

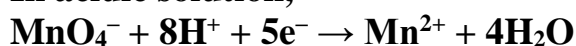
EXPERIMENT

Aim: To prepare 100 ml M/10 solution of oxalic acid solution and titrate it against the given potassium permanganate solution. Also find the molarity and strength of the potassium permanganate solution.

Theory:

Potassium permanganate is a strong oxidising agent and in the presence of sulphuric acid it acts as a powerful oxidising agent. In acidic medium the oxidising ability of KMnO_4 is represented by the following equation.

In acidic solution,



Solution containing MnO_4^- ions are purple in colour and the solution containing Mn^{2+} ions are colourless and hence permanganate solution is decolourised when added to a solution of a reducing agent. The moment there is an excess of potassium permanganate present the solution becomes purple. Thus, KMnO_4 serves as self-indicator in acidic solution.

Potassium permanganate is standardized against pure oxalic acid. It involves a redox reaction. Oxalic acid is oxidised to carbon dioxide by KMnO_4 , which itself gets reduced to MnSO_4 .

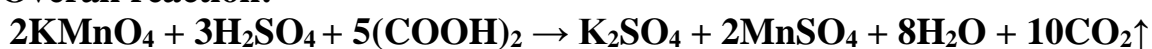
Chemical reaction:

Reduction Half reaction:-



Oxidation Half reaction:- $5(\text{COOH})_2 + 5[\text{O}] \rightarrow 5\text{H}_2\text{O} + 10\text{CO}_2\uparrow$

Overall reaction:-

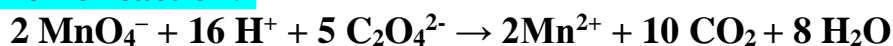


The ionic equation involved in the process is given below:

Reduction Half reaction:- $\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$

Oxidation Half reaction:- $\text{C}_2\text{O}_4^{2-} \rightarrow 2\text{CO}_2 + 2\text{e}^-$

Overall Ionic reaction:-



This titration cannot be carried out in the presence of acids like nitric acid or hydrochloric acid because it is an oxidising agent. So hydrochloric acid chemically reacts with KMnO_4 solution forming chlorine which is also an oxidising agent.

Indicator: Here KMnO_4 acts as a self - indicator and this titration is called permanganate titration.

Catalyst: Mn^{2+} (auto-catalysis)

Materials Required:

Oxalic acid

Potassium permanganate solution

Sulphuric acid

Chemical balance

Burette

Burette stand

Pipette

Conical flask

Funnel

Measuring flask

Weighing bottle

White tile

Burnet

Wire gauze

Apparatus Setup:

In burette – KMnO_4 solution

In Conical flask – 10ml of oxalic acid + half a test tube Sulphuric acid

End Point – Appearance of permanent pale pink colour.

Procedure:

(a) Preparation of 0.1 M standard solution of oxalic acid:

- The quantity of oxalic acid required for the 100 ml of the solution having a normality of 0.1 M can be calculated as follows.
- Molar mass of oxalic acid = 126 g
- $M = \frac{\text{wt} \times 1000}{\text{molar mass} \times \text{Volume (in ml)}}$
- $0.1 = \frac{\text{wt} \times 1000}{126 \times 100}$
- $\text{Wt} = ?$
- Weigh an empty watch glass using a chemical balance.
- Weigh ? g of oxalic acid accurately in the watch glass.
- With the help of a funnel transfer the oxalic acid into the measuring flask.
- Now wash the funnel with distilled water without removing the funnel from the flask.
- Make the solution up to the marked point with distilled water and make sure the oxalic acid is fully dissolved.
- This solution is 0.1 M standard solution of oxalic acid.

(b) Titration of potassium permanganate solution against standard oxalic acid solution:

- Rinse the burette with the potassium permanganate solution and fill the burette with potassium permanganate solution.
- Fix the burette in the burette stand and place the white tile below the burette in order to find the end point correctly.

- Pipette out 10ml of 0.1 M standard oxalic acid solution in a conical flask.
- Add a test tube full of sulphuric acid in order to prevent oxidation of manganese to form manganese dioxide.
- Heat the mixture up to 60°C before titrating with potassium permanganate.
- Note down the initial reading in the burette before starting the titration.
- The hot solution is titrated against potassium permanganate solution and simultaneously swirl the solution in the flask gently.
- Initially the purple colour of KMnO_4 is discharged with oxalic acid. The appearance of permanent pink colour reveals the end point.
- Repeat the titration until concordant values are obtained.
- Note down the upper meniscus on the burette readings. Record the reading in the observation table given below in order to calculate the molarity of KMnO_4 given.

Observations:

| S. No. | Volume of FAS | Volume of KMnO_4 | | Volume of KMnO_4 used |
|--------|---------------|---------------------------|---------------|--------------------------------|
| | | Initial reading | Final reading | |
| 1 | 10 ml | | | |
| 2 | 10 ml | | | |
| 3 | 10 ml | | | |
| | | | | |

Titre value:?

Calculations:

From the balanced chemical equation, it is clear that 2 moles of KMnO_4 reacts with 5 moles of oxalic acid.

According to the molarity equation,

$$\frac{\text{Molarity of } \text{KMnO}_4 \times \text{Volume of } \text{KMnO}_4}{\text{Molarity of oxalic acid} \times \text{Volume of oxalic acid}} = \frac{\text{No. of moles of } \text{KMnO}_4}{\text{No. of moles of oxalic acid}} = \frac{2}{5}$$

$$\text{Therefore, Molarity of } \text{KMnO}_4 = \frac{\text{Molarity of oxalic acid} \times \text{Volume of oxalic acid} \times 2}{\text{Volume of } \text{KMnO}_4 \times 5}$$

$$= 0.1 \times 10 \times 2 / ? \times 5$$

$$= ??$$

Strength of potassium permanganate in g/L = Molarity x molar mass

$$= ?? \times 158$$

$$= ???$$

Results:

- 1. Molarity of KMnO_4 is _____M**
- 2. The Strength of KMnO_4 is _____g/L**

Precautions:

- Clean all the apparatus with distilled water before starting the experiment and then rinse with the solution to be taken in them.**
- Rinse the pipette and burette before use.**
- Potassium permanganate is dark in colour, so always read the upper meniscus.**
- Use dilute sulphuric acid for acidifying the potassium permanganate.**
- Take accurate readings once it reaches the end point and don't go with average readings.**
- Do not use rubber cork burette as it can be attacked by KMnO_4**
- The strength of the unknown solution should be taken up to two decimal places only.**