Experiment : 5

Experiment :- To determine the amount of Fe^{2+} and Fe^{3+} ions by permanganometry.

Apparatus : Pipette, burette, beakers, conical flask, burette stand and clamp.

Chemicals - Mohr's salt solution (Ferrous ammonium sulphate, $FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$), permanganate ($KMnO_4$) and sulphuric acid ($H_2SO_4$)

Chemical Equation -

$$MnO_4^- + 8H^+ + 5Fe^{2+} \rightleftharpoons Mn^{2+} + 5Fe^{3+} + 4H_2O$$

Indicator - $KMnO_4$ acts as self indicator.

Observation

a.) Standardization of $KMnO_4$ solution

Volume of 0.1N FAS (N_1) solution taken for each titration = 10 ml.

S.No.	Burette reading (ml)		Vol. of $KMnO_4$ used 1 ml
	Initial	Final	
1	0	10.5	10.5
2	0	10.5	10.5
3	0	10.5	10.5

Mean Volume (V_1) = 10.5 ml

b.) Determination of Fe^{2+}

Volume of given sample taken for each titration = 10ml

S.No	Burette reading (ml)		Vol. of $KMnO_4$ used (ml)
	Initial	final	
1	0	10.5	10.5
2	0	10.5	10.5
3	0	10.5	10.5

Khushi Gel

Expt. No. 5 Date 26th Oct

Page No.

Experiment: To determine the amount of Fe^{2+} and Fe^{3+} ions by permanganometry.

Apparatus: pipette, burette, beakers, conical flask, burette stand and clamp.

Chemicals: Mohr's salt solution (Ferrous Ammonium sulphate; $FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$), permanganate ($KMnO_4$) and sulphuric acid ($H_2SO_4$)

Theory: Mn^{7+} oxidises Fe^{2+} in acidic medium to Fe^{3+} and itself gets reduced to divalent chromium (Mn^{2+})

$MnO_4^- + 8H^+ + 5Fe^{2+} \rightleftharpoons Mn^{2+} + 5Fe^{3+} + 4H_2O$.

$KMnO_4$ acts as a self indicator. If Fe^{3+} is present in the original solution, it can be reduced by boiling the soln with zinc pieces in acidic medium and can be titrated with standard $KMnO_4$. The endpoint in this case corresponds to presence of both Fe^{2+} and Fe^{3+} ions in the solution.

PROCEDURE. i) Standardisation of $KMnO_4$

1) Transfer 10ml of the standard 0.1N ferrous ammonium sulphate (FAS) solution to a clean conical flask using a pipette.
2) Add 5ml of 4N sulphuric acid.
3) Titrate the solution against $KMnO_4$ solution taken in a burette. The color of the solution changes from colorless to pink.
4) Note the volume of the solution used and repeat the titration atleast 5 times and take the mean of closely related readings (4).

Teacher's Signature: Khushi Goel

Mean Volume (V_2) = _____ ml

(c.) Determination of Fe^{2+} and Fe^{3+} (Total iron content)

Volume of given sample taken for each titration = 10ml

S.No	Burette reading (ml)		Volume of $KMnO_4$ used (ml)
	Initial	Final	
1.	0	14.5	14.5
2.	0	14.5	14.5
3.	0	14.5	14.5

Mean Volume (V_3) = 14.5 ml

CALCULATIONS

i) Normality of $KMnO_4$ solution

($KMnO_4$) $N_1V_1 = N_2V_2$ (FAS) = 0.1 N × 10 ml.

Normality of $KMnO_4$ (N_1) = $\frac{0.1 \times 10}{V_1}$ = S (N) = $\frac{1}{10.5}$ N = 0.095N

ii) Determination of Fe^{2+}

Volume of solution taken = 10 ml.

Volume of $KMnO_4$ solution used (V_2) = 10.5 ml

Normality of $KMnO_4$ (N_1) = 0.095 N

Normality of Fe^{2+} = $N = \frac{V_2 \times S}{10} = \frac{10.5 \times 0.095}{10} \simeq 0.1$

Strength of Fe^{2+} = $56 \times N = 56 \times 0.1 = 5.6$ gm/L

iii) Determination of Fe^{+3} in a mix of Fe^{2+} and Fe^{3+}

Volume of sol. taken used = 10 ml.

Volume of $KMnO_4$ used (V_3) = 14.5 ml

Normality of $KMnO_4$ (N_1) = 0.095 N

Normality of total Fe: $N_1 = \frac{V_3 \times S}{10} = \frac{0.095 \times 14.5}{10} \simeq 0.14N$

Strength of total Fe = $N_1 \times$ Eq Wt. = 56 × 0.14 = 7.7 gm/L

Khushi Goel

Expt. No. ..... Date .....

Page No. .....

ii) Determination of Fe^{2+}.

1) Pipette out 10ml of the given substance in a titration conical flask.
2) Add 5 ml of 4N sulphuric acid.
3) Titrate the soln against $KMnO_4$ soln taken in burette. The color of the substance changes from colorless to pink.
4) Note the volume of the soln used and repeat the titration atleast 5 times and take the mean of closely related reading (V_2)

iii) Determination of Fe^{2+} and Fe^{3+} (Total iron content)

1) Pipette out 10 ml of aq soln into the conical flask [The given solution has already been boiled with 2-3 g of zinc pieces and 5 ml of dilute H_2SO_4 to reduce Fe^{3+} to Fe^{2+}]
2) Add 5 ml of 4N H_2SO_4.
3) Titrate it with standard $KMnO_4$ solution till the color changes from colorless to pink.
4) Note the volume of the solution used and repeat the titration at least 5 times and take the mean of the closely related readings (V_3)

General Calculations

i) Normality of $KMnO_4$ soln

Applying the normality solution

N_1V_1 ($KMnO_4$) = N_2V (FAS) = $0.1N \times 10ml$.

Normality of $KMnO_4$ $N_1 = \frac{0.1 \times 10}{V_1} = S(N)$

iii) Determination of Fe^{2+}

Vol of solution taken = 10ml.

Teacher's Signature : _____

$= N_1 \times 56 = gm/L = 7.7\ gm/L$

Strength of Fe^{3+} ions = Normality of Eq wt

$$\frac{(V_3 - V_2) \times 8 \times 56}{10} = \underline{2.1}\ gm/L$$

Results : The amount of $Fe^{2+} = \underline{5.6}\ gm/L$

The amount of $Fe^{3+} = \underline{2.1}\ gm/L$

Khushi Goel

Expt. No.

Date

Page No.

Vol of $KMnO_4$ solution used = V_2 ml
Normality of $KMnO_4$ = 8N
Normality of Fe^{2+} $N_1 = \frac{V_2 \times 8}{10}$
Strength = $N_1 \times$ Eq wt $\Rightarrow N_1 \times 56$ gm/L

iii) Determination of Fe^{3+} in a mixture of Fe^{2+} and Fe^{3+}
Volume of soln taken = 10 ml
Volume of $KMnO_4$ solution used = V_3 ml
Normality of $KMnO_4$ = 8N
Normality of total Fe = $N_1 = V_3 \times 8/10$

Strength of total Fe = $N_1 \times$ Eq. wt = $N_1 \times 56$ gm/L
Strength of Fe^{3+} ions = Normality x Eq. wt
$(V_3 - V_2) \times 8 \times 56/10$

Results → The amount of Fe^{2+} = 5.6 gm/L
The amount of Fe^{3+} = 2.1 gm/L

Expected CLO's / Daily life Application: In quantitative and qualitative determination of Fe^{2+} and/or Fe^{3+} present in an ore or compound, water sample, etc.

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