

Exp. 5:

Titration of Oxalic Acid with KMnO_4

The titration of potassium permanganate (KMnO_4) against oxalic acid ($\text{C}_2\text{H}_2\text{O}_4$) is an example of redox titration. In close proximity to the endpoint, the action of the indicator is analogous to the other types of visual colour titrations in oxidation-reduction (redox) titrations.

Aim:

To determine the strength of potassium permanganate by titrating it against the standard solution of 0.1M oxalic acid.

Theory:

Potassium permanganate is a strong oxidising agent and in the presence of sulfuric 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.

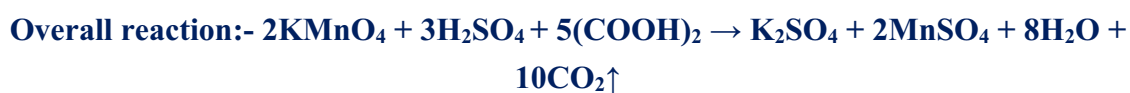
Thus, *KMnO_4 serves as self-indicator* in acidic solution.

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 . Oxalic acid reacts with potassium permanganate in the following way.

The chemical reaction at room temperature is given below.



The *overall reaction* takes place in the process is.



The *ionic equation* involved in the process is given below.



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

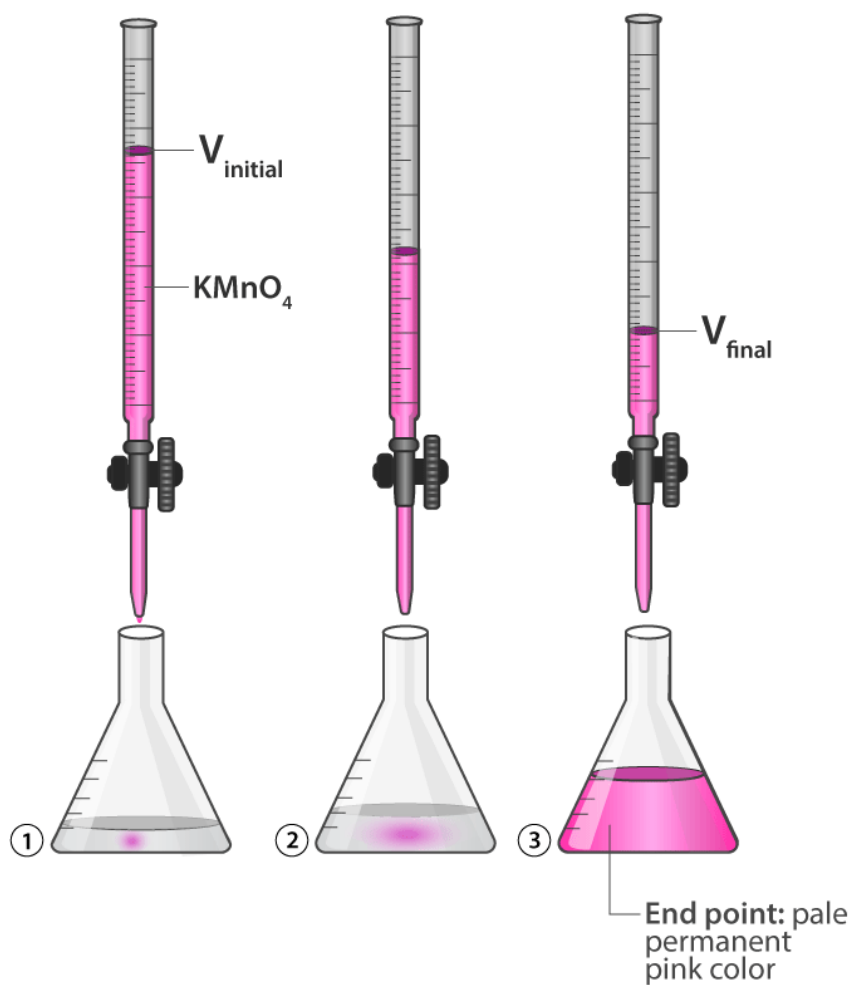
Materials Required:

1. Oxalic acid
2. Potassium permanganate solution
3. 1.0M sulphuric acid
4. Chemical balance
5. Burette
6. Burette stand.
7. Pipette
8. Conical flask
9. Funnel
10. Measuring flask
11. Weighing bottle
12. Magnetic stirrer with hot plate.

Apparatus Setup:

1. In burette – KMnO_4 solution
2. In Conical flask – 10ml of oxalic acid + sulphuric acid
3. Indicator – Self indicator (KMnO_4)
4. End Point – Appearance of permanent pale pink colour.

TITRATION OF OXALIC ACID VS KMnO_4



Procedure:

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

To determine the strength of potassium permanganate by titrating it against the standard solution of 0.1M oxalic acid.” we should calculate for 0.1 M of oxalic acid.

The molecular mass of oxalic acid =126 g

For the preparation of 100 ml of M/10 oxalic acid solution amount of oxalic acid required = 1.57 g

1. Weigh an empty watch glass using a chemical balance.
2. Weigh 1.57g of oxalic acid accurately in the watch glass.
3. With the help of a funnel transfer the oxalic acid into the measuring flask.
4. Now wash the funnel with distilled water without removing the funnel from the flask.
5. Make the solution up to the marked point in 100 ml volumetric flask with distilled water and make sure the oxalic acid is fully dissolved.

(b) Preparation of 0.1M standard solution of potassium permanganate KMnO_4 :

1. 3.16 g of potassium permanganate KMnO_4 should be dissolved in 100 ml in volumetric flask.

Fill up the prepared KMnO_4 in the burette.

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

1. Rinse the burette with the potassium permanganate solution and fill the burette with potassium permanganate solution.
2. Fix the burette in the burette stand and place the white tile below the burette in order to find the end point correctly.
3. Pipette out diluted sulphuric acid (20 ml) to 20 ml (Oxalic acid solution) in conical flask in order to prevent oxidation of manganese to form manganese dioxide.
4. Heat the mixture up to 60-70°C before titrating with potassium permanganate.
5. Note down the initial reading in the burette before starting the titration.
6. The hot solution is titrated against potassium permanganate solution and simultaneously swirl the solution in the flask gently.
7. Initially the purple colour of KMnO_4 is discharged with oxalic acid. The appearance of permanent pink colour reveals the end point.
8. 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.

Calculations:

To calculate the strength of given KMnO_4 in terms of molarity the following formula is used.

$$a_1M_1V_1 = a_2M_2V_2$$

Where a_1 and a_2 are stoichiometric coefficient of oxalic acid and KMnO_4 in a balanced chemical equation.

$$a_1 = 2$$

$$a_2 = 5$$

Where M_2 and M_1 are molarities of potassium permanganate and oxalic acid solutions used in the titration

V_2 and V_1 are the volume of potassium permanganate and oxalic acid solutions used in the titration.

Therefore,

$\text{KMnO}_4 = \text{Oxalic acid}$

$$5M_2V_2 = 2M_1V_1$$

$$M_2 = (2M_1V_1/5M_2V_2)$$

The strength of KMnO_4 is calculated by using the molarity.

Strength = Molarity x Molar mass

Results and Discussion:

1. Molarity of KMnO_4 is _____
2. The Strength of KMnO_4 is _____M.

Questions

- In this titration of KMnO_4 vs oxalic acid, what is the indicator used?
- What is meant by endpoint?
- What is meant by redox titration?
- Why we add diluted sulfuric acid to oxalic acid in Redox titration.