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Object :- To determine the strength of a given unknown copper sulphate solution with the help of hypo solution.

Apparatus and Reagents :- Burette, pipette, iodometric flask, measuring cylinder, sodium thiosulphate, known and unknown $CuSO_4$ sol., potassium iodide (10% sol.), starch, acetic acid etc.

Theory :- When Potassium iodide is added at pH (4-7) to copper sulphate solution, an equivalent amount of iodine is liberated, solution becomes brown.

$$2CuSO_4 + 4KI \longrightarrow 2K_2SO_4 + Cu_2I_2 + I_2$$

The liberated iodine is titrated with standard solution thiosulphate by using starch as an indicator.

$$I_2 + 2Na_2S_2O_3 \longrightarrow Na_2S_4O_6 + NaI$$

The liberated absorbs on starch & gives deep blue or violet colour in the solution.

$$Starch + I_2 \longrightarrow \text{starch iodo complex}$$
(Deep blue / violet colour)

From the above reaction it follows that

$$2CuSO_4 = I_2 = 2Na_2S_2O_3 \quad \text{or}$$

$$Cu. = I_2 = Na_2S_2O_3$$

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Procedure :- Prepare a standard copper sulphate solution of known strength by dissolving required amount of $CuSO_4 \cdot 5H_2O$ in distilled water in 100 ml volumetric flask. Add few drops of acetic acid to prevent hydrolysis.

1. Take 10 ml of standard copper sulphate solution in iodometric flask with the help of pipette.
2. Add about 5 ml of 10% KI solution in to the flask & stir. The solution will turn brown.
3. Fill the clean burette with hypo solution & titrate the $CuSO_4$ solution in the iodometric flask until brown colour changes to pale yellow. At this point add 2-3 drops of starch indicator.
4. Solution will turn blue due to formation of starch iodo complex. Continoue addition of hypo till the blue colour turns milky white. This will indicate the end point.
5. Repeat the titration for three or four times to get concordant reading.
6. Repeat the same procedure for unknown copper sulphate solution & obtain burette reading.

Calculation

For standard $CuSO_4$ solution with hypo solution.

$N_1V_1 = N_2V_2$

$N_1 \times 133 = \frac{N}{30} \times 10$

$N_1 = \frac{N}{133 \times 3}$

here N_1 = Normality of Hypo Solution

N_2 = Normality of known $CuSO_4$ = $N/30$

V_1 = Volume of Hypo Solution.

V_2 = Volume of known $CuSO_4$ Sol^n.

Now for unknown $CuSO_4$ with hypo Solution.

$N_3V_3 = N_4V_4$

$\frac{N}{3 \times 133} \times 10.2 = N_4 \times 10$

$\boxed{N_4 = 0.02556N}$

Strength of unknown $CuSO_4$ Solution.

= Normality of $CuSO_4$ x eq. weight of $CuSO_4$

= 0.02556×249.50

= 6.37819 gm/lit.

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Observations:-

Titration of standard copper solution with hypo solution.

S.No	Volume of known $CuSO_4$ Solution (ml)	Volume of Hypo Initial (ml)	Volume of Hypo Final (ml)	Difference (ml)	Concordant reading (ml)
1.	10 ml	0	12	12	13.3
2.	10 ml	12	25.3	13.3	
3.	10 ml	25.3	38.6	13.3	

Titration of unknown copper sulphate solution with hypo solution.

S.No	Volume of Unknown $CuSO_4$ Solution (ml)	Volume of Hypo Initial (ml)	Volume of Hypo Final (ml)	Difference (ml)	Concordant reading (ml)
1.	10 ml	38.6	48.7	10.1	10.2
2.	10 ml	48.7	58.9	10.2	
3	10 ml	58.9	69.1	10.2	

Calculation:-

Strength of Unknown $CuSO_4$ Solution

= Normality x equivalent weight of $CuSO_4$

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Result :- The Strength of unknown $CuSO_4$ solution is 6.3781.9 gm/lit.

