ELECTROCHEMISTRY

Definition: The branch of chemistry which deals with the study of relationship between electrical energy, chemical energy and inter conversion of one form into another is called electrochemistry

Electrolysis

Definition: The process of chemical decomposition of an electrolyte in solution or in the fused state by passage of electric current is known as electrolysis

Electrolyte

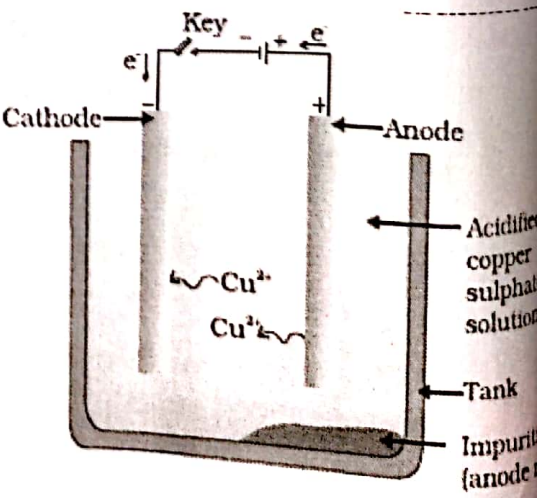
Definition: The substances which conduct electricity in their fused or in aqueous solution are called electrolysis

Ex- NaCl, $CaCl_2$ etc

Electrolytic cell

Definition: Electrolytic cell is a device in which electrical energy is converted in to chemical energy.

Process of Electrolysis



- The process of electrolysis is carried out in a vessel known as electrolytic tank
- It is made up of some insulating material such as glass, stone etc.
- Fused electrolyte or an aqueous solution of the electrolyte is taken in an electrolytic tank and two metallic plates are dipped in the electrolyte. These plates are known as electrodes.
- The electrodes are connected to an external source of emf (battery).The electrode which is connected with the positive end of the battery is called **anode** and the electrode which is connected to the negative end is called **cathode**.

• When an electric current is passed through the solution, cations move towards the cathode, whereas anions move towards the anode.

• This movement of ions towards oppositely charged electrodes is called **electrolytic** conduction.

Example of electrolysis

By using copper sulphate solution (using Pt electrode)

• When copper sulphate is dissolved in water it ionises as:

$CuSO_4 \longrightarrow Cu^{2+} + SO_4^{2-}$

$H_2O \longrightarrow 2H^+ + O^{2-}$ (slightly ionised)

• When electric current is passed through copper sulphate solution using platinum (Pt) electrodes, Cu^{2+} and H^+ ions move towards the cathode. However, only Cu^{2+} ions are discharged more readily than H^+ ions because of their low discharge potentials.

• These Cu^{2+} ions gain electrons and change into neutral atoms and get deposited at cathode.

At cathode: $Cu^{2+} + 2e^- \longrightarrow Cu$ (deposited)

b) SO_4^{2-} and OH^- ions move towards anode. However, only OH^- ions are discharged more readily than SO_4^{2-} ions because of their low discharge potential. These OH^- ions lose electrons and change into neutral hydroxyl groups

At anode: $2OH^- + 2e^- \longrightarrow 2OH$ (neutral)

• The neutral hydroxyl groups being unstable react with other neutral OH groups to form water and oxygen.

$2OH \longrightarrow H_2O + [O]$

$[O] + [O] \longrightarrow O_2$

Conclusion:

Hence during electrolysis of copper sulphate solution using platinum (unattackable) electrodes, copper and oxygen are liberated.

Faraday's 1st law of electrolysis

Definition: The mass of substance liberated at the electrode as a result of electrolysis is directly proportional to the quantity of electricity passed through the electrolyte.

If W is the mass of substance liberated at the electrode and Q is the quantity of electricity (in coulombs) passed through the electrolyte.

Then, $W \propto Q$

We know $Q = C.t$

Where c = current in amperes

t = time in seconds

Thus $W \propto C.T$

OR $\boxed{W = ZC.T}$

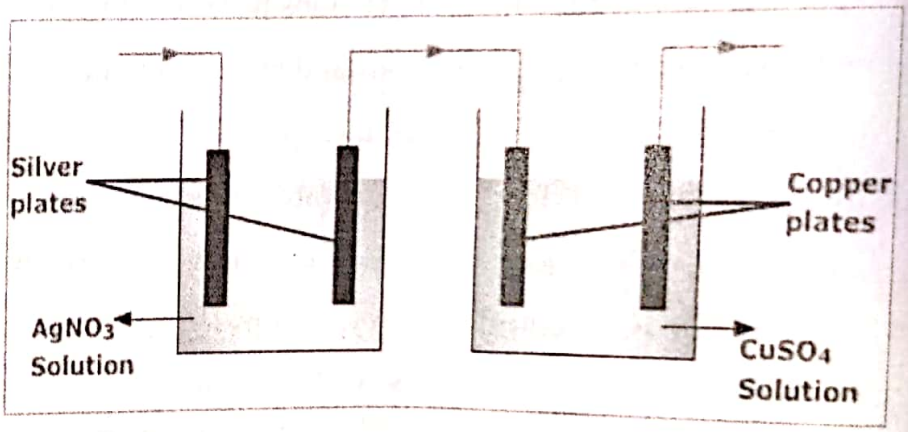
Where Z is a constant called Electro chemical Equivalent

In the above relationship, if c = 1 ampere and t = 1 second

then $\boxed{W = Z}$

Definition of ECC

Electrochemical equivalent of a substance is defined as the mass of substance liberated when one ampere of current is passed through the electrolyte for one second.



