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Electrochemistry

Conductance and Equivalent Conductance

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Conductance of electrolytes

We have seen that electrolyte solns conduct electric current through them by movement of the ions to the electrodes. The power of electrolytes to conduct electric current is termed conductivity or conductance. Like metallic conductors, electrolytes obey Ohm's law. Acc to this law, the current I flowing through a metallic conductor is given by the relation.

$$I = E/R$$

where E is the potential difference at two ends (in volts); and R is the resistance measured in ohms (or Ω). The resistance R of a conductor is directly proportional to its length, l and inversely proportional to the area of its cross-section, A. That is,

$$R \propto l/A$$

$$(\text{or}) \quad R = \rho \times l/A \quad \text{——— (1)}$$

where ρ "rho" is a constant of proportionality and is called resistivity or specific resistance. Its value depends upon the material of the conductor. From eqn (1) we can write

$$\rho = R \times A/l$$

If $l = 1$ cm & $A = 1$ sq. cm then $\rho = R$

Thus it follows that the specific resistance, of a conductor is the resistance in ohms which one centimetre cube of it offers to the passage of electricity.

Specific conductance

It is evident that a substance which offers very little resistance to the flow of current allows more current to pass through it. Thus the power of a substance to conduct electricity or conductivity is the converse of resistance. The reciprocal of specific resistance is termed specific conductance or specific conductivity. It is defined as: the conductance of one centimetre cube (cc) of a solution of an electrolyte.

The specific conductance is denoted by the symbol κ (kappa). Thus:

$$\kappa = \frac{1}{\rho} = \frac{1}{R} \times \frac{l}{A}$$

Unit of specific conductance

Specific conductance is generally expressed in reciprocal ohms (r.o) or mhos or ohm^{-1}. Its unit can be derived as follows.

$$K = \frac{1}{A} \times \frac{l}{R} = \frac{1}{ohm} \times \frac{cm}{cm^2}$$

$$= ohm^{-1} cm^{-1}$$

The internationally recommended unit for ohm^{-1} (or mho) is siemens, S. When S is used, the conductance is expressed as $S cm^{-1}$.

~~It may be noted that siemens is not a plural~~

The specific conductance increases with (i) ionic concentration and (ii) speeds of the ions concerned.

In measuring the specific conductance of the aqueous soln of an electrolyte, 1 volume of water in $\frac{C}{1}$ a certain amount of 1 electrolyte is dissolved is always measured in cubic centimeters (cc) and this is known as dilution. If the volume of a soln is Vcc, the specific conductance of the soln. is written as K

Equivalent Conductance

It is defined as the conductance of an electrolyte obtained by dissolving

One gram-equivalent of it in V cc of water.

The equivalent conductance is denoted by Λ. It is equal to the pdt of / specific conductance, K and the volume V in cc containing one gram-equivalent of the electrolyte at the dilution V.

Thus, $\Lambda = K \times V$

In general, if an electrolyte soln contains N gram-equivalents in 1000 cc of the soln, the volume of the soln containing 1 g-equivalent will be 1000/N. Thus,

$$\Lambda = \frac{K \times 1000}{N}$$

Unit of Equivalent conductance

The unit of equivalent conductance may be deduced as follows:

$$\Lambda = K \times V$$

$$= \frac{1}{R} \times \frac{l}{A} \times V$$

$$= \frac{1}{ohm} \times \frac{cm}{cm^2} \times \frac{cm^3}{eqvt}$$

$$= ohm^{-1}\ cm^2\ eqvt^{-1}$$