SURFACE CHEMISTRY

PREPARATION METHOD OF COLLOIDS

AND PURIFICATION OF COLLOIDS

Methods of preparations and dispersion methods :-

Preparation of lyophilic sols

Many organic substances like gelatin, starch, agar, egg albumin, glycogen etc. dissolve readily in water either in cold or on warming to give colloidal solutions directly. these are the lyophilic colloids. for example, sols of egg albumin or glycogen can be prepared by dissolving 1-2 g of the finely ground substance in 100 ml of distilled water and then allowing it to stand for two hours after constant stirring. after two hours, the solutions are filtered. gelatin may be regarded as a typical lyophilic linear colloid. if two grams of gelatin are placed in distilled water and kept there for several hours, it has been observed that unlike egg albumin and glycogen, gelatin does not dissolve in cold water although it does swell. the swollen gelatin may be dissolved by heating with water at 80- 90°c. if two grams of gelatin are dissolved in 400 ml of distilled water, a clear sol. is obtained on cooling.

Preparation of lyophobic sols:

such sols can be prepared by the two general ways.

1. By dispersion of coarse particles (dispersion method). here we start with bigger particles and break them down to the colloidal size.
2. By inducing molecular particles to form large aggregates (condensation method). here we start with particles of molecular dimensions and condense them to the colloidal dimensions.

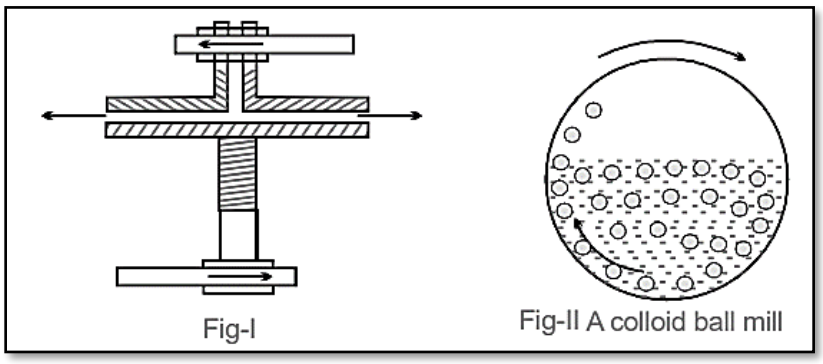
Dispersion methods: -

a. **Mechanical dispersion:**

Here the substance is first finely powdered and a coarse suspension is made by shaking the powdered substance with the dispersion medium. this suspension is then passed through a colloid mill consisting of two discs, moving in opposite directions at a very high speed (fig.i) the particles of the suspension are subjected to a great shearing force and break down to the

colloidal dimension. the space between the two discs controls the size of the colloidal particles to be obtained. rubber, ink, paints and varnishes are prepared by this method.

a ball mill shown in fig. (ii) has been employed to get a colloidal solution from a coarse suspension. due to a high speed rotation of the mill the coarse ball-like particles roll over one another and drop down at a certain position of the mill, thereby grinding the preliminary wetted mixture. this gives rise to particles of size 6 å. if some quantity of the dispersion medium is added, it becomes possible to get a colloidal solution.



b. Electrical dispersion- bredie's arc methods :

This is commonly used method for preparing the colloidal solutions of metals. an electric arc is struck between two metallic rods kept under the liquid (dispersion medium). a current of 10 amperes and a voltage of 100 to 300 volts is generally employed. the liquid is kept cooled by surrounding it with a cooling mixture. tiny particles of the metal break away from the roads and disperse in the liquid. gold, platinum, silver, copper and such other metals can thus be obtained in the colloidal form. (fig.iii)

svedberg modified this method and prepared sols in non-aqueous media like pentane, diethyl ether, by striking an arc with high frequency alternating current which greatly diminishes the decomposition of the liquid (fig.iv) svedberg has shown that the electrical methods are suitable not only for preparing the hydro sols of metals like gold, silver, platinum etc., but also for sols of strongly electropositive metals, such as sodium in benzene.