Unit of electricity - Coulomb

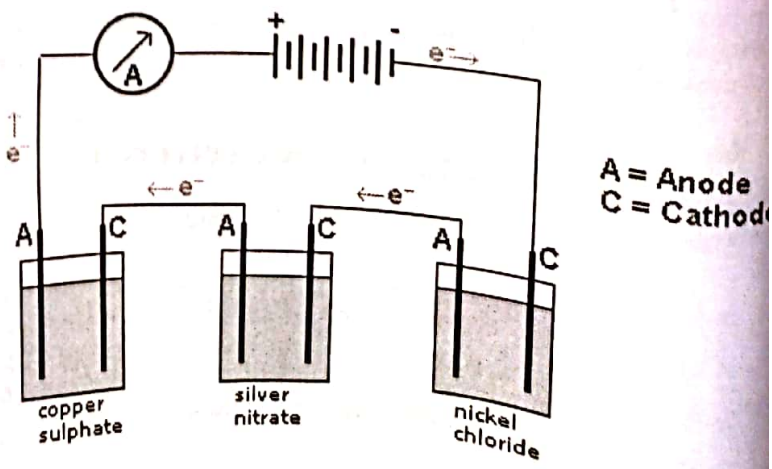
1 coulomb = 1 ampere x 1 second

$\boxed{1 \text{ Faraday} = 96500 \text{ coulomb}}$

Mass of substance liberated by passage of one faraday of electricity = 1 gm equivalent.

Faraday's 2nd law of electrolysis

Definition: It states that when the same quantity of electricity is passed through different electrolytic solutions, the weights of different substances produced at the electrodes are proportional to their equivalent weights.



Explanation:

There are three electrolytic cells containing Copper Sulphate, Silver Nitrate and Nickel Chloride solutions respectively.

- They are connected in series as shown in the diagram above
- On passing the current through the three cells for some time, the three cells receive the same amount of electricity.
- The weights of copper, silver and nickel liberated are in the ratio of their equivalent weights.

$$\frac{\text{Weight of Copper}}{\text{Weight of Silver}} = \frac{\text{Equivalent weight of Copper}}{\text{Equivalent weight of Silver}}$$

and

$$\frac{\text{Weight of Nickel}}{\text{Weight of Silver}} = \frac{\text{Equivalent weight of Nickel}}{\text{Equivalent weight of Silver}}$$

Industrial application of Electrolysis

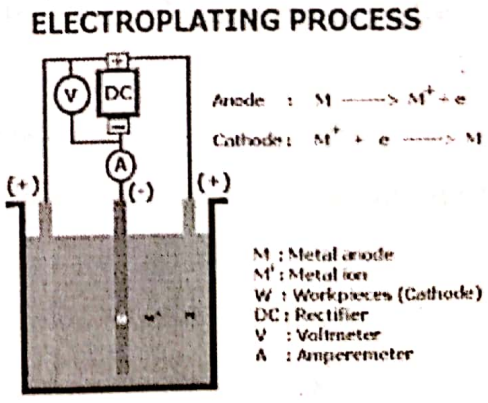
Electroplating

Electroplating is done for the following purpose.

a. Decoration

b. Protection

c. Repairs



Zinc Plating

For Zinc plating, acid and alkaline solutions are used for deposition.

Electrolytic bath

a) The acid solution used as electrolytic bath consists of a solution of:-

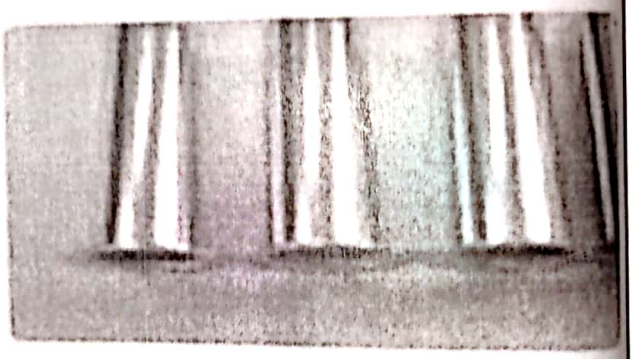
i) Zinc Sulphate (300gm)

ii) Sodium Chloride (15gm)

iii) Aluminium Sulphate (30gm)

iv) Boric acid (20gm)

v) Dextrin (15gm) in 1000ml water



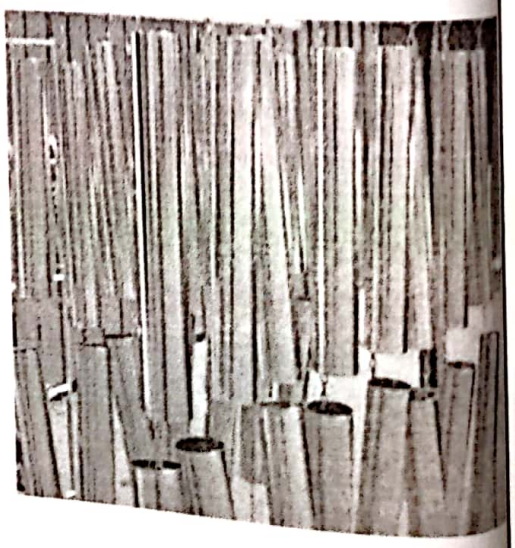
b) The alkaline solution consists of

i) Zinc Oxide (40gm)

ii) Sodium Cyanide (100gm)

iii) Sodium Carbonate (10gm) in 1000ml water

Temperature of the solution = 30-40°C



Application

Zinc plating is done on Iron articles to protect them from rusting.