Potassium Dichromate ($K_2Cr_2O_7$) Based Titrations

Introduction

Potassium dichromate ($K_2Cr_2O_7$) is an orange-colored crystalline solid used as a powerful oxidizing agent in acidic medium, primarily in redox titrations. Unlike potassium permanganate ($KMnO_4$), it is chemically stable and can be used as a primary standard.

Why $K_2Cr_2O_7$ is a Primary Standard?

A primary standard is a reagent that is:

- Pure and stable
- Non-hygroscopic
- Has a known and fixed composition
- Has a high molar mass

$K_2Cr_2O_7$ satisfies all these conditions:

- It is chemically pure and available in stable crystalline form.
- It does not absorb moisture from the air (non-hygroscopic).
- It has a high molar mass (294 g/mol) which reduces weighing errors.
- Its solutions remain stable over time if protected from light.

Balanced Redox Reaction in Acidic Medium

In acidic conditions, dichromate ions ($Cr_2O_7^{2-}$)

Each mole of dichromate accepts 6 electrons.

Common Examples of $K_2Cr_2O_7$ Titrations

1. Estimation of Ferrous Sulfate ($FeSO_4$) or Mohr's Salt

Reaction:

Indicator: Diphenylamine sulfonate (color change:

2. Estimation of Iron in an Alloy

- The iron is dissolved in acid and reduced to Fe^{2+} before titration.

- Same reaction and indicators as above.

3. Estimation of Tin(II) Chloride ($SnCl_2$)

Reaction:

4. Estimation of Hydrogen Peroxide (H_2O_2)

In acidic medium, H_2O_2 is oxidized to O_2.

Reaction:

5. Estimation of Iodide (I^-)

Reaction:

Liberated I_2 can then be titrated with sodium thiosulfate (iodometric titration).

Indicators Used

Since $K_2Cr_2O_7$ is not self-indicating, external or internal redox indicators are used:

- Diphenylamine sulfonate

These indicators undergo a visible color change when the oxidation is complete.

Advantages of $K_2Cr_2O_7$ in Titrations

- High purity and stability: Suitable as a primary standard.
- Stable in solution: Does not decompose over time like $KMnO_4$.
- Predictable oxidation behavior.
- Sharp endpoint with proper indicator.

Disadvantages

- Toxic and carcinogenic: Cr(VI) compounds are hazardous and environmentally unfriendly.
- Not self-indicating: Requires separate indicators.

Precautions

- Always use dilute sulfuric acid as the medium (not HCl, which may react to form Cl_2).
- Handle with gloves and dispose of waste responsibly due to chromium toxicity.