TYPES OF CORROSION PREVENTION METHODS

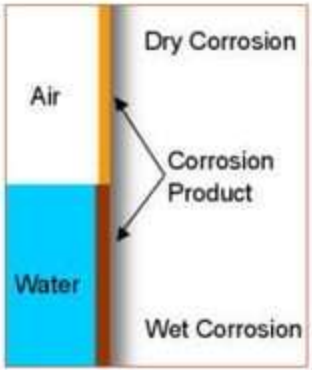
Sruthi's Pharma World

CORROSION

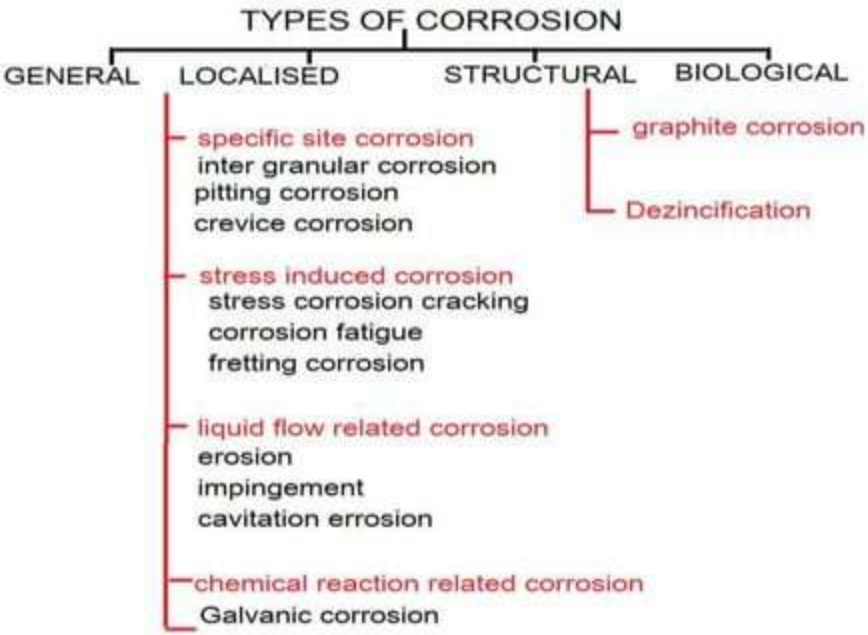
- Corrosion is defined as the reaction of metallic material with its environment
- It results measurable change to the material and can result in a functional failure of the metallic component or of a complete system
- Corrosion is a natural proc
- Two types
  - Dry corrosion
  - wet corrosion

TYPES OF CORROSION

Dry corrosion	Wet corrosion
Corrosion occurs in the absence of moisture	In the presence of conducting medium
slow	Rapid process
Corrosion products are produced at the site of corrosion	Corrosion occurs at anode but rust is deposited at cathode.



TYPES OF CORROSION



GENERAL CORROSION

- UNIFORM ATTACK CORROSION

- Most common type

- It is caused by a chemical or electro chemical reaction that damage the entire exposed surface of the metal

- Two types:
  - Physico chemical corrosion
  - Electro chemical corrosion

TYPES OF CORROSION

Physico chemical corrosion

- The effects are swelling, crazing cracking softening etc
- E.g. plastic
  Non metallic materials

Electro chemical corrosion

- This type of corrosion occurs at discrete points of metallic surface when electricity flows from cathodic area to anodic area

LOCALISED CORROSION

- It occurs numerous ways

SPECIFIC SITE CORROSION

Mechanically weak spots or dead spots in a reaction vessel cause specific site corrosion

INTERGRANULAR CORROSION

- A chemical or electro chemical attack on the grain boundaries of a metal cause inter granular corrosion
- Impurities present in the metal near to the grain boundaries cause corrosion

INTERGRANULAR CORROSION

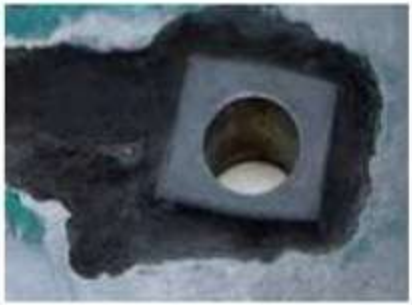
- Austenitic stainless steel with nitric acid when properly heated it cause intergranular corrosion due to precipitation of grain boundary

PITTING CORROSION

- This type of corrosion results in development of pits and cavities
- They range from deep cavities of smaller diameter to shallow depressions
- E.g. alloy of aluminum or stainless steel in the presence of aqueous solution and chlorides cause cavities.

