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Date:
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For. Deg II Chem Hons Paper IV &
Deg II sub chem. Courses

Electrode Potential & Concentration Cell

The tendency of an electrode to lose or gain electron is called electrode potential. Since the tendency to lose electron means also the tendency to get oxidised hence this tendency is called Oxidation Potential

Similarly the tendency to gain electron means also the tendency to get reduced hence this tendency is called reduction Potential.

Oxidation Potential is the reverse of reduction Potential thus if the oxidation Potential of an electrode is +1.5 Volt then its reduction Potential will be −1.5 Volt. For example −

$$Zn \longrightarrow Zn^{++} + 2e$$

$$E_{Ox} = +0.76\,V$$

$$Zn^{2+} + 2e \longrightarrow Zn$$

$$E_{Red} = -0.76\,V$$

Nerst equation of electrode Potential

If the electrode reaction is of following type –

$$M \rightleftharpoons M^{n+} + ne$$

Then $E = E^0 - \frac{2.303RT}{nF} \log C$ —(1)

Oxidation Potential

where C = Concentration of ions in solution

F = 1 Faraday = 96,500 coulombs

n = Valency of ion.

R = Gas Constant = 8.314 joules

E^0 = standard electrode Potential

The Potential of an electrode when the concentration of ion is unity and the temperature is 25°C is known as standard electrode Potential

At 25°C $\frac{2.303RT}{F} = \frac{2.303 \times 8.314 \times 298}{96,500}$

$= 0.0591$

Thus equation (1) can be Written as follows –

$$E = E^0 - \frac{0.0591}{n} \log C \quad \text{—— (2)}$$

Note

[When C = 1 M, $E = E^0$]

Concentration Cell

The Oxidation Potential, E of an electrode decreases as the Concentration of the ions increases.

Let us Consider two electrods of Zn, one in Contact with a solution of zinc ions of Concentration C_1 and the other in Contact with a solution of zinc ions of Concentration C_2. C_2 being greater than C_1. The two solutions are joined together through a salt bridge. The system may be represented as follows —

$$Zn \,|\, Zn^{++}(C_1) \,\|\, Zn^{++}(C_2) \,|\, Zn$$

(E_1 under the first half, E_2 under the second half)

Applying equation (1) the electrode potential E_1 and E_2 will be given by

$$E_1 = E^0 - \frac{0.0591}{2} \log C_1$$

$$E_2 = E^0 - \frac{0.0591}{2} \log C_2$$

The valency of Zn^{++} is 2.

E.M.F of Cell = $E_1 - E_2$

$= 0.0295 \log \frac{c_2}{c_1}$

Oxidation will occur at the Left hand electrode and reduction at right hand electrode.

Left hand electrode $Zn \rightarrow Zn^{++}(c_1) + 2e$

Right hand electrode $Zn^{++}(c_2) + 2e \rightarrow Zn$

Net reaction $Zn^{++}(c_2) \rightarrow Zn^{++}(c_1)$

Evidently, there is no net chemical reaction. There is merely transference of zinc ion from the solution of higher concentration (c_2) to a lower concentration (c_1).

Thus the E.M.F. of concentration cell of the above type is given by

E.M.F = $0.0295 \log \frac{c_2}{c_1}$ $[c_2 > c_1]$

[*The value of n here is 2,]

n = valency of ions