

Electrolysis

Electrolysis

It is the process of decomposition of a chemical compound in aqueous solution or in a molten state, accompanied by a chemical change using direct current.

Electrolyte

It is an ionic compound which in the fused state or in the aqueous solution allows the passage of an electric current and is decomposed by it.

Strong Electrolytes

The compounds which in their aqueous solution or in the fused state are almost completely ionised are called strong electrolytes.

Examples: Mineral acids, alkalis and salts

Weak Electrolytes

The compounds which in their fused state or aqueous solution are feebly ionised and are poor conductors of electricity are called weak electrolytes.

Examples: Acetic acid, oxalic acid

Non-electrolytes

The compounds which neither in solution nor in the molten state allow an electric current to pass through them are called non-electrolytes.

Examples: Kerosene, carbon disulphide

Electrolytic Cell

It is a device used to convert electrical energy into chemical energy.

Electrochemical Cell

It is a device used to convert chemical energy into electrical energy.

Electrodes

The graphite, metal plates or gas carbon rods immersed in the electrolyte through which current enters and leaves the electrolytic cell are called electrodes.

Cathode

The electrode connected to the negative terminal of the battery is called a cathode.

Anode

The electrode connected to the positive terminal of the battery is called an anode.

Ions

The atoms or groups of atoms which carry a positive or negative charge are known as ions.

Cations

Atoms which carry a positive charge are called cations.

Anions

Atoms which carry a negative charge are called anions.

Oxidation

It is a chemical process which involves the addition of oxygen or the removal of hydrogen.

Oxidising Agents

It is a substance which oxidises other substances either by accepting electrons or by providing oxygen or an electronegative ion.

Reduction

It is a chemical process which involves the removal of oxygen or the addition of hydrogen.

Reducing Agent

It is a substance which reduces other substances by providing electrons, hydrogen or an electropositive ion.

Dissociation

The process due to which an ionic compound dissociates into ions in the fused state or in the aqueous solution is called electrolytic dissociation.

Example: Electrovalent compounds such as NaCl. $\text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^-$

Ionisation

The process by which polar covalent compounds are converted into ions in water solution is called ionisation. $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$

Electrochemical Series

It is a series in which metals are arranged based on the ease with which atoms of metals lose electrons to form positively charged ions.

Cation			Anion
K ⁺	Discharged with most difficulty	Discharged with most difficulty	SO ₄ ²⁻
Ca ²⁺			NO ₃ ¹⁻
Na ⁺			Cl ¹⁻
Mg ²⁺			Br ¹⁻
Al ³⁺			I ¹⁻
Zn ²⁺			
Fe ²⁺			
Pb ²⁺			
H ⁺			
Cu ²⁺			
Hg ²⁺			
Ag ⁺			
	Discharged most easily	Discharged most easily	OH ¹⁻

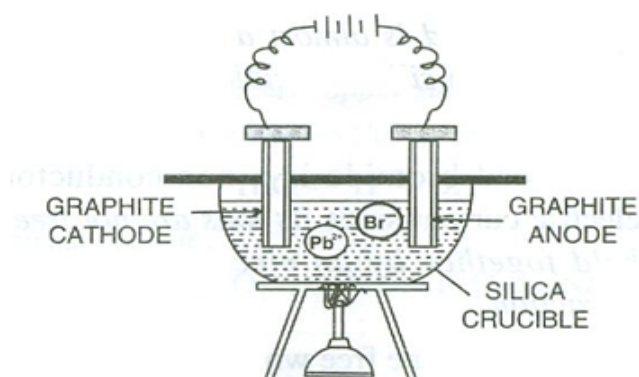
Selective Discharge of Ions

The preferential discharge of ions present in an electrolyte at the respective electrodes is known as selective discharge of ions.

It depends on the following factors:

- Relative position of ions in an electrochemical series
- Concentration of the ions
- Nature of the electrode

Electrolysis of Fused Lead Bromide



Electrolyte: Molten lead bromide (PbBr_2)

Anode: Graphite

Cathode: Graphite

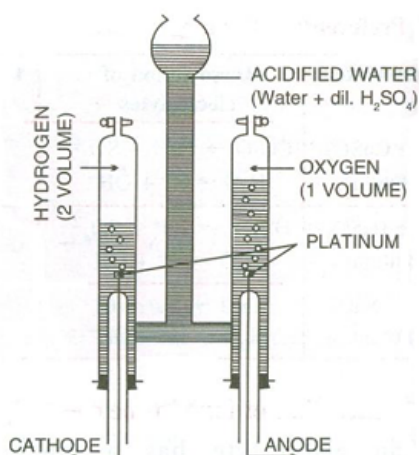
Overall reaction: $\text{PbBr}_2 \rightarrow \text{Pb}^{2+} + 2\text{Br}^-$

Reaction at the cathode: $\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$

