Passivity

- Passivity / Passivation is a phenomenon where a metal or an alloy shows unexpected more corrosion resistance than shown by its position in electrochemical or galvanic series.
- Passivity is observed due to formation of a very thin, highly stable, self healing protective film on the surface of metal or alloy. It makes the metal non-corrosive.
- This film is insoluble & non-porous.
- Metals like Ti, Al, Cr & no. of stainless steel alloys containing Chromium are passive. They are highly corrosion resistant in oxidising environment.
- Passivation is possible only when the metal/alloys can maintain thin protective oxide film on their surfaces.

e.g. ① Fe & Al are passive in conc. HNO_3 soln.
② Application of anodic current helps growth of oxide film increasing passivity.

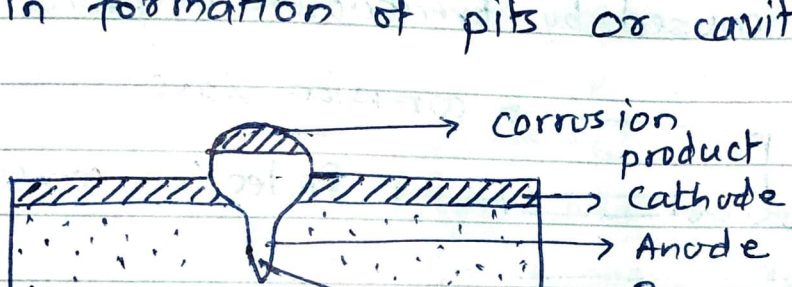
Pseudopassivity: can be achieved by physical isolation of metal from corroding medium/environment which is useful in reducing corrosion

e.g. Film of lead sulphate on lead in H_2SO_4.
Use of inhibitors, anodic polarisation.

Forms of corrosion

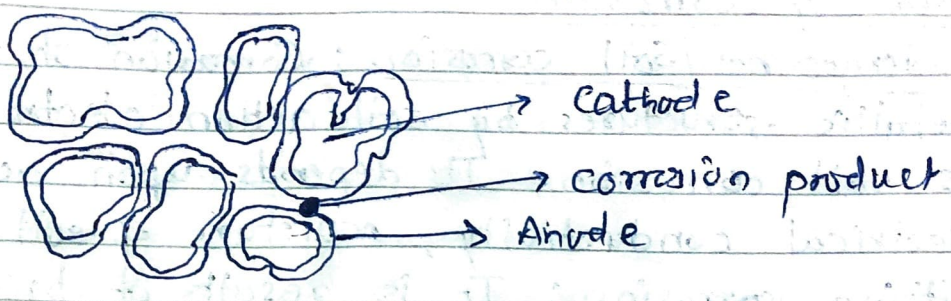
1) **Underground / Soil corrosion** : Corrosion of underground metallic structures by soil action electrochemically, is soil corrosion. It depends upon acidity of soil electrical conductivity, moisture & soil texture.

2) **Pitting corrosion** : It is result of breakdown or cracking of metallic protective film at some points, due to friction. Anode area is small & cathode is large. It is localised, accelerated corrosion resulting in formation of pits or cavities.

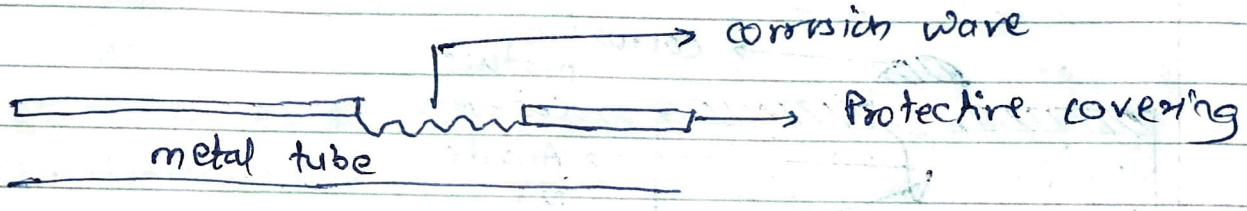


3) **Waterline corrosion** : It is differential aeration cell corrosion. When water / aq. solution are stored in metal vessels, the maximum corrosion takes place along a line just beneath the water level, then it is known as water line corrosion.
Area above water is highly oxygenated & unaffecte as it is cathode.

4) **Intergranular corrosion** : It occurs in heterogenous alloys. When molten metal is cast, solidification starts randomly. The grains are randomly arrange Grain boundries are susceptible for attack by corrodin liquid ∴ Boundries act as anode & grain centre is cathode. e.g. During welding of stainless stee chromium carbide is precipitated on grain boundries



5) Erosion - Corrosion - It is combined effect of corrosion & abrasion due to flow of gases/liquids, on metallic surfaces. It is caused by breakdown of protective film.



