Summary | Degradation

Introduction

Corrosion

Deterioration of metals due to the reaction with the environment.

All corrosion reactions are electrochemical in nature.

Electrochemical reactions

Pair of reactions in which electron transfer occurs from one reaction to another.

Oxidation

The reaction where an electron is released. Aka. anodic reaction.

Reduction

The reaction where an electron is consumed. Aka. cathodic reaction.

Anode

The site at which oxidation takes place.

Cathode

The site at which reduction takes place.

Common reactions

Hydrogen evolution reaction (HER)

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

Oxygen reduction reaction (ORR)

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

Standard Electrode Potential

Whether a metal becomes anode/oxidizes or cathode/reduces depends on its E^0 value. Measured in reference to hydrogen.

The metal with the least E^0 becomes the anode.

Cell

When 2 electrodes are electrically connected.

Cell potential

Absolute difference between the 2 electrode's standard electrode potentials. Denoted by ΔE^0.

For a corrosion reaction to occur spontaneously, $\Delta E^0 > 0$. Cell potential is an indication of the rate of corrosion.

Forms of Corrosion

8 forms:

1. Uniform / General corrosion
2. Galvanic corrosion
3. Crevice corrosion
4. Pitting corrosion
5. Inter-granular corrosion
6. Erosion corrosion
7. Stress corrosion
8. Selective leaching

Uniform corrosion

Occurs uniformly over the entire exposed area of the metal. Rust forms all over the surface. Leads to 30% of corrosion failures.

Galvanic corrosion

When 2 metals are in contact (electrically) and placed in a corrosive environment, only one metal — the element with most negative potential— corrodes. Aka. two metal corrosion.

Galvanic corrosion can happen even inside 1 metal. In such cases, one part of the metal becomes anodic to the rest.

Corrosion will be severe at the junction.

Area effect

Smaller the anode, severe will be the corrosion.

Galvanic series

Designed to be an extension of electrochemical series that includes alloys and non-metals. Materials are ordered in ascending order of reactivity. Materials in the lower position becomes the anode. Specific for a particular environment.