Colorimetric Method

COLORIMETRIC DETERMINATION OF COPPER

Principle: When a monochromatic light of intensity I_0 is incident on a transparent medium, a part, I_a of it is absorbed, a part, I_r is reflected and the remaining part, It is transmitted.

$$I_0 = I_a + I_r + I_t$$

For a glass-air interface I_r is negligible and therefore,

$$I_0 = I_a + I_t$$

$I_t / I_0 = T$ called the transmittance, $\log 1/T = \log I0 / It$ is called the absorbance or optical density. The relation between absorbance, A, concentration, c (expressed in mol/dm3) and path length, t (expressed in cm) is given by Beer-Lambert's law,

$$A = \log I0 / It = €ct$$

where € is the molar extinction coefficient, t is the path length and is a constant for a given substance at a given wavelength. If t, the path length is kept constant, then, A Vs C. Hence a plot of absorbance against concentration gives a straight line.

Procedure

A series of standard solutions of copper sulphate penta hydrate is treated with ammonia to get blue cuprammonium complex, and is diluted to a definite volume. The absorbance of each of these solutions is measured at 590 nm since the complex shows maximum absorbance at this wavelength. The absorbance values are plotted against concentration to get a calibration curve. The given test solution is treated with strong ammonia and diluted to the same volume as above. The absorbance of this solution at 620 nm is measured and its concentration is determined from the calibration curve.

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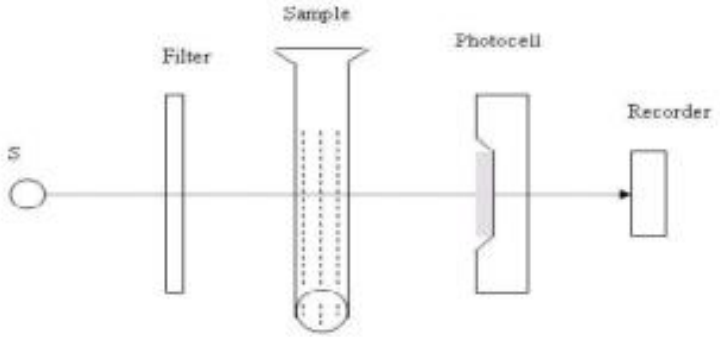
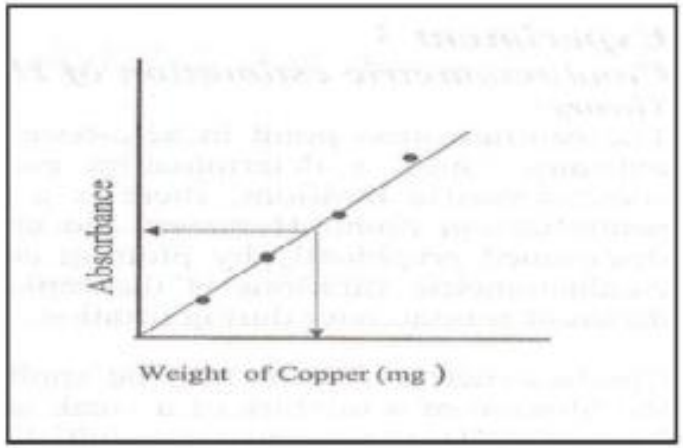
Instrumentation:

Source: tungsten bulb is used as a light source.
Filter: It is a device for isolating monochromatic light.
Sample: sample is hold in glass cell.
Photocell: Converts the emitted light into electrical signal.





Vol. of Cuso4	Vol. of NH3	Wt. of Cu in mg	Optical Density
Blank	5		
2	5		
4	5		
6	5		
8	5		
10	5		

Instrumentation

- Light source: A tungsten lamp is used as a light source for wavelength in the visible range (300-700 nm).
- Monochromators: It is a device for isolating monochromatic light.
- Lens: Instruments using filters as wavelength selectors require lenses to focus correctly the light from the source through the filter and cuvette to the detector.
- Cuvette: For accurate and precise reading, cuvette must be transparent , clean and devoid of any scratch. It is made of quartz, to minimize reflection of light.
- Photosensitive detector: It is made of photovoltaic cell, which receives the transmitted and convert it into electric signal. A digital device is there, which is capable of converting electric signal into absorbance value.

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Draw a calibration curve by plotting absorbance against volume of copper sulphate solution. Using the calibration curve, find out the volume of copper sulphate solution given i.e., the volume of test solution and calculate the amount of copper in the given solution.

From the graph

Volume of $CuSO_4$ in test solution = _____ ml (say V ml)

Working solution concentration = 4 mg/cc

249.6 mg of $CuSO_4\ 5H_2O$ contains 63.55 mg of Cu^{2+}

Therefore 4 mg of $CuSO_4\ 5H_2O$ contains $\frac{63.55 \times 4}{249.6}$

= ... 1.02 mg

1 ml of $CuSO_4.5H_2O$ contains 1.02 mg of Cu_2

V ml of $CuSO_4.5H_2O$ contains V x 1.02 mg of Cu_2

Since the stock solution is diluted to 50 times

Cu^{2+} present in test solution $\frac{V \times a}{50}$

= ..... mg

Result: Concentration of Cu^{2+} in test solution = _____ mg

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Applications:

- In quantitative analysis: large number of metal ions, anions and cations compounds can be determined by in this method
- Photometric Titration i.e. equivalence point can also be determined
- Determination of the composition of colored complex

Advantages:

- Can be determine the concentration of the colored solution
- It is very simple method
- Colorimeter gives most accurate value
- Used for lower concentration