Reduction v/s Oxidation Reactions

Let us consider a cell reaction :-

Anode : $Zn \longrightarrow Zn^{2+} + 2e^-$ (oxidation)
Cathode : $Cu^{2+} + 2e^- \longrightarrow Cu$ (reduction)
Cell reaction : $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$

1) For reduction half (Cathode) :-

Gain of $e^- \longrightarrow Cu^{2+} + 2e^- \longrightarrow Cu$

$\therefore$ Conc of Reactants ↑
Conc of Products ↓ $\Rightarrow$ [Reactant] > [Product]

$\therefore$ $+n$ in Nernst eq^n :- [Reactant $+ ne^- \rightarrow$ Product]

$$E = E^\circ - \frac{0.0591}{(+n)} \ln \frac{[\text{Product}]}{[\text{Reactant}]}$$

$$\therefore \boxed{E_{\text{reduction}} = E^\circ_{\text{reduction}} - \frac{0.0591}{n} \log Q}$$

$Q \rightarrow$ [Product] : [Reactant] ratio

$\therefore$ [Reactant] > [Product] :- $Q \uparrow \rightarrow \ln Q \uparrow$

$\therefore E \downarrow$ as a result (reduction half)

2) For oxidation half (Anode) :-

loss of e^- $\longrightarrow$ $Zn \longrightarrow Zn^{2+} + 2e^-$

(ox)

$Zn - (2e^-) \longrightarrow Zn^{2+}$

$\therefore$ Conc of Reactants $\downarrow$ Conc of Products $\uparrow$ $\Rightarrow$ [Reactants] < [Product]

$\therefore -n$ in Nernst eq$\hat{}$: [Reactant $- ne^- \rightarrow$ Products]

$$E = E^\circ - \frac{0.0591}{(-n)} \ln \frac{[Product]}{[Reactant]}$$

$$\therefore \boxed{E_{Oxidation} = E^\circ_{oxidation} + \frac{0.0591}{n} \log Q}$$

Q $\rightarrow$ [Product] : [Reactant] ratio

$\therefore$ [Reactant] < [Product] :- $Q \downarrow \rightarrow \ln Q \downarrow$

$\therefore E \uparrow$ as a result (oxidation half)

Summary :-

1) For reduction :- The eq$\hat{}$ uses -ve sign because of increase in concentration of products that leads to decrease in electrode potential of reduction half reaction

2) For oxidation :- The eq$\hat{}$ uses +ve sign because of increase in concentration of reactants that leads to increase in electrode potential of oxidation half reaction