# 9. ELECTRO CHEMISTRY

It is concerned with the relation between electrical energy and chemical change. It includes the study of formation and behaviour of ions in solution. An ion is an electrically charged atom or group of atoms; positively charged ions are called cations, while negatively charged ions are known as anions.

Substances, which in the liquid state or in the form of solutions in some solvent (mostly water) allow electricity to pass through are called electrolytes, e.g. water, common salt, molten salts, etc. Substances that do not allow electricity to pass through are called non-electrolytes, e.g. sugar, wax, naphthalene, etc.

The passage of electric current through an electrolyte is called electrolysis. During electrolysis, the electrodes become coated with a layer of metal; this process is called electroplating, and is useful in preventing rust formation and corrosion.

**Electrolysis**

The process of decomposition of an electrolyte (a compound formed by electrovalent bonds) by the passage of an electric current through its molten state or its aqueous solution is called electrolysis and the experimental arrangement used for this purpose is called an electrolytic cell.

This process of electrolysis can be explained by considering the decomposition of aqueous sodium chloride solution by an electric current as is explained below:

(i) The solution of sodium chloride in water contains sodium ions and chloride ions.

$$NaCl \xrightarrow{water} Na^+ + Cl^-$$

(ii) The sodium ions and chloride ions are moving aimlessly (random motion) in the solution.

(iii) When the two electrodes are connected with a battery, one electrode becomes positively charged and the other negatively charged.

(iv) The positively charged electrode (anode) attracts the negatively charged ions (anions, $Cl^-$) and the negatively charged electrode (cathode) attracts the positively charged ions (cations, $Na^+$).

(v) When the anions reach the anode, they give up their negative charge (electrons) to the anode and become neutral.

**At anode:**

$$Cl^- \qquad Cl + e^-$$

The neutral atoms (which are reactive) then combine to form molecules.

$$Cl + Cl \qquad Cl_2$$

(vi) When the cations reach the cathode, they accept electrons from it and become neutral atoms which may exist as an element.

**At cathode :**

$$Na^+ + e^- \qquad Na$$

Sodium obtained at cathode reacts with water to form sodium hydroxide, liberating hydrogen.

$$2Na + 2H_2O \qquad 2\,NaOH + H_2$$

It should be noted that an electrolyte is decomposed during electrolysis and the decomposition of the electrolyte takes place only at the electrodes and not in between the electrodes.

**Characteristics of Electrolysis**

(i) Electrolytic reaction or the process of electrolysis (that is a reaction in which an ion loses or gains electrons) starts as soon as the current is switched on and stops as soon as it is switched off.

(ii) The primary products of electrolysis, that is the products formed by the discharge of ions are liberated only at the electrodes.

(iii) Hydrogen and metals are usually set free at the cathode. Elements liberated at the cathode are said to be electropositive.

(iv) Non-metals are liberated at the anode. Elements liberated at the anode are said to be electronegative.

(v) The weight of a substance produced on an electrode during electrolysis is proportional to the quantity of electricity passed through the electrolye.

**Applications of Electrolysis**

The process of electrolysis is applied in a number of fields for various purpose. Some of the important applications are discussed below:

**(i) Electroplating** is a process of depositing one metal (generally a superior metal such as iron or copper) through the process of electrolysis.

Electroplating may be carried out for preservation or decoration. For example, articles, made of iron are electroplated with tin, nickel or chromium to prevent rusting. Similarly, many household articles such as tea sets and decoration pieces made of metals like copper

and brass are electroplated with gold or silver to enhance their beauty.

**(ii)** **Electrorefining** Metals can be refined (purified) by the electrolytic method. A thick slab of impure metal is made the anode and a thin sheet of pure metal is made the cathode in the solution of a suitable salt of the metal to be purified.

On passing electricity, the anode goes on dissolving and the pure metal gets deposited at the cathode. The impurities are thrown down in the form and anode mud. Copper is industrially purified by this method.

**(iii)** **Electroprinting** In large-scale printing, impression of the ordinary type page is made on wax or plaster of paris. The wax plate is made a conductor by sprinkling graphite on it and then made cathode in copper plating bath. On passing electric current, copper deposits on the wax plate till a sufficient thickness of copper deposit is obtained. It is removed and strengthened by filling its back with type-metal. The mould obtained is an exact copy of the printer's page and is used in large scale printing.

**(iv)** **Electrometallurgy** The process of extraction of metal from its ore by electrolysis is called electrometallurgy. For example, sodium is obtained by electrolysis of fused sodium chloride, while aluminium is extracted by the electrolysis of bauxite in fused cryolite.

**(v)** **Industrial Preparations** A large number of chemicals used in industry and medicine are prepared electrolytically. For example, caustic soda, washing soda, chlorine, and so on is obtained by electrolysis of sodium chloride, while hydrogen and oxygen are manufactured by electrolysis of acidulated water.