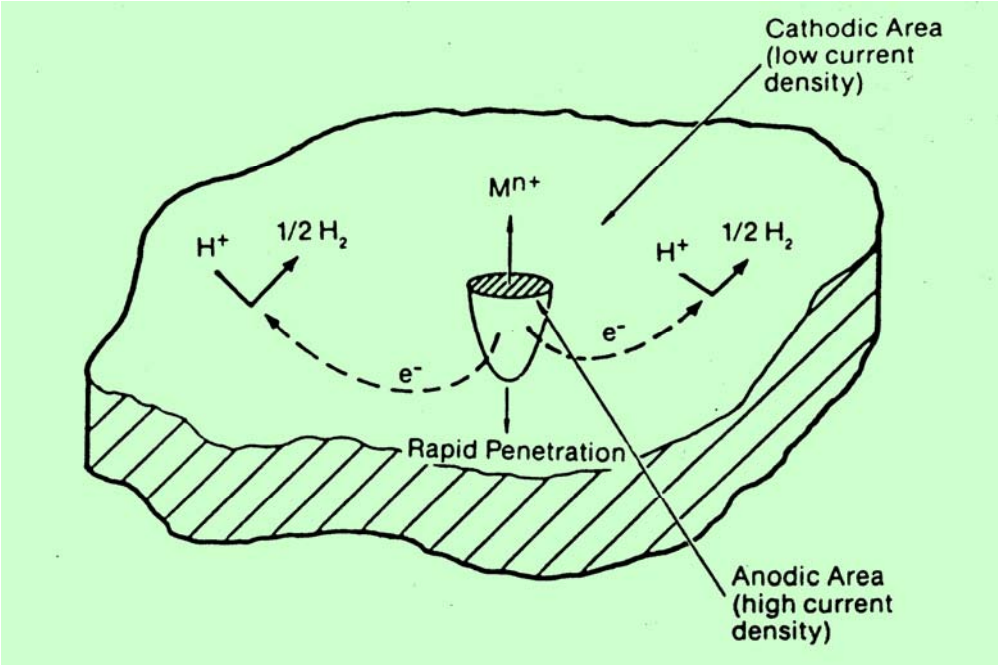
10. Localized Corrosion

- Uniform Corrosion : $i_{corr} \neq f(s)$
- Localized corrosion : $i_{corr} = f(s)$, where s is a site in which corrosion occurs.

Localized corrosion forms by severe anodic current concentrated at small anode that is separated from large cathode by relatively large distance. Factors causing the localized corrosion are heterogenities either in metal or in electrolyte. They are also related to geometrical effects.



• Schematic of localized corrosion illustrating the frequently large disparity between the anodic and cathodic areas

▶ *Factors causing localized corrosion*

- Heterogenities in metal

  Second phases.

  Non metallic inclusions.

  Non uniform microstructure : heat affected zone in weld.

  Non uniform cold work.

- Heterogenities in environment

  Differential aeration.

- Important features in localized corrosion

  Small anode area /large cathode area.

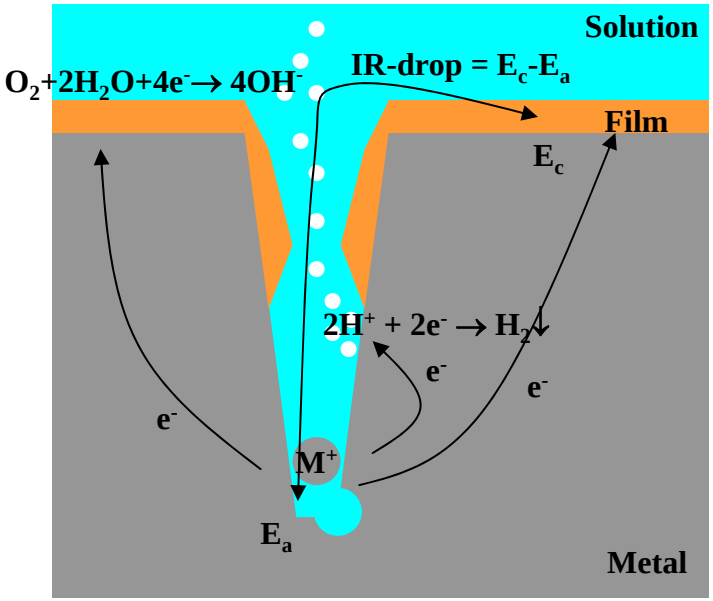
  Passivation.

  pH changes at the cathodic and anodic sites.

  Degree of occlusion.

  Cl^- concentration.

  iR effect



10.1 Localized corrosion by different aeration

The concentration of oxygen dissolved in water or soil frequently varies from one point to another. This difference in aeration produces a different equilibrium potential.

