GLASS ELECTRODE

Principle

It has been found experimentally by F.Friitz that when two solutions of different pH values are separated by a thin glass membrane, there develops a difference of potential between the two surfaces of the membrane. The potential difference developed is proportional to the difference in pH value.

The glass membrane functions as an ion exchange resin. Equilibrium is set up between the Na^+ ions of glass and H^+ ions in solution. This forms the basis of glass electrode.

CONSTRUCTION

Glass electrode consists of a thin walled glass bulb. The glass is of a special type of relatively low melting point and high electrical conductivity. The glass bulb may contain AgCl coated silver electrode or a platinum wire in 0.1M HCl.

Hence, the glass electrode may be represented as

$$Ag \mid AgCl, HCl_{(0.1M)} \mid glass$$

(or)

$$Pt, HCl(0.1M) \mid glass$$

Hydrochloric acid present in the glass bulb furnishes a constant H^+ ion concentration.

Thus, glass electrode is silver –silver chloride electrode, reversible with respect to chloride ion.

Glass electrode is usually employed as a internal reference electrode. The electrode potential varies with H^+ ion concentration and is given by $EG = E^oG + 0.0591pH\ V$

Hence glass electrode is mostly used to determine the pH of solutions, especially coloured solutions containing oxidising or reducing agent. Usually calomel electrode is used as the second electrode.

Determination of a pH of a solution using glass electrode

The glass electrode is placed in the solution under test and is coupled with saturated calomel electrode. The emf of the cell is measured, from which, pH of the solution is calculated.

$$E_{cell} = E_{right} - E_{left}$$

$$E_{cell} = 0.2422V - [E^o_{glass} + 0.0591\ V\ pH]$$

$$E_{cell} = 0.2422V - E^0G - 0.0591\ V\ pH$$

$$pH = \frac{0.2422V - E^0G - Ecell}{0.0591}$$

ADVANTAGES OF GLASS ELECTRODE

- It can be easily constructed and readily used
- The results are accurate.
- It is not easily poisoned.
- Equilibrium is rapidly achieved.

LIMITATIONS

Since the resistance of glass membrane is quite high, special electronic potentiometers are employed for measurement.

The glass electrode can be used in the pH range of 0 to 10. Above pH 12 (high alkalinity),cations of the solution affect the glass and make the electrode useless.

APPLICATIONS OF ISE

- ISEs are used to determine the concentrations of cations like H^+,Na+,K^+,Ag^+, and Li^+
- ISEs are used for the determination of hardness (Ca^{2+} Mg^{2+} ions)
- Concentrations of anions like NO^{3-} , CN^- , S^{2-} and halides can also be determined.
- ISEs are used in the determination of concentration of a gas by using gas sensing electrodes.
- pH of the solution can be measured by using gas sensing electrodes.

ELECTROCHEMICAL SERIES OR EMF SERIES

The standard reduction potential of a number of electrodes is given in the table. These values are determined potentiometrically by combining the electrode with another standard electrode, whose electrode potential is zero.

Electrode	Electrode reaction	Potential E_o (V)	Nature
Li^+ / Li	$Li^+ + e^- \rightleftharpoons Li$	– 3.01	Anodic ↑
Ca^{2+} / Ca	$Ca^{2+} + 2e^- \rightleftharpoons Ca$	– 2.93	
Na+ / Na	$Na^+ + e^- \rightleftharpoons Na$	– 2.90	
Mg2+ /Mg	$Mg^{2+} + 2e^- \rightleftharpoons Mg$	– 2.71	