

# Corrosion

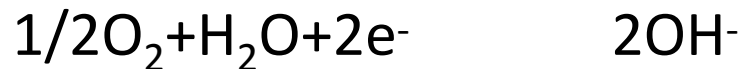
## Concentration cell corrosion or Differential aeration corrosion :

It occurs when metallic surface is partially immersed in an electrolyte and partially exposed to air.

Poor oxygenated metallic part becomes anodic and undergoes oxidation.

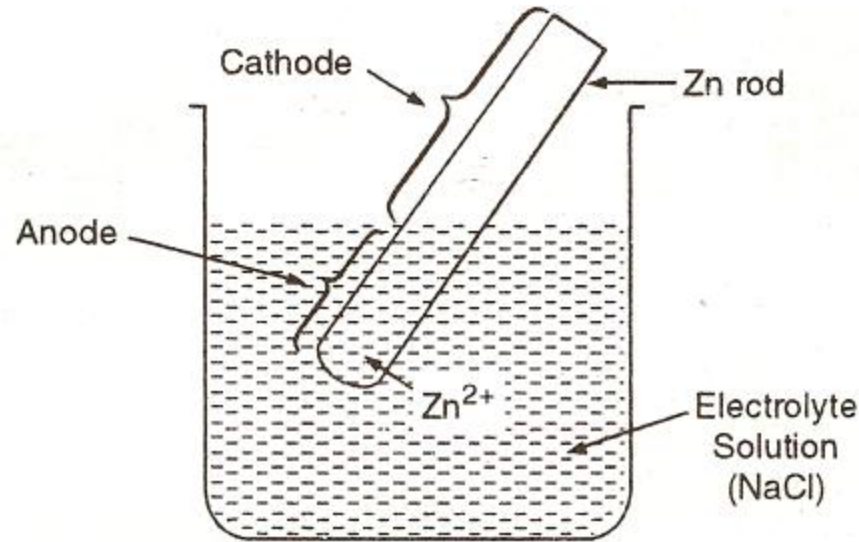


Oxygen rich metallic part becomes cathodic. At the cathode, O<sub>2</sub> takes up electrons to form OH<sup>-</sup> ions.



The Zn<sup>2+</sup> and OH<sup>-</sup> ions interact to  $\overrightarrow{\text{give Zn (OH)}_2}$  Therefore, corrosion occurs at anode.

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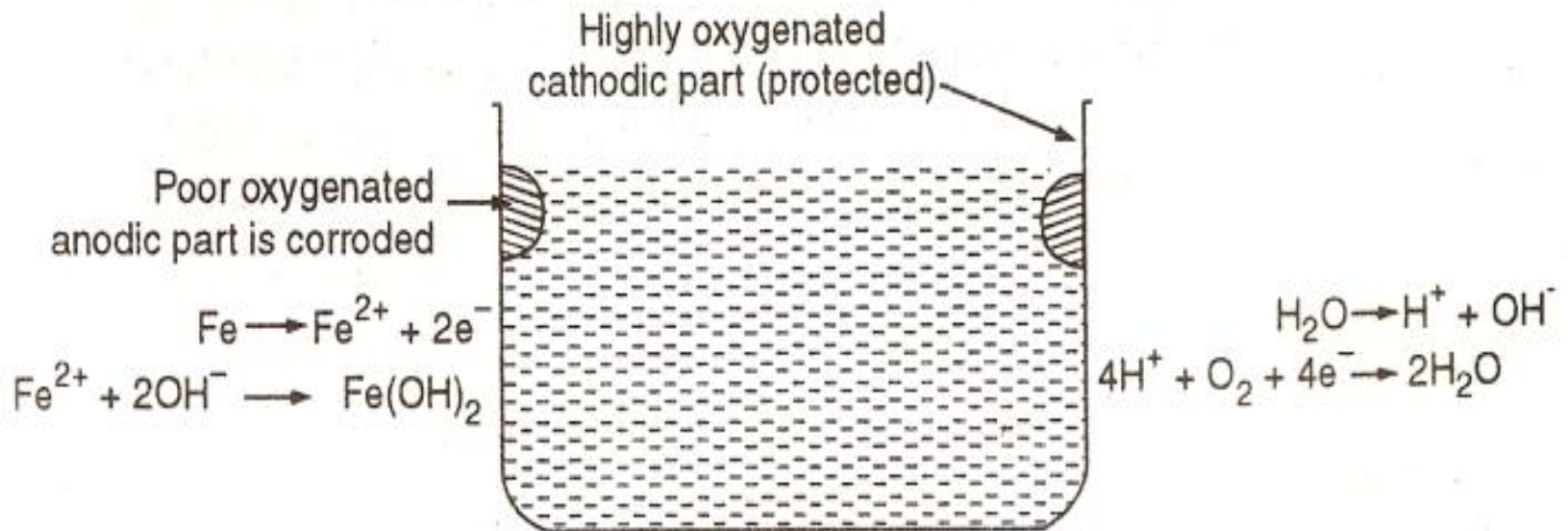
## Water-line Corrosion :

When water is stagnant in a steel tank, the concentration of Oxygen above the water surface is greater than that under the surface. This generates an oxygen concentration cell. In this cell the metal just above the water level is cathodic w.r.t. the metal below the water level.

