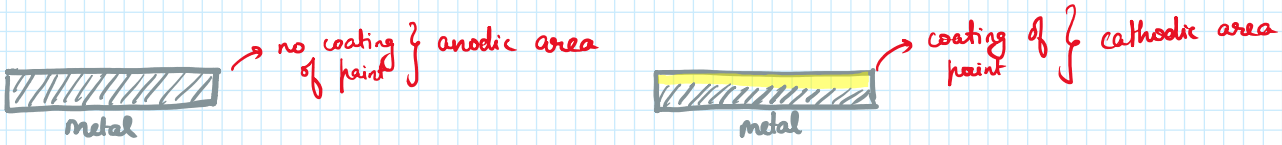
5. Corrosion, Electrochemical Theory of Corrosion

13 October 2023 08:16

INTRODUCTION



Rusting of iron: $Fe_2O_3 \cdot 3H_2O$

Rusting of copper: $CuCO_3 \cdot Cu(OH)_2$

Why does Fe undergo corrosion?

Ore: Fe_2O_3, Al_2O_3 [stable → ground state]

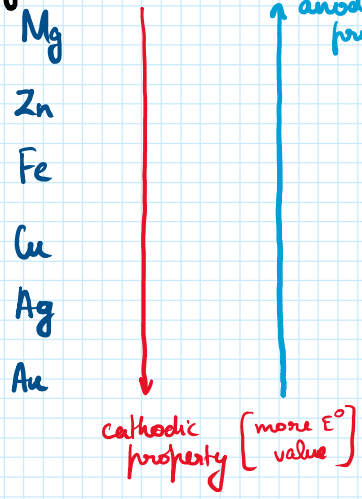
↓ Endothermic process

Anodic area: Fe, Al [unstable]

↓

Fe_2O_3, Al_2O_3 [stable]