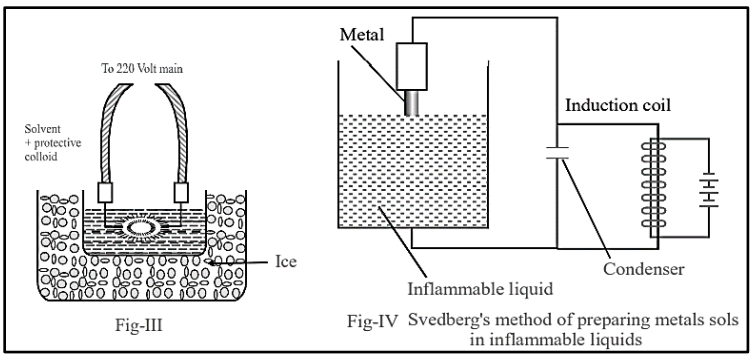


Fig-III

Fig-IV Svedberg's method of preparing metals sols in inflammable liquids

c. Peptization:

The process of bringing a precipitated substance back into the colloids state is known as peptization. it is carried out by the addition of an electrolyte. the electrolyte added is termed as peptising or dispersing agent. it involves the adsorption of a suitable ion supplied by the electrolyte added by the particles of the precipitate. peptisation may be carried out by the following ways :

i. By electrolyte:

Freshly prepared precipitate of $fe(oh)_3$ can be changed into colloidal state when precipitate is treated with a small amount of $fecl_3$ solution. the sol thus obtained is positively charged due to the preferential adsorption of fe^{+++} ions (from $fecl_3$) on sol particles of $fe(oh)_3$ as [fe $(oh)_3$] fe^{+++} . it should be noted that only freshly prepared precipitates can be peptized.

ii By washing a precipitate:

Peptization sometimes can be brought about by repeated washings of a precipitate. for example if the precipitate of $baso_4$ is washed continuously, a state is reached when the washings carry some of the particles of the substances in the form of colloidal solution.

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Condensation methods :-

1. Preparation of lyophilic sols:

The colloidal solutions of lyophilic colloids like starch, glue, gelatin etc., can be readily prepared by dissolving these substances in water either in cold or on warming.

2. Preparation of lyophobic sols:

Lyophobic sols are prepared by special methods. these methods fall into two categories.

i. dispersion methods: by splitting coarse aggregates of a substance into a colloidal size.

ii. condensation methods: by aggregating very small particles into the colloidal particles.

i. Dispersion method

a. Mechanical dispersion

b. Electro-dispersion

c. Ultrasonic dispersion

d. Peptization

ii. Condensation methods

a. Exchange of solvents

b. Change of physical state

c. Chemical methods

3.i. Double decomposition

3.ii. Oxidation

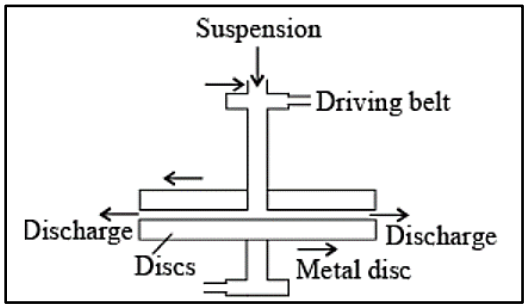
3.iii. Reduction

3.iv. Hydrolysis

i. dispersion methods

a. Mechanical dispersion using colloidal mill

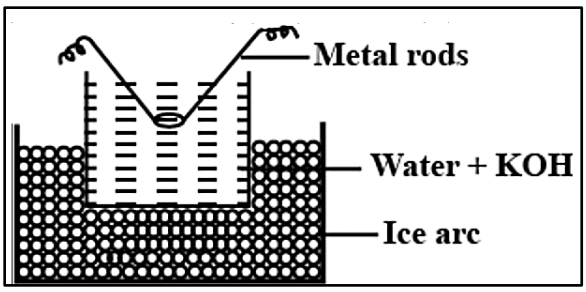
The solid along with the liquid is fed into a colloidal mill. the colloidal mill consists of two steel plates nearly touching each other and rotating in opposite directions with high speed. the solid particles are ground down to colloidal size and then dispersed in the liquid. colloidal graphite and printing inks are made by this method.



Colloidal mill

b. Electro-dispersion method: (bredig's arc method)

This method is suitable for the preparation of colloidal solution of metals like gold, silver, platinum etc. an arc is struck between the metal electrodes under the surface of water containing some stabilising agent such as trace of alkali. the water is cooled by immersing the container in a cold bath. the intense heat of the arc vapourises some of the metal which condenses under cold water.



Bredin's arc method

c. Ultra-sonic dispersion:

The sound waves of high frequency are usually called ultra-sonic waves. ultrasonic waves are passed through the solution containing larger particles. they break down to form colloidal solution.

d. Peptization:

The dispersion of a precipitated material into colloidal solution by the action of an electrolyte in solution is termed as peptization. the electrolyte used is called a peptizing agent.a few examples are silver chloride can be converted into a sol by adding hydrochloric acid ferric hydroxide yields a sol by adding ferric chloride

ii. Condensation methods

a. By exchange of solvent

If a solution of Sulphur or phosphorus in alcohol is poured into water, a colloidal solution of Sulphur or phosphorus is obtained due to low solubility in water.

b. By change of physical state

Colloidal solutions of certain elements such as mercury and Sulphur are obtained by passing their vapor through cold water containing a stabilizer.

c. Chemical methods

The chemical methods involve chemical reaction in a medium in which the dispersed phase is sparingly soluble. some of the methods are

i. **Double decomposition**:

An arsenic supplied sol is prepared by passing a slow stream of hydrogen supplied gas through a cold solution of arsenious oxide. this is continued till the yellow color of the sol attains maximum intensity.