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Corrosion occurs at the anodic part, the metal just below the water level.

The cathodic area completely unaffected by corrosion.



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**Passivity** : Passivity means the lack of activity under conditions where a metal would be expected to react readily. There are certain metals which are passive to certain corroding agents. For example; iron is passive to conc.  $\text{HNO}_3$ . Aluminium has no action with conc.  $\text{HNO}_3$  in absence of chlorides etc.

Metals which are susceptible to corrosion are made passive by alloying with one or more of metals which are passive or resist corrosion. For example; Iron is rendered passive by alloying it with any of the transition metals such as chromium, nickel and molybdenum.

The quantity of passive metal to be added depends upon the environments. For example; Iron-chromium alloy, when the quantity of chrome added is from 12 to 20%, the alloy is passive to neutral salt solution but no concentration of chromium in iron makes the alloy passive to hydrochloric acid.

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**FACTORS INFLUENCING CORROSION :** The rate and extent of corrosion, depends on the following factors :

1. Nature of the metal:

- (i) Position in the galvanic series:** The greater the oxidation potential, when the metal is higher up in the galvanic series, greater is its tendency to become anodic and hence greater is the rate of corrosion.
- (ii) Purity of metal:** Lesser is the percentage purity of a metal, faster is the rate of corrosion. The impurities present in a metal cause heterogeneity and thus tiny electrochemical cells are set up at the exposed part of the impurity and corrosion of metal around the impurity takes place due to local action.
- (iii) Physical state of the metal:** The rate of corrosion is influenced by physical state of metal. The smaller the grain size of the metal or alloy, the greater will be its corrosion. Moreover, areas under stress, even in a pure metal, tend to be anodic and corrosion takes place at these areas.

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- (iv) Nature of the oxide film:** The ratio of the volumes of the metal oxide to the metal, is known as "specific volume ratio". Greater the specific volume ratio, lesser is the oxidation corrosion rate.
- (v) Relative areas of the anode and cathode:** When two dissimilar metals or alloys are in contact, the corrosion of the anodic part is directly proportional to the ratio of the cathodic part and the anodic part. When cathodic area is smaller, the demand for electrons will be less and this result in the decreased rate of dissolution of metal at anodic regions.
- (vi) Solubility of corrosion products:** In the electrochemical corrosion, if the corrosion product is soluble in corroding medium, then corrosion proceeds at a faster rate. For example, Pb in  $\text{H}_2\text{SO}_4$  medium forms  $\text{PbSO}_4$  which is insoluble in the corroding medium, hence corrosion proceeds at a smaller rate.

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**(vii) Volatility of corrosion products:** Rapid and continuous corrosion of metal take place if corrosion product is volatile. This is due to the fact that as soon as corrosion product is formed, it volatilize, thereby leaving the underlying metal surface for further attack.

## 2. Nature of the corroding environment:

**(i) Temperature:** With increase of temperature of environment, the reaction as well as diffusion rate increase, thereby corrosion rate is generally enhanced.

**(ii) Humidity of air :** The greater is humidity, the greater is the rate and extent of corrosion. This is due to the fact that moisture acts as a solvent for  $O_2$ ,  $H_2S$ ,  $SO_2$  and  $NaCl$  etc. to furnish the electrolyte essential for setting up a corrosion cell.

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- (iii) Effect of pH:** Corrosions of those metal which are readily attacked by acids can be reduced by increasing the pH of the attacking environment.
- (iv) Presence of impurities in atmosphere:** Corrosion of metals is more in areas near to the industry and sea. This is due to the fact that corrosive gases like  $\text{H}_2\text{S}$ ,  $\text{SO}_2$ ,  $\text{CO}_2$  and fumes of  $\text{H}_2\text{SO}_4$  and  $\text{HCl}$  in the industrial areas and  $\text{NaCl}$  of sea water leads to increased conductivity of the liquid layer in contact with the metal surface, thereby increase the corrosion rate.
- (v) Presence of suspended particles in atmosphere:** In case of atmospheric corrosion; (a) if the suspended particles are chemically active in nature [like  $\text{NaCl}$ ,  $(\text{NH}_4)_2\text{SO}_4$ ], they absorb moisture and act as strong electrolytes, thereby causing enhanced corrosion;