Determine the Percentage Composition Of a Mixture Of Sodium Oxalate $\begin{bmatrix} COONa \\ | \\ COONa \end{bmatrix}$ & Oxalic Acid $\begin{bmatrix} COOH \\ | \\ COOH \end{bmatrix} . 2H_2O$. Provided N/20 $KMnO_4$

Chemical Equations

Molecular Equations

$$2\,KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$

$$\begin{matrix} COOH \\ | \\ COOH \end{matrix} . 2H_2O + [O] \longrightarrow 2CO_2 + 3H_2O$$

$$\begin{matrix} COONa \\ | \\ COONa \end{matrix} + H_2SO_4 + [O] \longrightarrow 2CO_2 + H_2O + Na_2SO_4$$

Ionic Equations

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O\ ] \times 2$$

$$C_2O_4^{2-} \longrightarrow 2CO_2 + 2e^-\ ] \times 5$$

$$2MnO_4^- + 16H^+ + 5C_2O_4^{2-} \longrightarrow 2Mn^{2+} + 8H_2O + 10CO_2$$

Theory

Both oxalic acid and sodium oxalate can be titrated against N/20 $KMnO_4$ since both of them are reducing agents.
So normality (N_2) of the solution will be due to both of them. From the combined normality (N_2), the composition of each can be calculated.

Indicator

KMn04 is a self-indicator.

End Point

Colourless to permanent pink ($KMnO_4$ in burette).

Procedure

1. Rinse and fill the burette with the N/20 $KMnO_4$, solution.

2. Weigh exactly 1.0 g of the given mixture of oxalic acid and sodium oxalate and dissolve in water to prepare exactly 250 ml of solution using a 250 ml measuring flask. Rinse the pipette with the prepared oxalate solution and pipette out 20.0 ml of it in a washed titration flask.
3. Add one test-tube (~ 20 ml) full of dilute sulphuric acid (~ 4 N) to the solution in titration flask.
4. Note the initial reading of the burette.
5. Heat the solution of titration flask to 60-70°C and run down $KMnO_4$ solution from the burette till a permanent light pink colour is just imparted to the solution in the titration flask.
6. Note the final reading of the burette.
7. Repeat the above steps 4-5 times to get three concordant readings.

Observations

Normality of $KMnO_4$ solution = 1/20
Volume of oxalate solution taken for each titration = 20.0 ml.

S. No.	*Initial reading of the burette*	*Final reading of the burette*	*Volume of the $KMnO_4$ solution used*
1.	—	—	— ml
2.	—	—	— ml
3.	—	—	— ml
4.	—	—	— ml

Concordant volume = x ml (say).

Calculations

x ml of N/20 $KMnO_4$ solution are equivalent to 20 ml of the given oxalate solution.
Applying normality equation,

$$\underset{KMnO_4}{N_1V_1} = \underset{\text{oxalate soln.}}{N_2V_2}$$

$$\frac{1}{20} \times x = N_2 \times 20$$

$\therefore$ Normality of oxalate solution, $N_2 = \frac{x}{400}$

$\frac{x}{400}$ is the total normality due to oxalic acid and sodium oxalate.

Suppose, strength of oxalic acid = a g/litre

$\therefore$ Strength of sodium oxalate = $(4 - a)$ g/litre

Normality due to oxalic acid, $N_{\text{oxalic acid}} = \frac{a}{\text{Eq. mass of oxalic acid}} = \frac{a}{63}$

Normality due to sod. oxalate, $N_{\text{sod. oxalate}} = \frac{4-a}{\text{Eq. mass of sod. oxalate}} = \frac{4-a}{67}$

$\therefore$ Total normality of the oxalate solution = $N_{\text{oxalic acid}} + N_{\text{sod. oxalate}}$

$$\frac{x}{400} = \frac{a}{63} + \frac{4-a}{67}$$

From this equation, 'a' can be calculated. Knowing 'a', the percentage composition of the mixture can be calculated.

% of oxalic acid $= \frac{a}{4} \times 100 = X$ (say)

% of sod. oxalate $= \frac{4-a}{4} \times 100 = Y$ (say).

Instructions for the Preparation of Solutions

Provide the following solutions :

1. $KMnO_4$ solution (1.58 g/litre)
2. A mixture of oxalic acid and sodium oxalate
3. 4N H_2SO_4.