$as_2o_3 + 3\ h_2s$ --- --- -- > $as_2s_{3(yellow)} + 3\ h_2o$

excess hydrogen supplied is removed by passing in a stream of hydrogen

ii. **Oxidation:**

A colloidal solution of sulphur is obtained by passing h_2s into a solution of sulphur dioxide.

$2h_2s + so_2$ ---- -- - > $2h_2o + 3\ s$

iii. **Reduction:**

Silver sols and gold sols can be obtained by treating dilute solution of silver nitrate or gold chloride with organic reducing agents like tannic acid or formaldehyde.

$agno_3$ + tannic acid --- -- > ag sol

$auno_3$ + tannic acid --- -- > au sol

iv. **Hydrolysis:**

Colloidal solutions of the hydroxides of fe, cr, al etc can be prepared by hydrolysis of their salts. a colloidal solution of ferric hydroxide is obtained by boiling a dilute solution of ferric chloride.

$fecl_3 + 3h_2o$ -- --- - -> $fe(oh)_{3(red\ sol)} + 3hcl$

Purification of colloidal solution :-

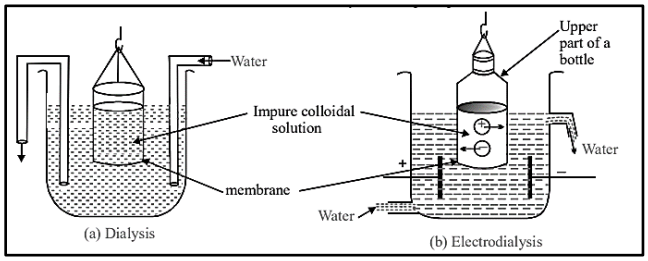
Purification of sols

Excessive quantities of electrolytes and some other soluble impurities remain in a sol as a result of the method selected for preparation, particularly in chemical condensation methods.

1. **Dialysis:**

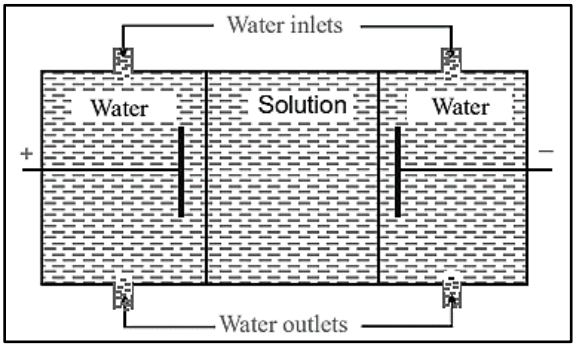
This method is based on the fact that colloidal particles are retained by animal membrane or a parchment paper while electrolytes pass through them. the sol is taken in a parchment or cellophane bag, which itself is placed in running water in a trough. gradually the soluble

impurities diffuxe out leaving a pure sol behind. dialysis is a slow process and it takes several hours and sometimes even days for complete purification.



2. Electrodialysis :

Dialysis can be fastened by applying an electric field if the substance in true solution is an electrolyte. this process is then called electrodialysis. by means of electrodialysis it is possible to get a colloid in pure state in short time, although the electric current does not affect non-conducting impurities such as alcohol, sugar, etc.



3. Ultra-filtration:

This is a method not only for purification of the sol but also for concentrating the sol. the pores of the ordinary filter paper are large enough (1030 mμ) for the colloidal particles (203 mμ) to pass through. but if the pores are made smaller the colloidal particles may be retained on the filter paper. this process is known as ultra-filtration.

4. Electro decantation :

This is a method not only for purification of the sol but also for concentrating the sol. if electrodialysis is carried out without stirring the sol, the lower layer becomes more concentrated whereas the top layer becomes dilute. this process is known as electro decantation and was introduced by pauli.

5. Ultracentrifuging :

The colloidal particles share the motion of the molecules of the dispersion medium and are in a state of continuous zigzag motion, called browninan movement. sol particles are prevented from setting by this continuous haphazard zigzag motion. the sol is kept in a high speed centrifuging machine revolving at a very high speed (about 15,00 revolutions per minute) so that the colloidal particles settle quickly, the slim can be suspended in water so as to get a sol.