Galvanic series



With greater anodic / lesser cathodic property, corrosion increases

Passive metals

Al, Ti, Cr

S: Stable metal oxide

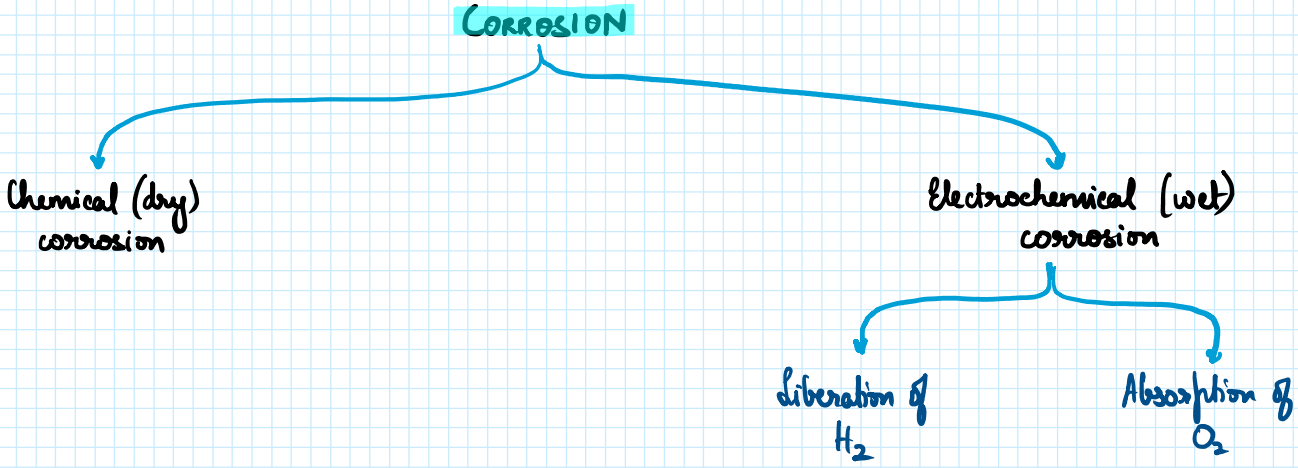
U: Uniform metal oxide layer formed

N: Non-porous

I: Insoluble

N : Non-porous

I : Insoluble



CORROSION

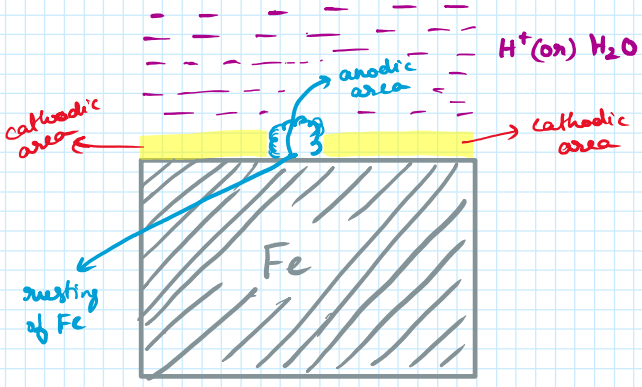
Destruction, deterioration and consequent loss of a metal due to a chemical or electrochemical attack by an environment.

CHEMICAL CORROSION

Destruction, deterioration and consequent loss of a metal due to a chemical attack by an environment.

ELECTROCHEMICAL THEORY OF CORROSION

Destruction, deterioration and consequent loss of a metal due to an electrochemical attack by an environment.



Anodic reaction

$$Fe \longrightarrow Fe^{2+} + 2e^-$$

Cathodic reactions

- Liberation of H_2
- Absorption of O_2

Acid (H^+)

$2H^+ + 2e^- \longrightarrow H_2\uparrow$

Neutral (H_2O)

$2H_2O + 2e^- \longrightarrow 2OH^- + H_2\uparrow$

Acid (H^+)

$2H^+ + \frac{1}{2}O_2 + 2e^- \longrightarrow H_2O$

Neutral (H_2O) → important

$H_2O + \frac{1}{2}O_2 + 2e^- \longrightarrow 2OH^-$

Cell representation

Anode: $Fe \longrightarrow Fe^{2+} + 2e^-$

Cathode: $H_2O + \frac{1}{2}O_2 + 2e^- \longrightarrow 2OH^-$

$Fe + H_2O + \frac{1}{2}O_2 \longrightarrow Fe^{2+} + 2OH^-$

$Fe^{2+} + 2OH^- \longrightarrow Fe(OH)_2\downarrow$

$Fe(OH)_2$ —(more O_2)→ $Fe_2O_3 \cdot 3H_2O$ (reddish brown rust)

$Fe(OH)_2$ —(less O_2)→ $Fe_3O_4 \cdot 3H_2O$ (or) $FeO \cdot Fe_2O_3 \cdot 3H_2O$ (black rust)

$4Fe(OH)_2 + \underset{\text{(more)}}{O_2} + 2H_2O \longrightarrow 2[Fe_2O_3 \cdot 3H_2O]$

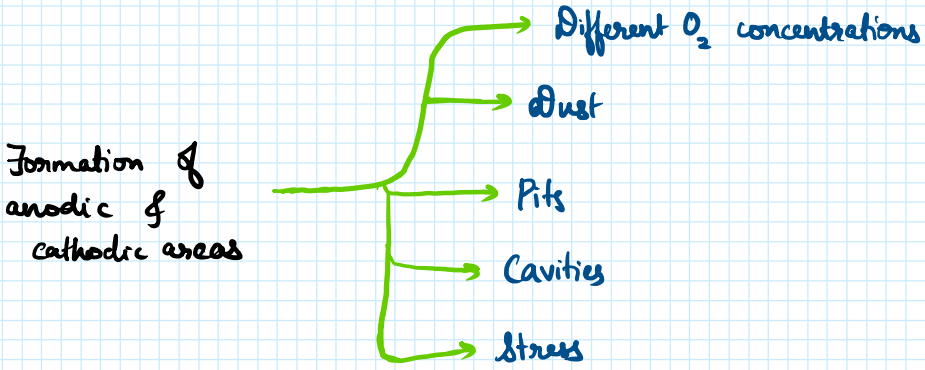
reddish-brown

$3Fe(OH)_2 + \underset{\text{(less)}}{\frac{1}{2}O_2} \longrightarrow FeO \cdot Fe_2O_3 \cdot 3H_2O$

black

Points to remember

- A tiny galvanic cell to form from anodic, cathodic areas on the metal surface [OR]
  In galvanic series some metals act as anode & some metals act as cathode
- Anodic area → corrosion
  Cathodic area → unaffected
- Anodic area → loss of e^-
  Cathodic area → gaining of e^-


Formation of anodic & cathodic areas
Different O_2 concentrations
Dust
Pits
Cavities
Stress