Corrosion

Ankita Ojha
Department of Chemistry
IIT(BHU), Varanasi
VARANASI

What is Corrosion???

Corrosion is an irreversible interfacial reaction of a material with its environment which results in consumption of the material or in dissolution of a component of environment into the material.

https://upload.wikimedia.org/wikipedia/commons/thumb/b/bb/Rust_and_dirt.jpg/220px-Rust_and_dirt.jpg

- **Some available pictures on corrosion from internet**

http://nhanvietgroup.vn/wp-content/uploads/2018/03/Corrosion-Control.jpg

https://www.bendplating.com/wp-content/uploads/2017/03/rust-1-e1488346306943-1288x724.jpg

CORROSION is the Cancer of metal health

- Corrosion is vulture of metallurgy.
- Corrosion is the greatest killer of metals.
- Corrosion is the extractive metallurgy in reverse.
- Corrosion is a silent wrecker, operating at all times, at all levels and in all establishments.
- Corrosion is an epidemic that leads to mass destruction of metals.

THERMODYNAMICS OF CORROSION

IMPOSED

EXTRACTION

MINERALS

[oxides, sulfides, hydroxides, carbonates, etc.

+

ENERGY

METAL

[higher energy state]

-ΔG = nFE

CORROSION

NATURAL

GOLD, Mined from the Earth in native form

NO CORROSION

Stored in underground vaults as GOLD

FACTORS INVOLVED IN CORROSION

Characteristics of Metal
Composition, atomic structure, crystallographic structures, microscopic heterogeneities, stress (residual, tensile, compressive, cyclic) etc.

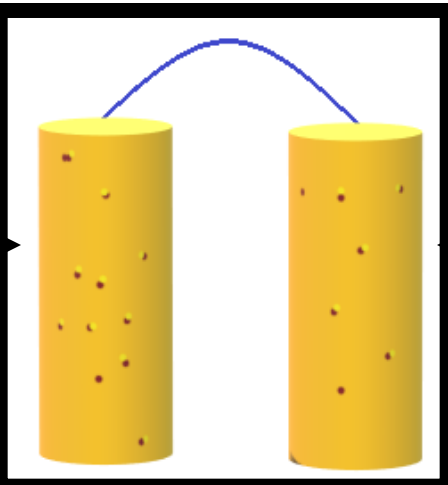
Characteristic of Environment
Chemical nature, concentration of reactive species, temperature, velocity of impingement, etc.

Characteristics of Interfacial Reaction

Kinetics of metal , Oxidation or dissolution, kinetics of reduction of species in solution; nature and location of corrosion products; film growth and film dissolution, etc.

Electrochemical Theory

Galvanic or concentration cell is formed at metal-environment interface.



Part of metal becomes anodic

$M \rightarrow M^{n+} + ne^-$

More likely to happen where

Anodic impurity is present

Metal is stressed

Oxygen deprived sites

Surface film of corrosion product being destroyed by OH^- ions

Electrons released are taken up by a depolarizer.

Which can be

Hydrogen ions

$2H^+ + e^- \rightarrow H_2$

Oxygen $2H_2O + O_2 + 4e^- \rightarrow 4\ OH^-$

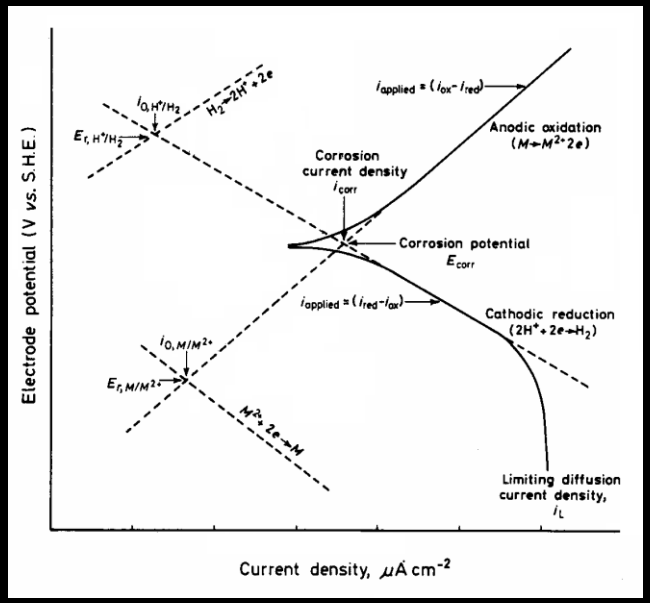
Cations of a more noble metal $M^{x+} + xe^- \rightarrow M$