CREVICE CORROSION

- Corrosion occurs at crevices because solutions are retained at such places
- Which takes longer time to dry out
- Acidic conditions or depletion of oxygen in a crevice can cause crevice corrosion



STRESS INDUCED CORROSION

- **Residual internal stress** in the metal or **external applied stress** accelerates the corrosion.
- Residual internal stress is produced by
  - deformation during fabrication
  - stress induced by rivets, bolts, shrink fits
- Eliminating high stress areas prevents this type of corrosion

STRESS CORROSION CRACKING

- When **tensile stress** is greater than **yield stress**, then cracks develop on the surface

FRETTING CORROSION

- Fretting corrosion occurs when metals slide over each other and cause mechanical damage to one or both

FLOW RELATED CORROSION

- Liquid metals can cause corrosion
- E.g. mercury attack on aluminum alloy
- Molten zinc on stainless steel

IMPINGEMENT CORROSION

- It is also referred to as **erosion corrosion**

Or velocity accelerated corrosion

- Erosion is the **destruction of a metal** by abrasion and attrition caused by the **flow of liquid/gas** with or with out suspended solids

CAVITATION CORROSION

- It occurs due to the formation of vacuum bubbles in liquid stream when passed over the surface.

- This type of corrosion generally occur around propellers

CHEMICAL REACTION RELATED CORROSION

- Corrosion involves chemical reactions such as oxidation and reduction at anode and cathode respectively.

GALVANIC CORROSION

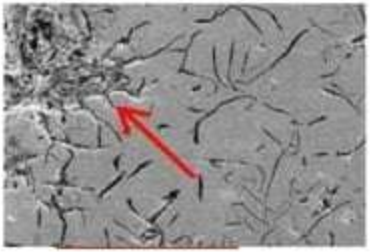
- Occurs when two different metals are found together in a corrosive electrolyte
- A galvanic cell is formed between two metals
- One metal become the anode and the other metal become the cathode
- The anode corrodes and deteriorates faster while the cathode deteriorate more slowly

FLUID CORROSION-STRUCTURAL

- Structural strength is reduced on account of corrosion
- This may occur when one component of the alloy is removed or released in to the solution
- The corrosion products may remain in the plant
- Two types:
  - Graphite corrosion
  - Dezincification

GRAPHITE CORROSION

- Graphite is an allotropy of carbon
- Occurs in gray iron
- In which metallic iron get converted in to corrosion product leaving a residue of intact graphite mixed with iron corrosive products and other insoluble constituents of cast iron



DEZINCIFICATION

- This is observed in **brass** which contain more than 15% zinc
- In brass the principal product of corrosion is metallic copper
- Mechanism:
  - redeposition of copper over the corrosion products
  - Formation of zinc corrosion products leaving copper residue

DEZINCIFICATION

- This type of corrosion can be decreased by adding little amount of arsenic, antimony, phosphorous to the alloy

BIOLOGICAL CORROSION

- Occurs due to the metabolic activity of microorganism which cause deterioration of the metal
- Due to
  - changing resistance to surface film
  - Developing electrolyte concentration cells on metal surface
  - Developing corrosive environment
  - Altering rate of anodic/cathodic reaction

PREVENTION OF CORROSION

METAL SELECTION:

- The corrosion metal has a strong relation with the environment to which it is exposed

- Rate of corrosive attack =

$$\frac{\text{corrosiviy of the environment}}{\text{corrosion resistance of metal}}$$

METAL SELECTION:

- Proper knowledge of the nature of the environment to which the material is exposed is very important

DESIGN OF EQUIPMENT

- Proper design reduce the time and cost required for corrosion maintenance and repair
- Corrosion frequently happen in dead space or crevices so we can eliminate or minimize these areas while designing
- A direct contact between metal should be avoided if they are separated widely in electrochemical series

COATINGS AND LININGS

- The metals are more prone to corrosion
- Non metal coating and linings can be applied on steel and other materials of construction to prevent corrosion
- Electroplating, cladding, organic coating are the commonly used methods

COATINGS AND LININGS

- Organic coatings are used as linings in the equipment such as tanks, piping pumping lines and shipping containers

- E.g. ceramic, carbon bricks

COATINGS AND LININGS

linings	uses
Tin coated steel	Food containers
Lead coating	roofing
Aluminum coated steel	High temperature conditions

ALTERING ENVIORMENT

- Corrosion can be combated or reduced by
  - removing air from boiler feed water prevent the influence of water on steel.
  - Reducing temperature
  - Eliminating moisture
  - Reducing the velocity or turbulence
  - Shortening the time of exposure

INHIBITORS

- The corrosion inhibitors are added to the environment to decrease the corrosion of metals
- These inhibitors form a protective film

