MANIPULATION N°4

Redox titration (Oxidation-Reduction Titration)

Oxidation-Reduction Titration :

1- Introduction :

Le dosage consiste à déterminer la normalité d'une solution réductrice connaissant celle de la solution oxydante. On se propose d'étudier l'oxydation de l'ion Fe^{2+} *par l'ion permanganate* MnO_4^- *en milieu acide.*

Ce dosage est appelé ***manganimétrie****. Les propriétés oxydantes de l'ion permanganate sont à l'origine de la manganimétrie. La forme oxydante* MnO_4^- *est* ***violette****, la forme réductrice* Mn^{2+} *est* ***incolore****, ce qui permet de déterminer le* ***point équivalent*** *sans utiliser* ***d'indicateurs colorés****.*

Titration consists of determining the normality of a reducing solution given the normality of the oxidising solution. We propose to study the oxidation of the Fe^{2+} *ion by the permanganate ion* MnO_4^- *in an acid environment.*

This titration is called ***manganometry****. The oxidising properties of the permanganate ion are at the origin of manganometry. The oxidising form* MnO_4^- *is* ***violet****, while the reducing form* Mn^{2+} *is uncoloured, making it possible to determine the equivalent point* ***without using coloured indicators****.*

2- Purpose of the Tractical work :

The objective is to determine the normality of a solution ($FeSO_4$*), using a solution of Potassium Permanganate (*$KMnO_4$*) prepared in the laboratory.*

3- Definitions :

3-1. Oxidation *: Oxidation is a reaction in which a reactive agent* ***gives up*** *(****loses****) one or more* ***electrons****.*

$$Fe \rightarrow Fe^{2+} + 2e^-$$

In this reaction, the Fe^{2+} *ion is the oxidised form and* ***Fe*** *is the reduced form of the (redox couple) (*Fe^{2+}/Fe*).*

3-2. Reduction *: A reduction is a reaction in which a reactive agent* ***captures*** *(****takes****) one or more* ***electrons****.*

$$Cu^{2+} + 2e^- \rightarrow Cu$$

In this reaction, copper metal is the reduced form and the Cu^{2+} *ion is the oxidised form of the (redox couple) (*Cu^{2+}/Cu*).*

3-3. The Oxidant: *is the reagent capable of causing oxidation, that is to say that it* ***captures*** *one or more* ***electrons*** *from another reagent.*

$$Cu^{2+} : \quad Cu^{2+} + 2e^- \rightarrow Cu$$
$$Fe^{2+} : \quad Fe \rightarrow Fe^{2+} + 2e^-$$

3-4. The reductant: *is the reagent capable of causing a reduction, that is to say that it* ***gives up*** *one or more* ***electrons*** *to another reagent.*

$$Cu : \quad Cu^{2+} + 2e^- \rightarrow Cu$$
$$Fe : \quad Fe \rightarrow Fe^{2+} + 2e^-$$

3-5. Redox couple: *a redox couple is a couple formed by an oxidant and its conjugate reductant.*

oxidant + ne^- ⇄ reductant

Examples of redox couple :

Redox couple	Oxidant	+ n e^-	⇄	Reductant
Cu^{2+}/Cu	Cu^{2+}	+ 2 e^-	⇄	Cu
Fe^{2+}/Fe	Fe^{2+}	+ 2 e^-	⇄	Fe
H^+/H_2	$2H^+$	+ 2 e^-	⇄	H_2
Ag^+/Ag	Ag^+	+ 1 e^-	⇄	Ag

3-6. Potassium permanganate :

*Potassium permanganate (**$KMnO_4$**) is a particularly powerful oxidant. It is in the form of violet crystals composed of potassium **K^+** ions and permanganate ions, **$[MnO_4]^-$** it is odorless and its taste is bitter.*

In the laboratory, potassium permanganate is used for titration. At the equivalence point, the solution changes colour from violet to pink. Potassium permanganate is also used in water treatment to oxidise the iron and manganese in groundwater. In everyday life, it can be used in dilute solution to remove the black marks left by fungi between bathroom glass tiles.

4- Experimental part :

Titration of iron in ferrous sulphate with potassium permanganate :

Materials: *Burette, Erlenmeyer flask, Graduated cylinder, wash bottle, $KMnO_4$ solution (0.1N), $FeSO_4.7H_2O$ solution, distilled water, H_2SO_4 (10%).*

1- *Rinse the equipment. Burette, Erlenmeyer flask, etc.*
2- *Fill the burette with the Normality **$KMnO_4$** solution (**N_A= 0.1N**).*
3- *Take (**V_B=10 ml**) of the solution (**$FeSO_4.7H_2O$**) and place in a 250 mL erlenmeyer flask.*
4- *Add about **5 ml** of **H_2SO_4** (**10%**) and about **50 ml** of distilled **water**.*
5- *Place the Erlenmeyer flask on a blank sheet of paper under the burette.*
6- *Make a rapid titration to estimate the volume of equivalence.*
7- *Record the volume **V_A** of (**$KMnO_4$**) added.*
8- *Repeat the titration 2 more times.*

4- Results and Calculations :

4-1. Titration of iron in ferrous sulphate using potassium permanganate:

1- *What is the objective of the experiment?*
2- *Write down the **oxidation-reduction** half-reactions and indicate the **redox** couples.*
3- *Write down the **global** reaction.*
4- *Record the volume **V_A** of (**$KMnO_4$**) added and calculate the normality (**N_B**) of (**$FeSO_4.7H_2O$**).*
5- *Calculate the Concentration (**C_B**) of the solution (**$FeSO_4.7H_2O$**).*
6- *What to conclude when the role of sulphuric acid **H_2SO_4** ?*
7- *Identify the **limiting** reagent in this reaction?*
8- *Can sulphuric acid be replaced by **HCl** or **H_3PO_4**? Explain.*