Experiment

Aim

To prepare Colloidal Solution of Ferric Hydroxide [$Fe(OH)_3$] sol.

Theory

Ferric hydroxide forms a lyophobic sol. The substances such as metal hydroxides or sulphides which are insoluble and do not readily give colloidal solutions on treatment with water are called lyophobic colloids.

Ferric hydroxide sol is prepared by the hydrolysis of ferric chloride with boiling distilled water. The reaction that takes place can be represented as:

$$\underset{\text{Ferric chloride}}{FeCl_3(aq)} + 3H_2O(l) \xrightarrow{\text{boil}} \underset{\text{Ferric Hydroxide}}{Fe(OH)_3(s)} + 3HCl(aq)$$

The hydrolysis reaction produces insoluble ferric hydroxide particles which undergo 'amalgmation' i.e. cluster formation to yield bigger particles of the colloidal size. These particles adsorb Fe^{+3} ions preferentially from the solution to result in positively charged solution. HCl which is produced during the preparation process tries to destabilize the sol and so must be removed by dialysis process, otherwise sol will not be stable. The sol is represented as $Fe(OH)_3$.

Material Required

Conical flask (250 ml), beaker (250 ml), a boiling tube, glass rod, funnel, round-bottom flask, iron stand with a clamp, wire gauze, tripod stand, burner, a burette or a dropper, 2% solution of ferric chloride (prepared by dissolving 2 g of pure $FeCl_3$ in 100 ml distilled water) and distilled water.

Procedure

1. Take a 250 ml conical flask and clean it by the steaming-out process.
2. To this cleaned flask, add 100 ml of distilled water, heat it to boil by placing the flask on a wire gauze.
3. Add ferric chloride solution dropwise (using a burette or a dropper) to the boiling water.
4. Continue heating until a deep red or brown solution of ferric hydroxide is obtained. Replace the water lost by evaporation during boiling at regular intervals.
5. Keep the contents of the conical flask undisturbed for some time at room temperature. Label the solution as "ferric hydroxide sol".

Result

A red color sol. of ferric hydroxide is obtained.

Precautions

1. Since ferric hydroxide sol is affected by impurities, the apparatus required for the preparation of sol should be thoroughly cleaned by the steaming-out process.
2. Add ferric chloride solution dropwise.
3. Hydrochloric acid formed because of hydrolysis of ferric chloride is removed by the dialysis process.

VIVA VOCE

Q 1. What is the significance of preparing a colloidal solution of ferric hydroxide in chemistry?

Ans. The preparation of a colloidal solution of ferric hydroxide allows us to study the properties and behavior of metal hydroxide colloids, which have applications in industries such as wastewater treatment, catalysis, and pigment production.

Q 2. How does the colloidal nature of ferric hydroxide differ from its behavior in a true solution or a suspension?

Ans. In a colloidal solution, ferric hydroxide forms dispersed particles that are intermediate in size between true solutions and suspensions, exhibiting characteristics such as the Tyndall effect and Brownian motion. In contrast, in a true solution, ferric hydroxide ions are uniformly dissolved, while in a suspension, they settle out over time.

Q 3. Describe the method you used to prepare the colloidal solution of ferric hydroxide.

Ans. The colloidal solution of ferric hydroxide can be prepared by adding a solution of ferric salt to water under controlled conditions, followed by the addition of a base to precipitate the ferric hydroxide colloid.

Q 4. What role does the base (alkali) play in the formation of the colloidal solution of ferric hydroxide?

Ans. The base reacts with the ferric salt to precipitate ferric hydroxide as a gelatinous colloid. It also helps in controlling the pH of the solution, which is crucial for stabilizing the colloidal particles.

Q 5. How would you ensure the uniform dispersion of ferric hydroxide particles in the colloidal solution?

Ans. To ensure uniform dispersion, it is important to add the ferric salt solution and base slowly and with continuous stirring, allowing sufficient time for the precipitation of finely divided ferric hydroxide particles.

Q 6. What factors affect the stability of the colloidal solution of ferric hydroxide?

Ans. Factors such as pH, temperature, presence of electrolytes, and degree of dispersion can affect the stability of the colloidal solution by influencing the balance between attractive and repulsive forces among the particles.

Q 7. How could you modify the experimental procedure to produce a more concentrated colloidal solution of ferric hydroxide?

Ans. To produce a more concentrated colloidal solution, one could use a higher concentration of ferric salt solution or reduce the volume of water used for dispersion while maintaining the same amount of ferric hydroxide precipitate.

Q 8. Can you explain the mechanism of stabilization of ferric hydroxide colloids?

Ans. The stabilization of ferric hydroxide colloids is achieved through electrostatic repulsion between the negatively charged hydroxide ions on the particle surface, preventing aggregation and sedimentation.

Q 9. What methods can be employed to characterize the colloidal nature of the solution you have prepared?

Ans. Characterization methods such as observing the Tyndall effect, measuring zeta potential, and conducting electron microscopy can be used to confirm the colloidal nature of the solution.