5.17 CONCENTRATION CELL

In a galvanic cell, electrical energy (nFE) arises from the decrease in free energy ($-\Delta G$) from the chemical reactions taking place in the cell. However, in a concentration cell, there is *no net chemical reaction. The electrical energy in a concentration cell arises from the* ***transfer of a substance*** *from the solution of a higher concentration (around one electrode) to solution of lower concentration (around the other electrode). A* ***concentration*** *cell is made up of two half-cells having identical electrodes, identical electrolyte, except that the* ***concentrations of the reactive ions at the two electrodes are different.*** *The two half-cells may be joined by a* **salt bridge**, *e.g.*

$^-$Ag	$AgNO_3(C_1)$ *(Dilute)*	Salt bridge of satd. NH_4NO_3	$AgNO_3(C_2)$ *[Concentrated]*	Ag^+

or $\quad {}^-Ag \mid AgNO_3(C_1M) \parallel AgNO_3(C_2M) \mid Ag^+ \qquad (C_2 > C_1)$

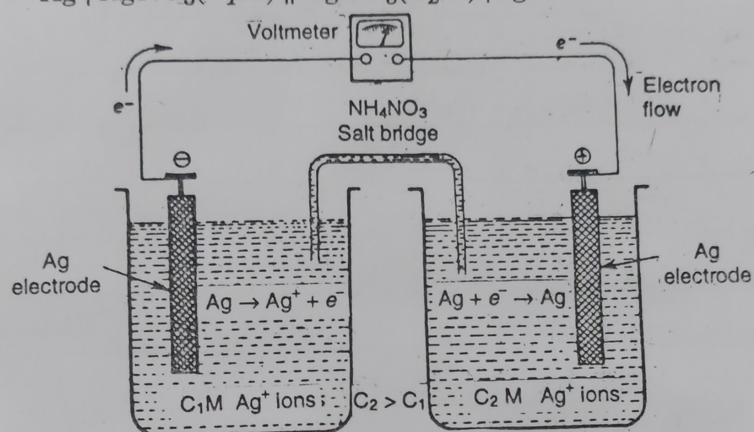

Fig. 13. Concentration cell.

Theory : When a metal (M) electrode is dipped in a solution containing its own ins [M^{n+}], then a potential (E) is developed at the electrode, the value of which varies with the concentration (C) of the ions in accordance with the Nernst's equation :

$$E = E^\circ + \frac{2.303\,RT}{nF}\log C$$

Let us consider a general concentration cell represented as :

$$^-M \mid M^{n+}(C_1M) \parallel M^{n+}(C_2M) \mid M^+$$

where C_1 and C_2 are the concentrations of active metals ions (M^{n+}) in contact with two electrodes respectively and $C_2 > C_1$.

$\therefore$ E.M.F. of cell $= E_{right} - E_{left}$

$$= [E^\circ + \frac{0.0592\text{ V}}{n}\log C_2] - [E^\circ + \frac{0.0592\text{ V}}{n}\log C_1]$$

$$\therefore E = \frac{0.0592}{n}\log\frac{C_2}{C_1}$$

At left electrode $M \rightarrow M^{n+}(C_1) + ne^-$

At right electrode $M^{n+}(C_2) + ne^- \rightarrow M$

$M^{n+}(C_2) \rightarrow M^{n+}(C_1)$

EMF is developed due to transference of metal ions from solution of higher concentration (C_2) to solution of lower Conc (C