



NERNST EQUATION FOR ELECTRODEPOTENTIAL

Consider the following electrode reaction:aq



The emf of a reversible cell can be measured by free energy change (ΔG) of a reaction takes place in the reversible cell. If the reaction involves the transfer of 'n' electrons, 'F' Faradays of electricity will flow and E is the emf of the cell, then the total electrical energy produced by the cell is given by following equation

$$-\Delta G = nFE \dots (1)$$

Where, $-\Delta G$ is decrease in free energy change.

In other way,

$$-\Delta G^0 = nFE^0 \dots (2)$$

Where, $-\Delta G^0$ is standard free energy change and E^0 is the standard emf of a cell.

For a reversible reaction, the interrelationship of free energy change and equilibrium constant (K) is given by the following equation :

$$-\Delta G = -\Delta G^0 + RT \ln K \dots (3)$$

It can be written as,

$$-\Delta G = -\Delta G^0 + RT \ln [\text{Product}] / [\text{Reactant}] \dots (4)$$

The equation (4) is called as Van't Hoff isotherm.

Substituting the value of products and reactants in equation (4), we get

$$\Delta G = \Delta G^0 + RT \ln [M] / [M^{n+}] \dots (5)$$

Substituting the equation (1) and (2) in (5), we get

$$nFE_{red} = nFE^0_{red} + RT \ln [M] / [M^{n+}] \dots (6)$$

$$E_{red} = \frac{nFE^0_{red} + RT \ln [M]}{nF [M^{n+}]}$$

$$E_{red} = \frac{E^0_{red} + RT \ln [M]}{nF [M^{n+}]} \dots (7)$$

$$E_{red} = E^0_{red} + \frac{2.303RT \log [M]}{nF [M^{n+}]} \dots (8)$$

T = 298 K

R = 8.314 J K⁻¹ mol⁻¹



$F = 96500$ coulombs $[M] = 1$

Substituting all the values in equation (8), we get

$$E_{\text{red}} = E_{\text{red}}^0 + \frac{0.0591 \log 1}{n [M^{n+}]} \dots\dots\dots (9)$$

This equation is known as the Nernst equation

$$E_{\text{red}} = E_{\text{red}}^0 - \frac{0.0591 \log [M^{n+}]}{n} \dots\dots\dots (10)$$

Nernst equation for this equation is the reduction potential of single electrode
 Consider the following oxidation reaction:



Then, the Nernst equation (10) becomes

$$E_{\text{oxi}} = E_{\text{red}}^0 + \frac{0.0591 \log [M^{n+}]}{n} \dots\dots\dots (11)$$

Equation (11) is Nernst equation for oxidation potential of single electrode.

Applications of Nernst Equation

- It is used to calculate the emf of a given cell.
- It is also used to calculate the electrode potential of a given
- Corrosion tendency of metals can be predicted.
- Spontaneity of a given cell reaction can be predicted.