Precaution :-

(i) The starch solution should be added just near the end point.

(ii) Freshly prepared starch solution should be used.

(iii) Exact volume of $CuSO_4$ is taken with the help of pipette.

Industrial Application :-

1.) It is used to determine the strength of $CuSO_4$ in Unknown solution.

2.) In small concentration, copper sulphate is used to control algae growth in surface drinking water supplies. It is a poisonous substance & need to be analyzed at regular intervals.

3.) Copper sulphate is a fungicide used to control bacterial and fungal diseases of fruits, vegetables nut and field crops. Some of the diseases that are controlled by this fungicide include mildew, leaf spot and apple scab.

4.) Copper sulphate is used in combination with lime & water as a protective fungicide, referred to as Bordeaux mixture, for leaf application & seed treatment.

5) Copper sulphet is also used as herbicide in irrigation & municipal water treatment system.

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Viva Question

Q1 What is iodometric titration?

Ans Iodometric titration is a type of redox titration that involves iodine (I_2) and is used to determine the concentration of oxidizing agents. It is an indirect titration method where an oxidizing agent reacts with excess iodide ions to produce iodine (I_2), which is then titrated with a reducing agent like sodium thiosulfate ($Na_2S_2O_3$)

Q2 Differentiate between iodometric & iodimetric titration.

Ans Iodometric titration is an indirect method, where iodine is liberated by an oxidizing agent & then titrated.

Iodimetric titration is a direct method, where iodine itself is used as a titrant to react with a reducing agent.

Q3 Differentiate between primary & secondary solution?

Ans Primary solution are prepared from highly pure, stable compounds and have known concentrations.

Secondary solution have unknown or approximate concentrations and must be standardized before use in titrations.

Q4 Which type of indicator is used in this titration? Name it.?

Ans Starch.

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Q5 What is the equivalent weight of copper sulphate?

Ans equivalent weight of $CuSO_4$ = 79.75 gm/eq.

(Hydrated) $CuSO_4 \cdot 5H_2O$ ⇒ 124.75 gm/eq.

Q6 Why freshly prepared starch solution is used in this titration?

Ans Because starch decomposes over time, leading to inaccurate results.

Q7 Why starch is added near the end point of the titration?

Ans Starch is added near the end point of titration, because it acts as an indicator for the presence of iodine. If we add starch in beginning then starch Iodine complex becomes too stable & may not dissociate.

Q8 Explain the reaction involved in this titration.

Ans When potassium iodide is added at pH (4 to 4.7) to copper sulphate solution, an equivalent amount of iodine is liberated & solution becomes brown.

$$2CuSO_4 + 4KI \longrightarrow 2K_2SO_4 + I_2 + Cu_2I_2$$

This liberated iodine is titrated with standard solution of sodium thiosulphate by using starch as an indicator

$$I_2 + 2Na_2S_2O_3 \longrightarrow Na_2SO_6 + NaI$$

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The liberated iodine absorbs on starch & gives deep blue or violet colour.

Starch + I_2 ⟶ Starch iodo complex
(violet / blue colour)

From the above reaction it follows that

$2CuSO_4 = I_2 = 2Na_2S_2O_3$ or $Cu = I_2 = Na_2S_2O_3$

Q9 Write chemical name & formula of Hypo solution

Ans Hypo solution is nothing but Sodium thiosulfate
its chemical formula is $Na_2S_2O_3$
In aqueous form ⇒ $Na_2S_2O_3 \cdot 5H_2O$

Q10 How will you prepare N/30 $CuSO_4$ solution in 250 ml.

Ans To prepare 250 ml of N/30 $CuSO_4$ solution.
Calculate required mass
eq. weight ($CuSO_4 \cdot 5H_2O$) = 124.84
required mass = 1.04 g in 250 ml
Dissolve in water
weigh 1.04 g of $CuSO_4 \cdot 5H_2O$
Dissolve in 100 ml distilled water in a 250 ml volumetric flask.
Dilute & mix
Add distilled water up to 250 ml mark.
Now solution is ready.