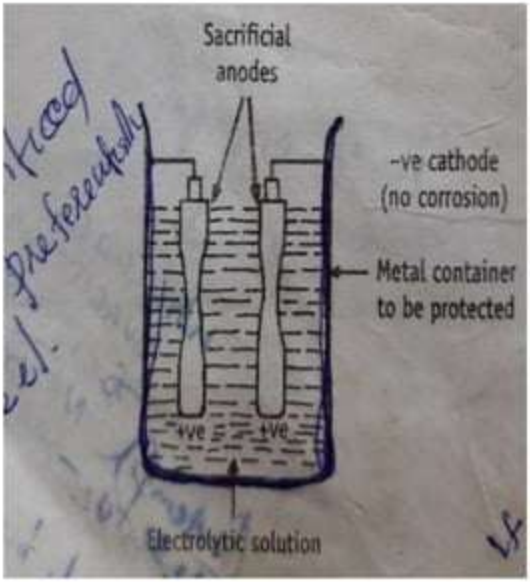
inhibitor	Materials protected in medias
Chromates, phosphates	iron and steel in aqueous solution

CATHODIC PROTECTION

- Two methods
  - sacrificial anode method
  - impressed emf method

SACRIFICAL ANODE METHOD

- In this method anodes are kept in electrical contact with the metal to be protected(cathode)
- No external current is used
- The electric potential difference between the anode and cathode cause current to flow
- So the anodes are sacrificed and goes in

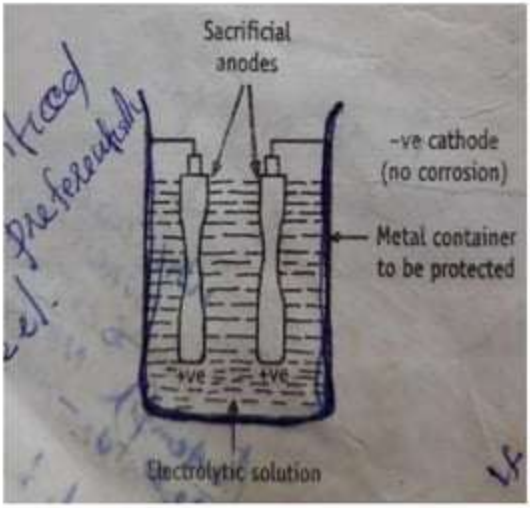


SACRIFICAL ANODE METHOD

- Zinc, aluminium, magnesium and their alloys – sacrifical anodes
- ADVANTAGES: no external electric current required
- Easy to install

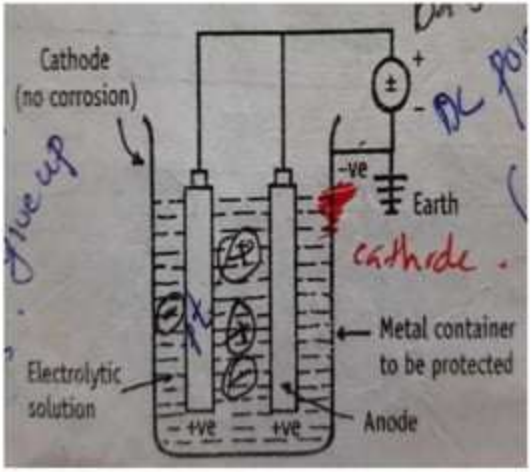
DISADVANTAGES:

Frequent monitoring and replacement of anode required



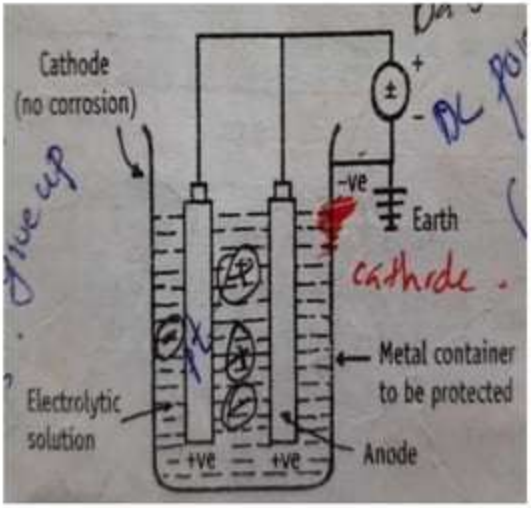
IMPRESSED EMF METHOD

- Applied current system
- External voltage is impressed between tank and electrodes
- The –ve terminal of power supply is connected to the material to be protected so the anode is maintained +ve
- Therefore the natural galvanic effect is avoided



IMPRESSED EMF METHOD

- This method is used for large tanks to store mild corrosive liquors
- simple and most effective
- Inexpensive



THANK YOU