In electrochemical theory of corrosion at the surface of metal oxidation takes place and that point behaves as an anode. The electrons that are released at this anodic surface further move through the metal and reach to an another point on the metal and reduces oxygen at that spot in presence of H^+ (which is believed to be available from H_2CO_3 formed due to dissolution of carbon dioxide from air into water in moist air condition of atmosphere. Hydrogen ion in water may also be available due to dissolution of other acidic oxides from the atmosphere). This point hence behaves as a cathode.

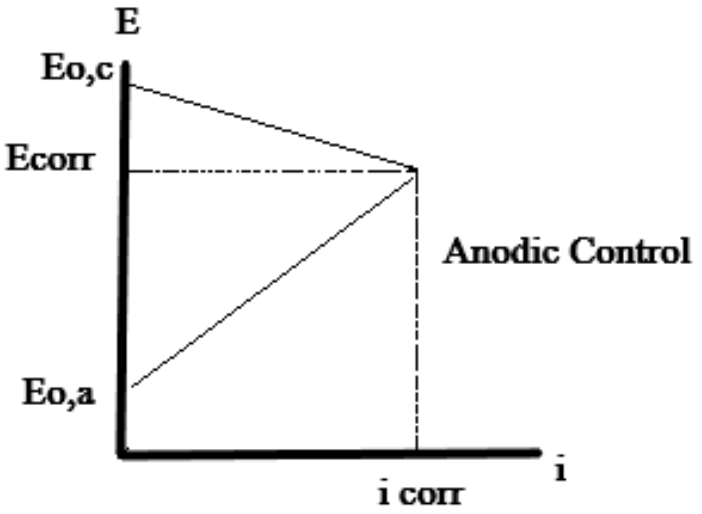
Mixed potential theory

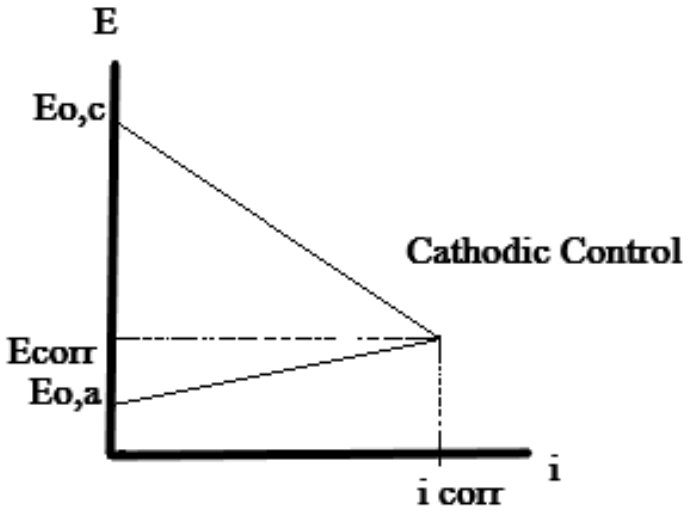
- **Anodes and cathodes are not discrete.**
- **Both oxidation and reduction reactions occur on the same surface –whole surface acts as mixed electrodes**
- **An electrochemical reaction consists of more than one oxidation and reduction reactions occurring simultaneously.**