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Object:- To determine Dissolved Oxygen Content in given ~~strength~~ sample of water.

Apparatus and reagents:- Burette, pipette, Beaker, Iodometric flask, Magnese sulphate solution, Alkaline potessium Iodide solution, sulphuric Acid, 1% Starch solution & standard Sodium Thiosulphate Solution.

Theory:- Dissolved oxygen is estimated using the Iodometic method. Magnese reacts with alkali (during fixation) to form a white precipitate of $Mn(OH)_2$, which gets oxidized to brown precipitate in acidic medium, Mn^{+2} ions are reduced by I^- (Iodide) ions to form I_2 (Iodine). The amount of I_2 liberated is equivalent to the amount of oxygen in the sample. This ~~is~~ I_2 is titrated with standard $Na_2S_2O_3$ solution. Interference due to oxidizing agents such as NO_2^- and SO_3^{-2} present in water sample is eliminated by addition of solution azide (NaN_3) to the solution & on acidification, NO_2 is decomposed.

$$MnSO_4 + 2KOH \longrightarrow Mn(OH)_2 + K_2SO_4$$

$$2Mn(OH)_2 + O_2 \longrightarrow 2MnO(OH)_2$$

$$MnO(OH)_2 + H_2SO_4 \longrightarrow MnSO_4 + 2H_2O + [O]$$

$$2KI + H_2SO_4 + [O] \longrightarrow K_2SO_4 + H_2O + I_2$$

$$I_2 + 2Na_2S_2O_3 + \text{Starch} \longrightarrow Na_2S_4O_6 + 2NaI +$$

Blue coloured complex

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Calculation

Titration between Sample water with Hypo Solution.

$N_1V_1 = N_2V_2$

$N_1 \times 50 = \frac{N}{30} \times 4$

$N_1 = \frac{N}{50 \times 30} \times 4$

Here N_1 = strength of sample water.

N_2 = Strength of known Hypo Solution.

V_1 = Volume of Sample water

V_2 = Volume of Hypo Solution.

Strength of D.O.

= Normality × eq. weight of O_2 × 1000

= $\frac{N}{50 \times 30} \times 4 \times 8 \times 1000$

= 21.33 ppm.

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* Procedure

1. Wash all the apparatus with distilled water.
2. In 500 ml reagent bottle, take 200 ml water sample.
3. Add 1ml $MnSO_4$ and 1ml alkaline azide solution [NaOH + KI + NaN_3] to it. Brown precipitate of $Mn(OH)_2$ appears.
4. After 15-20 minutes, add 2 ml of H_2SO_4 & shakes the reagent bottle properly, The precipitate gets dissolved and reddish brown colour solution appears.
5. Take 50ml of above solution in an iodometric flask and titrate it with solution thiosulphate solution. When solution becomes light yellow, add 2-4 drops of starch in it. Blue colour appears.
6. Continue to add hypo solution drop by drop while constantly shaking till the blue color disappears, it indicates the end point.
7. Repeat the titration to get concordent reading.

Observation table :-

Titration between water sample and hypo solution.

S.No.	Volume of sample water (ml)	Volume of Hypo Solution Initial (ml)	Final (ml)	Difference (ml)	Concordant reading (ml)
1.	50	0	5	5	4.0
2.	50	5	7.7	2.7	
3.	50	7.7	11.5	4.0	

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Result :- The amount of dissolved Oxygen in given water sample = 21.32 ppm.

Precaution :-

1. The glass wares used should be thoroughly washed with distilled water and dried.
2. All the solution should be freshly prepared
3. Same volume of indicator should be used in every titration.