For the oxygen reduction reaction in water;

$$1/2\ O_2 + 2H^+ + 2e^- \rightarrow H_2O$$

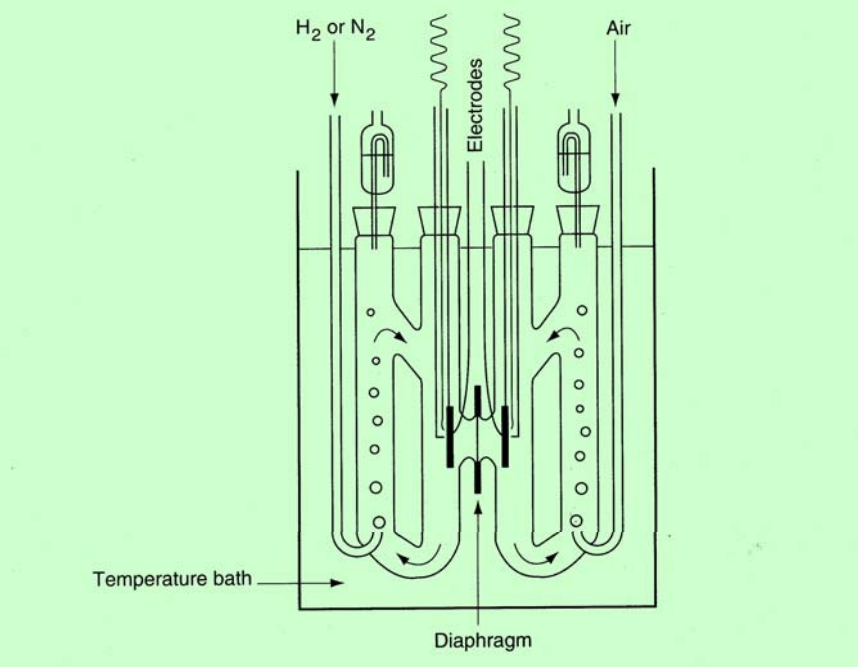
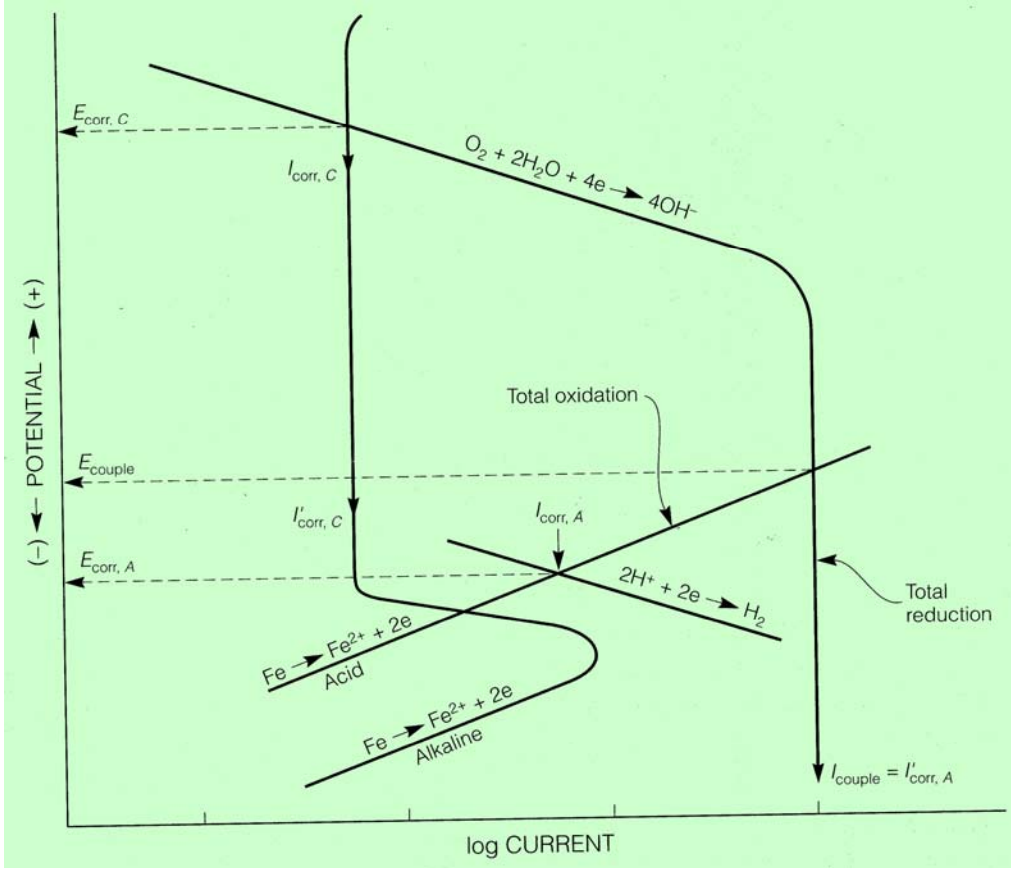
$$E_{O_2} = E^\circ + 0.059/2 \log (a_{O_2})^{1/2} (a_{H^+})^2 / (a_{H_2O})$$

Thus, a stronger oxygen conc. provides a more noble equilibrium potential.

Chemical reaction in low O_2 compartment:

Anodic dissolution : $Fe \rightarrow Fe^{2+} + 2e^-$
Hydrolysis reaction : $Fe^{2+} + 2H_2O \rightarrow Fe(OH)_2 + 2H^+ \rightarrow pH \downarrow$.
Low pH $\rightarrow$ prevent passivation and undergoes severe corrosion

Chemical reaction in High O_2 compartment

Oxygen reduction : $O_2 + 2H_2O + 4e^- \rightarrow 4OH^- \rightarrow pH \uparrow$
High pH favors the formation of passive film

▶ Corrosion of Fe in differential aeration cell