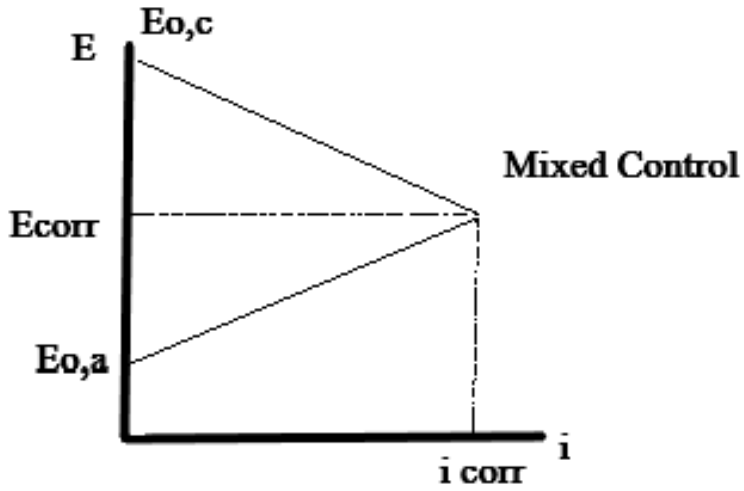
$$M + nH^+ \rightarrow M^{n+} + n/2\ H_2$$
$$M \rightarrow M^{n+} + ne$$
$$H_2 \rightarrow 2H^+ + 2e$$
$$M^{n+} + ne \rightarrow M$$
$$2H^+ + 2e \rightarrow H_2$$



At any time: TOTAL RATE OF OXIDATION = TOTAL RATE OF REDUCTION


E
Eo,c
Ecorr
Eo,a
Anodic Control
i
i corr


E
Eo,c
Cathodic Control
Ecorr
Eo,a
i
i corr

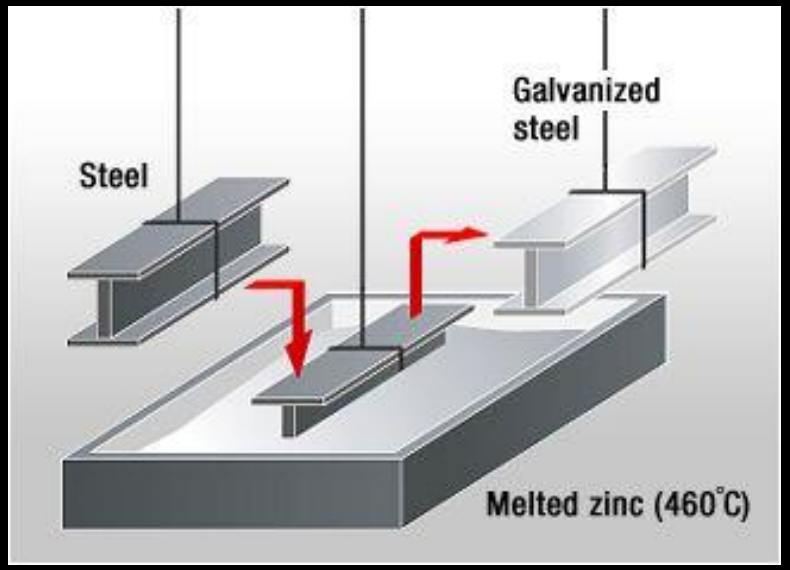

Eo,c
E
Mixed Control
Ecorr
Eo,a
i
i corr

Corrosion preventive techniques

General

- Galvanization & tinning
- Phosphatization & anodization
- Paints & Polymers
- Enamels

Galvanization or galvanizing (also spelled galvanisation or galvanising) is the process of applying a protective zinc coating to steel or iron, to prevent rusting.



https://i.pinimg.com/736x/49/dc/69/49dc699d0a64b4687c1b1455072e04cc--steel-structure-dip.jpg

Metallurgical

- Dealloying and Further Alloying
- Heat treatment

Dealloying is a technique for leaching out less noble metal from an alloy and then this metal is added with more

Mechanical

- **Proper designing**
- **Avoiding formation of galvanic couple**

Electrochemical

- **Anodic Protection**
- **Cathodic Protection**
- **Corrosion Inhibitors**

Thank You

Stay Home Stay Safe

Details will be updated soon in the video