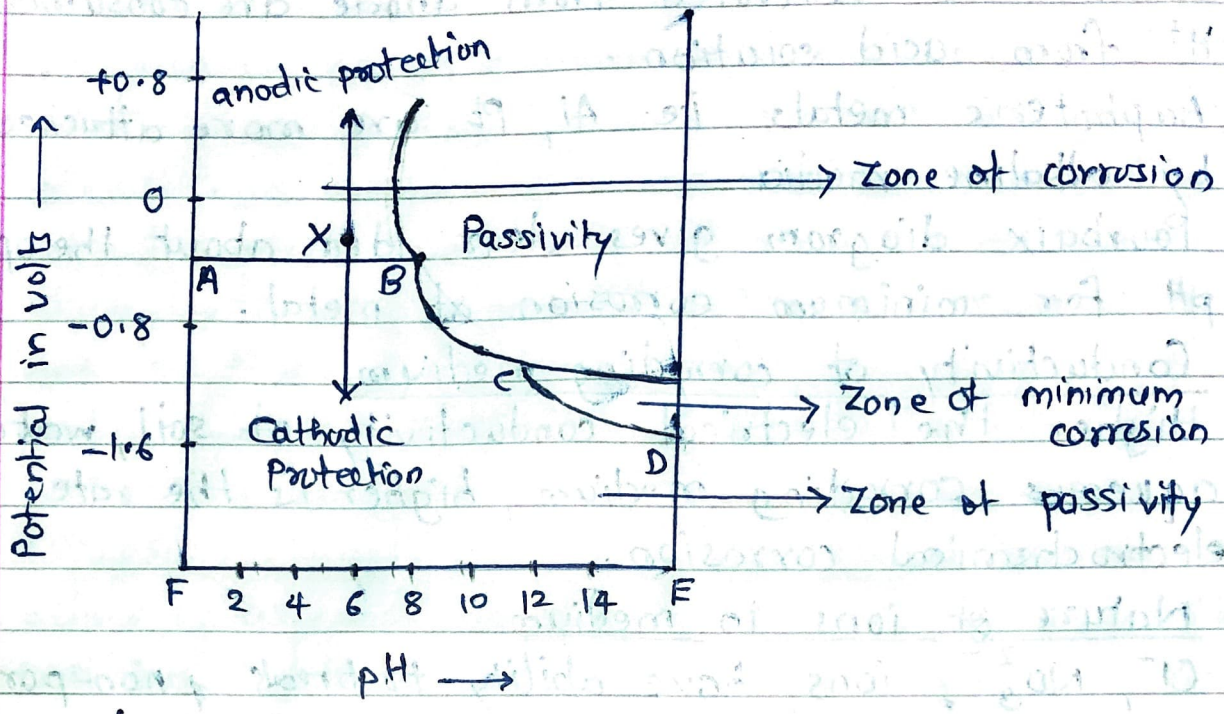
Erosion corrosion can be guessed by appearance of grooves, waves, valleys & usually it exhibits directional pattern.
e.g. Corrosion of pipes, heat exchange tubes, condenser tubes.

6) Microbiological corrosion : It is caused by metabolic activity of various micro-organisms.
E.g. Sulphate reducing bacteria, film forming bacteria.

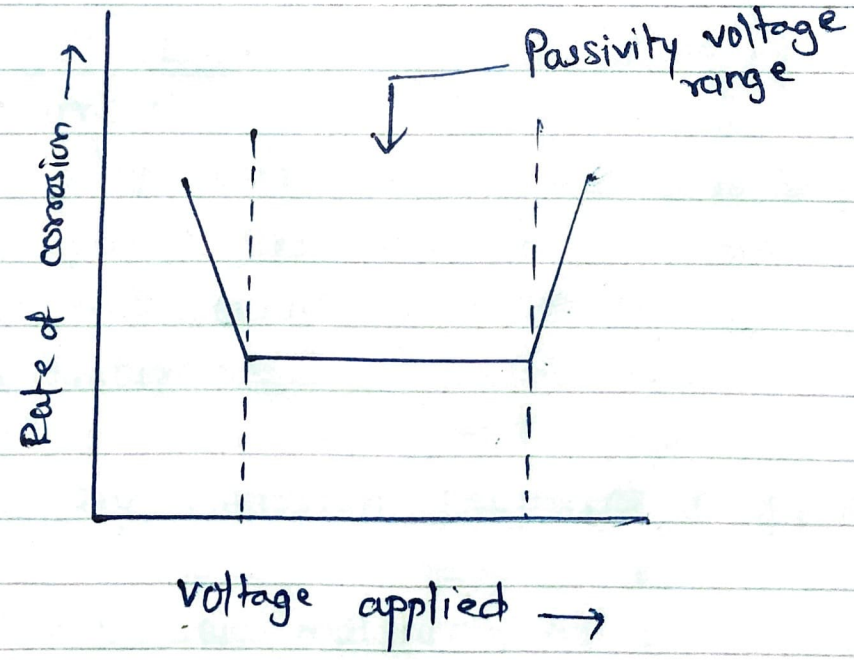
7) Crevice corrosion : Local corrosion by differential aeration cell formation, occurs near bolts, cracks.

8) Stray current corrosion : Corrosion due to e^- leakages from powerline. e.g. Water pipes, poles near powerline.

Pourbaix Diagram



Graph : (A)



Graph (B)

- Pourbaix diagram gives an idea about optimum pH for minimum rate of corrosion.
- There are 2 plots in this diagram
  ① Potentials of metal vs pH of medium
  ② Rate of corrosion vs voltage applied
- First graph shows zones of corrosion, passivity & zone of minimum corrosion. Area ABCDEF is zone of passivity.
- Point X in graph (A) shows directions for corrosion control methods i.e. anodic protection & cathodic protection.
- Graph (B), Rate of corrosion vs voltage applied shows voltage range over which a metal is passive & resists action of medium.
- From the diagram (A), we can modify the pH of corroding medium around metal to make metal passive towards corroding medium.
- From graph (B), we get an idea about proper potential to be applied on metal so that rate of corrosion will be minimum.

Applications

Corrosion control of a metal using Pourbaix diagram

(1) Modifying pH of corroding medium
(2) Applying passivity range of voltage in anodic protection
(3) Impressed current in cathodic protection.