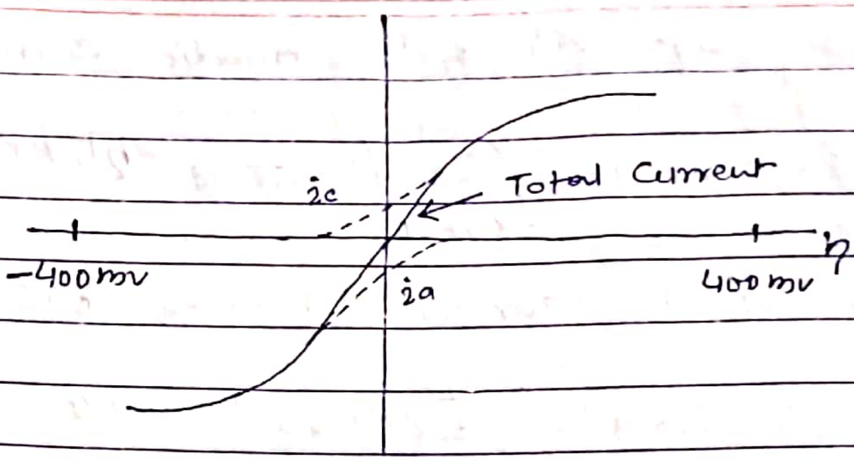


[Plot of the Butler- Volmer equation for a redox reaction with an appricible exchange (Current)].

06

*. TAFEL Equation from BUTLER-VOLMER Equation –

When the over potential . η is very small so, that $\eta F/RT << 1$

then since $e^x = 1 + x + \frac{x^2}{2!} + \ldots\ldots$

We get

$$i(net) = i_0 \left\{ \left[1 + (1-\alpha)\eta F/RT + \ldots\ldots\right] - \left[1 - \alpha \frac{\eta F}{RT} + \ldots\right] \right\}$$

i.e. $i(net) = i_0 \eta F/RT$

i.e. current density is propotional to the over potential.

$$\eta = \frac{RT}{F}\left(\frac{i_{net}}{i_0}\right)$$

(a) When η is small & positive, the current is anodic $(i_{net}) > 0$

(b) when $\eta > 0$

& $i_{net} < 0$ when $\eta < 0$

(a) when the over potential is Large and +ve, the Second exponential in Butler-Volmer eqⁿ. is much smaller than the first and may be neglected, giving

$$i_{(net)} = i_0 \, e^{(1-\alpha)\eta F/RT}$$

or $\ln i_{(net)} = \ln i_0 + (1-\alpha)\eta F/RT$ —— (I)

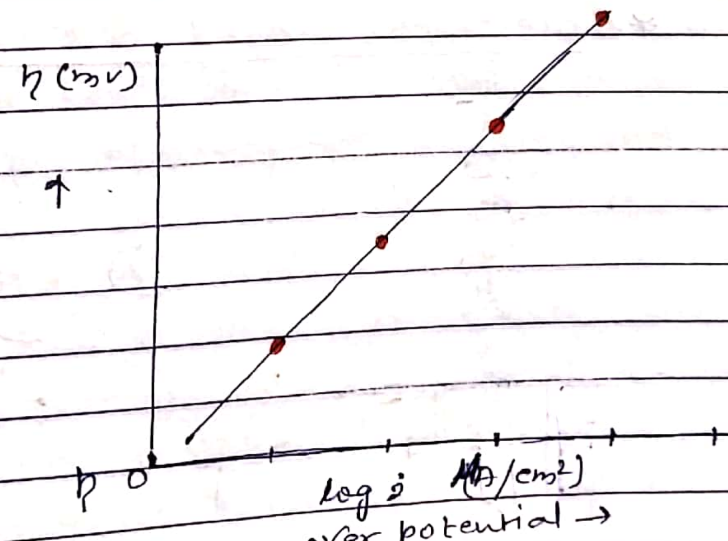
(b) when the over potential is Large but -ve, the 1st exponential in Butler-volmer eqⁿ is much Smaller than the second & may be neglected, So,

$$i_{(net)} = -i_0 \, e^{-\alpha\eta F/RT}$$

or $-\ln i_{(net)} = \ln i_0 - \alpha\eta F/RT$ —— (II)

Equation -(I) and -(II) are called TAFEL Equation.

These equation suggest that a graph of $\ln i$ against the overpotential should give a straight line.



[TAFEL PLOT]

The intercept at η=0 is the exchange current & α can be estimated from the slope.