

## Factors affecting rate and extent of corrosion

As we know that corrosion occurs due to interaction between metal and its surrounding environment. So, any factor that has the ability to change either the nature of the metal or the nature of the environment or both is definitely going to alter the rate & extent of corrosion.

So, let us list first how the rate of corrosion depends on the nature of metal.

### ➤ *Nature of the metal:*

- (i) ***Particle size (grain size) of metal:*** Smaller is the particle size; larger is the rate of anodic dissolution. If particle size of the metal will be smaller then, the rate of anodic dissolution will be faster.
- (ii) ***Residual stress in the metal:*** Stressed part acts as anode and undergoes corrosion in a corrosive environment. So, between a bent iron wire and a straight wire, the rate of corrosion will be faster in case of bent wire with stressed part (anode).
- (iii) ***Purity of metal:*** Lesser is the % purity; greater is the rate of corrosion. For example, between a 99 % pure Zn and 60 % pure Zn, rate of corrosion will be more in case of later.
- (iv) ***Nature of the oxide film:*** The smaller is the specific volume ratio (i.e., the ratio of volume of metal oxide to the volume of metal); greater is the oxidation/dry corrosion. Porous and volatile oxide layer causes rapid dry corrosion.
- (v) ***Position of the metals and alloys in the Galvanic series:*** Greater is the difference in their position, faster is the rate of Galvanic corrosion.
- (vi) ***Size of the anode:*** Smaller is the size of the anode; greater is the rate of corrosion. If cathodic area will be large, then it will demand more electrons from the small anode for reduction reaction to happen. So, in order to fulfill the huge demand of electrons by the cathode, anode will undergo rapid dissolution (i.e., loss of electrons) process. Hence, this causes rapid corrosion at anodic part.
- (vii) ***Passive nature of metal:*** Some metals like Al, Cr, Ni, Co, etc. resist corrosion as they form protective oxide layer on their surface. The exhibition of improved corrosion resistance than expected from their position in the EMF/Galvanic series owing to the formation of protective oxide layer is known as *Passivity*.
- (viii) ***Solubility of corrosion products:*** Larger is the solubility of the product in the medium; greater is the rate of corrosion. For example,

Pb undergoes corrosion at smaller rate in  $\text{H}_2\text{SO}_4$  medium. The reason is that when Pb reacts with  $\text{H}_2\text{SO}_4$ , it forms a product  $\text{PbSO}_4$  that is insoluble in the medium itself. This product gets coated over the metal and resists further dissolution process.

- (ix) **Volatility of corrosion products:** Volatile corrosion products result in rapid and continuous corrosion. Molybdenum (Mo) metal suffers from rapid oxidation corrosion as the product  $\text{MoO}_3$  is volatile in nature and it volatilizes leaving the underlying metal surface for further oxidation corrosion.

➤ **Nature of the environment**

- (i) **Temperature:** The rate of corrosion increases with rise in temperature (T) due to the following reasons (i) Decrease in concentration of dissolved oxygen with rise in T; (ii) Increase in rate of anodic dissolution; and (iii) Increase in rate of evolution of  $\text{H}_2$  gas at cathode.
- (ii) **% Humidity:** In general, greater is the % humidity in the atmosphere, the larger is the rate of corrosion. The reason is that moisture dissolves many gases like  $\text{O}_2$ ,  $\text{H}_2\text{S}$ ,  $\text{SO}_2$ , etc. and salt like NaCl to supply the electrolyte needed for setting up of electrochemical cell.
- (iii) **pH of the medium:** Rate of corrosion is more in acidic media than in alkaline or neutral medium. For example, rate of corrosion of Fe is faster in a medium with  $\text{pH} = 4$  and slower when  $\text{pH} = 11$ .
- (iv) **Conductance of the medium:** Greater is the conductivity of the electrolytic medium; larger is the rate of corrosion. For example, the rate of corrosion of buried iron pipe is greater in clayey and mineralized soil than that of dry sandy soil. The reason is that clayey and mineralized soil is more conducting due to presence of ions than that of dry sandy soil.
- (v) **Formation of  $\text{O}_2$  concentration cell:**  $\text{O}_2$  concentration cell is developed when a metal is exposed to differential aeration. The poorly oxygenated part acts as anode and undergoes corrosion. For example, part of an iron nail inside a wooden structure suffers from this class of corrosion. As the part inside the wood has less access to oxygen, acts as anode and undertake corrosion.
- (vi) **Presence of impurities in the atmosphere:** Rate of corrosion is more in industrial areas and coastal belt. The reason for is that presence of gases like  $\text{H}_2\text{S}$ ,  $\text{SO}_2$ ,  $\text{CO}_2$  and fumes of acids like  $\text{H}_2\text{SO}_4$  and  $\text{HCl}$  in industrial areas makes the environment more conducting near the

surface of the metal. Similarly, in sea areas presence of NaCl in the atmosphere makes the environment a good electrolyte and hence, a more conducting medium.

- (vii) ***Presence of suspended particles in the atmosphere:*** Presence of suspended particles like NaCl,  $(\text{NH}_4)_2\text{SO}_4$ , activated charcoal, etc. in the atmosphere has the ability to absorb moisture and providing a good conducting medium near the surface of metal.

**Q. Aluminum is not attacked by conc.  $\text{HNO}_3$  but Iron gets rapidly corroded even by dil.  $\text{HNO}_3$ . Justify this statement.**

Ans. In Conc.  $\text{HNO}_3$ , Al gets oxidized and forms a protective layer of  $\text{Al}_2\text{O}_3$  on its surface.

**Q. Give reason that Stainless steel (SS) exhibits high corrosion resistance in  $\text{HNO}_3$  solution over a wide range of concentrations.**

Ans. Because Cr present in SS forms a protective layer of  $\text{Cr}_2\text{O}_3$  on its surface upon oxidation by  $\text{HNO}_3$ .

**Q. What is meant by the term Passivity?**

Ans. Passivity is a phenomenon by which a metal or alloy exhibit high corrosion resistance due to formation of a highly protective film on its surface.

**Q. A 55 % purity Zn suffers from rapid corrosion as compared to 99.9 % Zn. Give reason.**

Ans. Greater is the % impurity of a metal, faster is the rate of corrosion due to formation a large number of electrochemical cells.

**Q. Corrosion of Zn can be minimized by increasing the ph to 11. Give reason.**

Ans. At  $\text{pH} = 11$ , Zn forms  $\text{Zn}(\text{OH})_2$  ppt. and gets adsorbed on the surface of Zn to resist further dissolution.

**Q. Corrosion of metals occurs at a faster rate in clayey and mineralized soil. Give reason.**

Ans. Conductivity of clayey and mineralized soil is more than sandy soil.

**Q. Which gases in the atmosphere are likely to accelerate the rusting of iron?**

Ans.  $\text{CO}_2$ ,  $\text{SO}_2$ ,  $\text{SO}_3$ ,  $\text{NO}_2$ , etc.

**Q. Rate of metallic corrosion increases with increase in temperature. Give reason.**

Ans. Corrosion rate increases with temperature due to increase in the rate of diffusion of ions.

**Q. Discuss on any seven factors which affects the rate of corrosion? (5 marks)**

Ans. Refer above