Industrial Application :-

1. In liquid wastes dissolved oxygen (DO) is the factor that determines whether the biological charges are brought about by aerobic or anaerobic organisms.
2. DO measurements are vital for maintaining aerobic conditions both in natural water that receive polluted matter and in aerobic treatment processes intended to purify domestic & industrial wastewater.
3. DO determination used to evalute the pollution strength of domestic and industrial waste.
4. The DO tests helps to controls the corrosion because Oxygen is a significance factor in the corrosion of iron & steel in aqueous medium.

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Viva Quation

Q1 What is dissolved Oxygen in water?

Ans Dissolved oxygen (DO) is the amount of oxygen gas that present in water. It is essential for the survival of aquatic organisms such as fish, invertebrates & micro-organism. DO levels are influenced by factors like temp., water movement & biological activity.

Q2 What is the importance of D.O. in water.

Ans Dissolved Oxygen (DO) is essential for aquatic life, water quality and ecosystem balance. It supports fish and microorganisms, helps decompos organic matter, influences chemical reactions & prevents water pollution & eutrophication. Low DO levels can harm aquatic organisms & indicates poor water quality

Q3 What is the range of DO in water?

Ans Dissolved oxygen (DO) in water ranges from 0 to 14 mg/L. Healthy levels are 5-14 mg/L, while below 2 mg/L can cause aquatic life stress or death.

Q4 Name the type of titration for determination of D.O. in water?

Ans Winkler method, a type of redox titration is commonaly used to determine DO in water.

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Q5 Explain the principle of this titration.

Ans D.O. is estimated using the Iodometric method. Mn reacts with alkali, to form a white precipitate of $Mn(OH)_2$, which gets oxidized to brown precipitate in acidic medium.

$$MnSO_4 + 2KOH \longrightarrow Mn(OH)_2 + K_2SO_4$$

Mn^{+2} ions are reduced by I^- (iodide) to form I_2 iodine. The amount of I_2 liberated is eq. to the amount of O_2 in sample.

$$2Mn(OH)_2 + O_2 \longrightarrow 2MnO(OH)_2$$

$$MnO(OH)_2 + H_2SO_4 \longrightarrow MnSO_4 + 2H_2O + [O]$$

$$[O] + 2KI + H_2SO_4 \longrightarrow K_2SO_4 + I_2 + H_2O$$

$$\boxed{E\,O] = I_2}$$

Q6 Give other name of the titration.

Ans Titration is also known as volumetric analysis because it involves measuring the volume of a solution required to react with a known quantity of another substance.

Q7 Explain the role of sodium azide in the titration.

Ans Sodium azide (NaN_3) is used in iodometric titration to eliminate nitrite interference. Nitrites (NO_2^-) can oxidize iodide (I^-) to iodine (I_2), leading to errors. Sodium azide reacts with nitrites, converting them into nitrogen gas (N_2) & water, preventing unwanted oxidation & ensuring accurate titration result.

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Q8 What is the effect of temp. on solubility of dissolved gases in water?

Ans The solubility of dissolved gases in water decreases as temperature d. increases. This happens because high temperature provide more energy to gas molecules, making them escape from the liquid into the atmosphere. (Henry's law.)

Q9 What is the effect of D.O. on equality of drinking water?

Ans Dissolved Oxygen (DO) affects drinking water quality by influencing taste, corrosion, bacterial growth, and oxidation of contaminants. High DO improves taste but may cause pipe corrosion while low DO can lead to bacterial growth and bad odors.

Q10 Name the chemical which interfere in determination of DO? How they can be removed?

Ans There are interfering chemical & their Removal-

(i) Nitrites (NO_2) - Interfere with iodine reaction. Remove with sodium azide (NaN_2)

(ii) Ferrous Iron (Fe^{+2}) & reducing agents consume Oxygen - oxidize with potassium permagonate. ($KMnO_4$)

(iii) Organic Matter - Depletes Oxygen - filter or treat with oxidizing agent.

(iv) Sulfur Compounds (H_2S sulfides) - Reacts with iodine. Precipitate using zinc acetate ($Zn(CH_3(OO)_2$)

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