INTRODUCTION

Electrochemistry is a branch of chemistry which deals with the study of chemical reactions produced by passing electric current through an electrolyte or the production of electrical energy by chemical reactions.

Simply, Electrochemistry deals with inter conversion of electrical energy and chemical and vice versa.

The principle of electrochemistry is useful in various fields like electro analytical techniques for qualitative and quantitative analysis, corrosion prevention, batteries, electroplating, metallurgy, etc.,

Electrochemical Terms and Conventions

The following terms and conventions must be adopted for the electrode reaction, electrode potential and electrochemical cell.

i) Current

It is the flow of electrons through a conductor.

ii) Conductor

Conductor is a material that allows electric current to pass through it. Conductance is the ability of a material to conduct the electricity.

Examples : All metals, graphite, aqueous solution of acids and bases and fused salts.

The conductors are broadly classified into two types :

(a) Metallic conductors. (b) Electrolytic conductors.

a) Metallic Conductors or Electronic Conductors

Metallic conductors are the solid substances that conduct electricity without producing chemical reaction. In metallic conductor, the transfer of current from one end to another end is due to movement of electrons. *Examples :* All metals, graphite, etc.

b) Electrolytic Conductors

Electrolytic conductor is the solution that conduct electricity by producing chemical reaction. Here, conduction of electricity is only due to movement of ions from one electrode to another electrode. The chemical reactions take place at the electrode surface.

Examples : Acids, bases, salts, etc.

Difference between Metallic Conductorsand Electrolytic Conductors

S.No	Metallic Conductors	Electrolytic Conductors
1	It involves the flow of electrons.	It involves the flow of ions.
2	Chemical reactions does not occur.	Chemical reactions occur at electrode surface.
3	It does not involve any transfer of matters.	It involves transfer of ions fromone electrode to another.
4	Conduction decreases with increase in temperature.	Conduction increases with increase in temperature

Electrolytic conductors are further classified into three types. They are as follows:

1) Strong Electrolytes: Strong electrolytes are substances, which ionise completely almost at all dilution.

Examples : HCl, NaOH, NaCl, KCl, CH_3COONa, etc.

2) Weak Electrolytes : Weak electrolytes are substances which ionise to a very small extent even at high dilution.

Examples : CH_3COOH, NH_4OH, $CaCO_3$, $BaSO_4$,AgCl, etc.

3) Non Electrolytes : Non electrolytes are substances which do not ionize at any dilution.

Examples : Glucose, sugar, alcohol, benzene, petrol, etc.

iii) Non-conductor or Insulator

Non-conductor or insulator is the materials which do not allow electricity to pass through it.

Examples : Wood, plastics, non-metals, etc

iv) Electrolyte

Electrolyte is a water soluble substance forming ions in solution and conducts electricity.

v) Electrode

Electrode is a metallic rod/bar which conducts the electricity. In electrochemical cells, there are two electrodes:

a) Anode where oxidation takes place.

b) Cathode where reduction takes place.

vi) Anodic Compartment

It contains anode metal and its electrolytic solution where oxidation reaction occurs.

vii) Cathodic Compartment

It contains cathode metal and its electrolytic solution where reduction reaction occurs.

viii) Half Cell

It is a part of the cell. It containing electrode dipped in electrolytic solution. If oxidation occurs at the electrode then it is called oxidation half cell.

If reduction takes place at electrode then it is called reduction half cell.

ix) Cell

A cell is a single arrangement of two electrodes and an electrolytic solution capable of yielding electricity due to chemical reaction within the cell or producing chemical reaction by passing Electricity through the cell.

Types of Cells

There are two types of cells

1) Electrolytic Cells 2) Electrochemical Cells

ELECTROLYTIC CELLS

Electrolytic cells are the device which converts electrical energy into chemical energy.

Example : Electrolysis of an acid solution.

ELECTROCHEMICAL CELLS

Electrochemical cells or galvanic cells are the device which converts chemical energy into electrical energy.

REPRESENTATION OF CELL NOTATION

i) The anode is written on the left hand side and the cathode is written on the right hand side.

Daniel cell can be written as follows:

$$Zn \mid Zn^{2+} \parallel Cu^{2+} \mid Cu.$$

ii) The anode must be written by writing electrode metal first and then electrolyte. These two are separated by a single vertical line (|) or semicolon (;). The electrolyte may be written by the formula of the compound (or) by ionic species.

Examples :

(a)Zn | Zn (or) Zn | ZnSO4 (or) Zn ; Zn

(b) Standard hydrogen electrode, Pt, H_2 (1 atm) ; H^+ (1 M)

iii) The cathode must be written by writing electrolyte first and then electrode metal. These two are separated by a single vertical line or semicolon.

Examples :

$$Ag^+ \mid Ag \text{ (or) } AgNO_3 \mid Ag \text{ (or) } Ag^+ ; Ag$$

Cu^{2+} | Cu (or) $CuSO_4$ | Cu (or) Cu^{2+} ; Cu

iv) The two half cells are separated by a salt bridge, which is indicated by a double vertical lines (two).*Examples :* Daniel cell

$Zn | ZnSO_4$ (1M) || $CuSO_4$ (1M) | Cu (Or)

$Zn | Zn^{2+} || Cu^{2+} | Cu$ (or) $Zn | Zn^{2+}$ (1M) || Cu^{2+} (1M) | Cu (or)

$Zn ; Zn^{2+}$ (1M) || Cu^{2+} (1M);Cu

EMF of the Cell

Electricity cannot flow from one point to another point unless there is a potential difference between two points. Hence, the flow of electricity from one electrode to another electrode in a Daniel cell indicates that the two electrodes have different potential.

The potential difference which causes flow of current from higher potential electrode to lower potential electrode is called electromotive force. It is measured in volts.

Thus, the emf of a cell can be calculated by using the following relationship. Standard reduction Standard reduction

EMF = (Standard reduction potential of R.H.E) - (Standard reduction potential of L.H.E)

Where, R.H.E. and L.H.E. are right and side electrode and left and side electrode respectively. In otherwords,

$$\mathbf{E^0_{cell} = E^0_{right} - E^0_{left}} \ \textbf{(or)} \ \mathbf{E^0_{cell} = E^0_R - E^0_L}$$

For Daniel cell, the notation is

$Zn_{(s)} | Zn^{2+}$ (1M) || Cu^{2+} (1M) | Cu

L.H.E. R.H.E.

E^0_{cell} = 0.34 – (–0.76) = + 1.1 volts.

The emf of a cell depends on the following factors:
a) Nature of the electrode and electrolyte.
b) Concentration of the electrolyte.
c) Temperature of the electrolytic solution.
d) pH of the electrolytic solution.