Reaction at the anode: $\text{Br}^- - \text{e}^- \rightarrow \text{Br}$

$\text{Br} + \text{Br} \rightarrow \text{Br}_2$

Electrolysis of Acidified Water

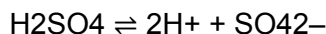


Electrolyte: Acidified water

Anode: Platinum

Cathode: Platinum

Ionisation of acidified water: $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$



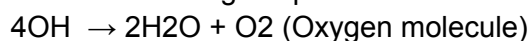
Ions present: H^+ , SO_4^{2-} , OH^-

Reaction at the cathode: $\text{H}^+ + \text{e}^- \rightarrow \text{H}$

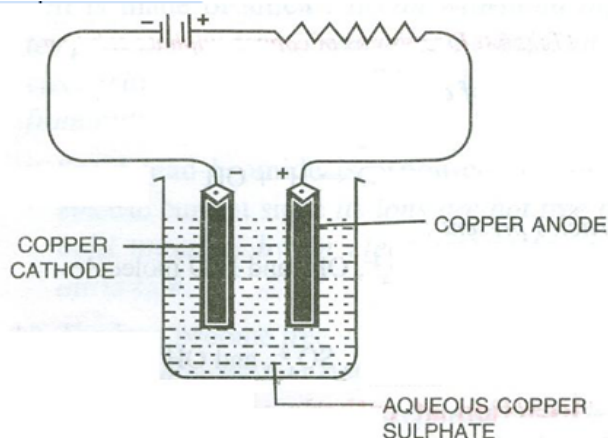


Reaction at the anode: $\text{OH}^- - \text{e}^- \rightarrow \text{OH} \times 4$

OH^- ion discharge in preference to SO_4^{2-}



Electrolysis of Aqueous Copper Sulphate



Electrolyte: Aqueous copper sulphate solution

Anode: Copper

Cathode: Copper

Dissociation of aqueous copper sulphate: $\text{CuSO}_4 \rightleftharpoons \text{Cu}^{2+} + \text{SO}_4^{2-}$
 $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$

Reaction at the cathode: $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$

Cu being lower in the electrochemical series.

Reaction at the anode: $\text{Cu} - 2\text{e}^- \rightarrow \text{Cu}^{2+}$

SO_4^{2-} and OH^- are not discharged.

Applications of Electrolysis

- i. Electroplating with metals
- ii. Electrorefining of metals
- iii. Extraction of metals

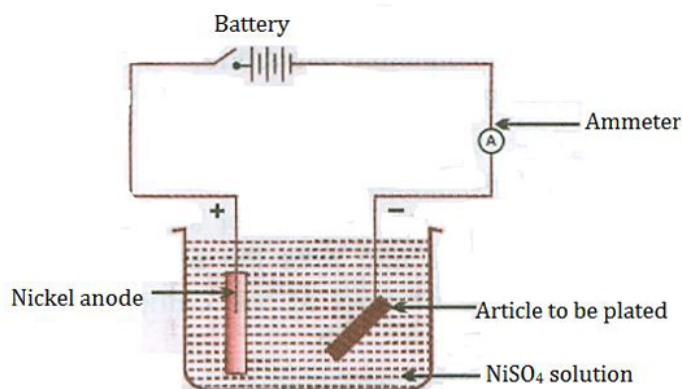
Electroplating

It is a process in which a thin film of a metal, such as gold, silver or nickel, gets deposited on another metallic article with the help of electricity.

Reasons for Electroplating

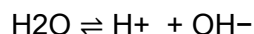
- i. Decoration purposes
- ii. To protect from rusting and corrosion

Electroplating with Nickel



Electrolyte: Aqueous solution of nickel sulphate

Dissociation: $\text{NiSO}_4 \rightleftharpoons \text{Ni}^{2+} + \text{SO}_4^{2-}$



Cathode: Article to be electroplated

Anode: Block of pure nickel

Reaction at cathode: $\text{Ni}^{2+} + 2\text{e}^- \rightarrow \text{Ni}$ (deposited)

Reaction at anode: $\text{Ni} - 2\text{e}^- \rightarrow \text{Ni}^{2+}$

Note: Article to be electroplated is always kept at the cathode.

Electrolytic refining of metals

It is a process by which metals containing impurities are purified electrolytically to give a pure metal.

Electrolytic refining of copper

Electrolyte: Copper sulphate solution and dil. sulphuric acid

Cathode: Thin strip of pure copper

Anode: Impure copper

Reaction at cathode: $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$

Reaction at anode: $\text{Cu} - 2\text{e}^- \rightarrow \text{Cu}^{2+}$

Electrometallurgy

It is the process of extraction of metals by electrolysis.

K
Na
Ca
Mg
Al

Extracted by electrolysis of their fused salts

Zn
Fe
Pb
[H]
Cu
Hg
Ag

Extracted by reducing agents like carbon, carbon monoxide etc.

Pt
Au

Extracted by thermal decomposition

Acids, Bases and Salts as Electrolytes

They can be classified as strong or weak electrolytes depending on the degree of dissociation.

Degree of dissociation

$$\frac{\text{Number of molecules dissociated}}{\text{Total number of molecules}} \times 100$$