# The d & f - Block Elements

**Potassium permanganate, KMnO4:**

It is prepared by fusing pyrolusite ore ($MnO_2$) with KOH in the presence of atmospheric oxygen or an oxidizing agent like $KNO_3$ or $KClO_3$ to get potassium manganate, $K_2MnO_4$ (green mass). The green mass is extracted with water and is oxidized to potassium permanganate, either electrolytically or by passing chlorine or ozone into the solution. The purple solution is

$$2MnO_2 + 4KOH + O_2 \xrightarrow{heat} 2K_2MnO_4 + 2H_2O$$

$$K_2MnO_4 \longrightarrow 2K^+ + MnO_4^{2-}$$

$$MnO_4^{2-} \longrightarrow MnO_4^{--} + e$$

(i) Potassium permanganate exists as dark purple black prismatic crystals having a greenish metallic lustre. It melts at 523 K. It is moderately soluble in water at room temperature giving a purple solution. However, its solubility in water increases with temperature.

(ii) **Effect of heat**. $2KMnO_4 \xrightarrow{Heat} K_2MnO_4 + MnO_2 + O_2$

(iii) **Oxidising properties**.

(a) In acidic medium :

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

(b) In neutral medium :

$$2KMnO_4 + H_2O \rightarrow 2KOH + 2MnO_2 + 3[O]$$

(c) In basic medium :

$$2KMnO_4 + 2KOH \rightarrow 2K_2MnO_4 + H_2O + [O]$$

In basic medium, $MnO_4^-$ (managanate ions) is further reduced to $MnO_2$ in the presence of reducing agent. As such equivalent weight of $KMnO_4$ in basic medium is same as in neutral medium.

In acidic medium potassium permanganate oxidises.

(i) Ferrous to ferric salt

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

(ii) Oxalates to carbon dioxide

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

(iii) Iodides to iodine

$$10I^- + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 5I_2 + 8H_2O$$

(iv) Sulphites to sulphates

$$5SO_3^{2-} + 2MnO_4^- + 6H^+ \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$$

**In alkaline solution**

(i) Iodides to iodates

$$I^- + 2MnO_4^- + H_2O \rightarrow \quad IO_3^- + 2MnO_2 + 2OH^-$$

**Uses**.

(i) As oxidizing agent in laboratory and industry.

(ii) In volumetric estimation of ferrous salts, oxalates and other reducing agents in redox titration.

(iii) As disinfectant in water.

(iv) For qualitative detection of halides, oxalates, tartarates.

**Use of $KMnO_4$ in redox – titrations:**

Potassium permanganate is a powerful and versatile oxidizing agent and is widely used for titration against reducing agents like oxalic acid and Mohr's salt. During the titration, the reduction of potassium permanganate by a reducing agent e.g., oxalic acid or Mohr's salt, produces manganous ions which are nearly colourless.

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

As the titration proceeds and when the whole of the reducing agent is consumed up, then the addition of an excess drop of potassium permanganate solution gives its own colour (pink) to the solution. Therefore, at the end point the colour changes from colourless to pink. Thus, potassium permanganate acts as a self indicator.

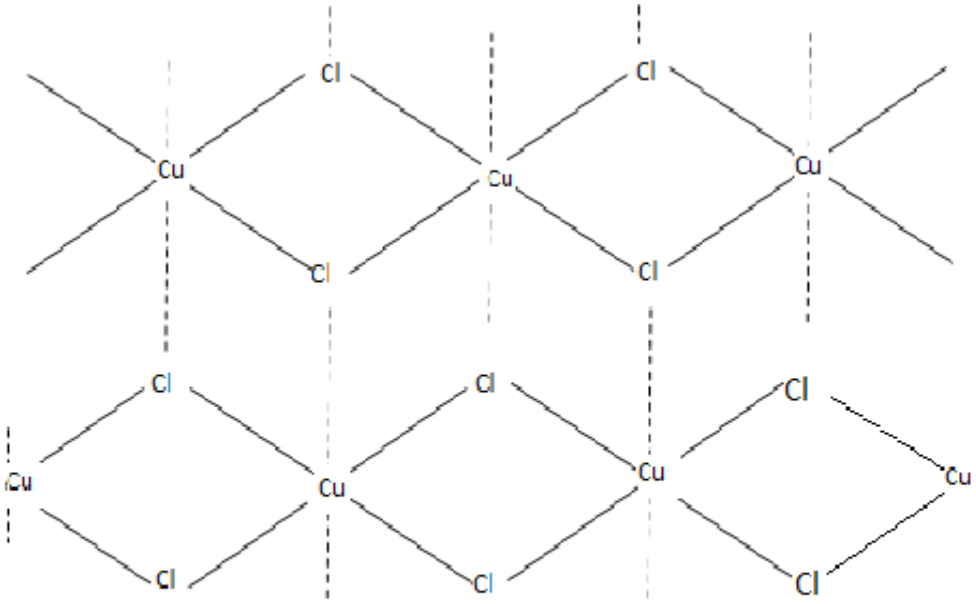
**SOME OTHER COMPOUNDS OF TRANSITION METALS :**

**Halides of transition metals**:

(i) Halides of transition metals in higher oxidation states exhibit a greater tendency to hydrolysis

e.g. $TiCl_4 + 2H_2O \rightarrow TiO_2 + 4HCl$

(ii) Bonding in fluorides is essentially ionic. In the chlorides, bromides and iodides, the ionic character decreases with increase in atomic mass of the halogens. For example $CuF_2$ is ionic while $CuCl_2$ and $CuBr_2$ are covalent compounds consisting of infinite chains. The structure of copper (II) chloride is given below.




Structure Of Copper (II) Chloride

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