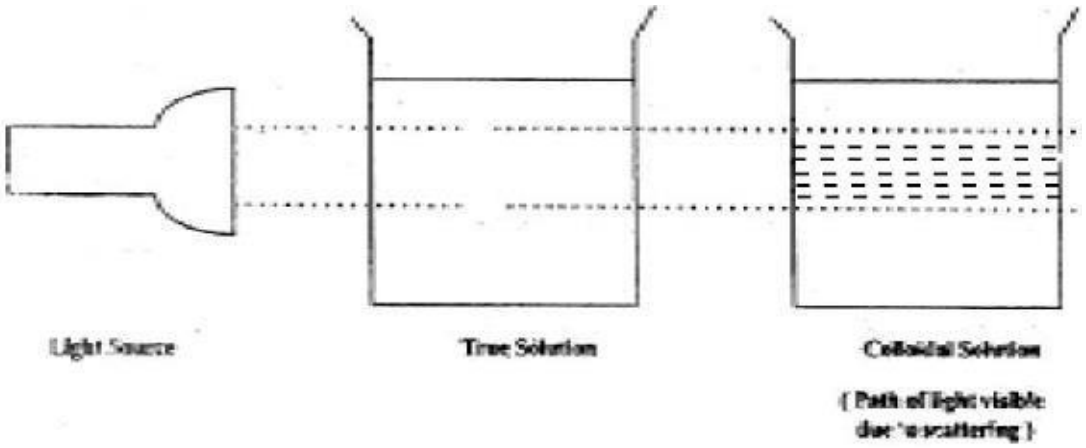

Fig. The Tyndall Effect

(ii) The intensity of the scattered light depends on the difference between the refractive indices of the dispersed phase and the dispersion medium.

(iii) In lyophobic colloids, the difference is appreciable and, therefore, the Tyndall effect is well - defined. But in lyophilic sols, the difference is very small and the Tyndall effect is very weak.

(iv) The Tyndall effect confirms the heterogeneous nature of the colloidal solution**.**

(v) The Tyndall effect has also been observed by an instrument called ultra – microscope**.**

Some example of Tyndall effect are as follows

(a) Tail of comets is seen as a Tyndall cone due to the scattering of light by the tiny solid particles left by the comet in its path.

(b) Due to scattering the sky looks blue.

(c) The blue colour of water in the sea is due to scattering of blue light by water molecules.

(d) Visibility of projector path and circus light.

(e) Visibility of sharp ray of sunlight passing through a slit in dark room.

(5) Electrical properties

(i) Electrophoresis

(a) The phenomenon of movement of colloidal particles under an applied electric field is called electrophoresis.

(b) If the particles accumulate near the negative electrode, the charge on the particles is positive.

(c) On the other hand, if the sol particles accumulate near the positive electrode, the charge on the particles is negative.

(d) The apparatus consists of a U-tube with two *Pt*-electrodes in each limb.

(e) When electrophoresis of a sol is carried out with out stirring, the bottom layer gradually becomes more concentrated while the top layer which contain pure and concentrated colloidal solution may be decanted. This is called electro decanation and is used for the purification as well as for concentrating the sol.

(f) The reverse of electrophoresis is called Sedimentation potential or Dorn effect. The sedimentation potential is setup when a particle is forced to move in a resting liquid. This phenomenon was discovered by Dorn and is also called Dorn effect.

(ii) Electrical double layer theory

(a) The electrical properties of colloids can also be explained by electrical double layer theory. According to this theory a double layer of ions appear at the surface of solid.

(b) The ion preferentially adsorbed is held in fixed part and imparts charge to colloidal particles.

(c) The second part consists of a diffuse mobile layer of ions. This second layer consists of both the type of charges. The net charge on the second layer is exactly equal to that on the fixed part.

(d) The existence of opposite sign on fixed and diffuse parts of double layer leads to appearance of a difference of potential, known as zeta potential or electrokinetic potential. Now when electric field is employed the particles move (electrophoresis)

(iii) Electro-osmosis

(a) In it the movement of the dispersed particles are prevented from moving by semipermeable membrane.

(b) Electro-osmosis is a phenomenon in which dispersion medium is allowed to move under the influence of an electrical field, whereas colloidal particles are not allowed to move.

(c) The existence of electro-osmosis has suggested that when liquid forced through a porous material or a capillary tube, a potential difference is setup between the two sides called as streaming potential. So the reverse of electro-osmosis is called streaming potential.