MSE 326– Corrosion & Protection (3 CH)

Pre-requisites: MSE-213 Metals and Alloys-1

Course Objectives

1. Provide fundamental understanding of aspects of electrochemistry and materials science relevant to corrosion phenomena.
2. Provide methodologies for predicting, measuring, and analyzing corrosion performance of materials.
3. Identify practices for the prevention and remediation of corrosion.

Desired Course Outcomes

4. The successful student will:
    a. Understand the origin of the difference in electrical potential across an interface, in particular, a metal/electrolyte interface.
    b. Understand the relationship between rates of electrochemical reactions and the potential drop across interfaces.
    c. Understand the causes of and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, inter-granular corrosion, and various modes of environmentally assisted cracking.
    d. Be knowledgeable of the influence of a material's composition and microstructure on its corrosion performance.
    e. Be knowledgeable of the effect of an electrolyte's composition on the corrosion of metals.
    f. Be able to identify materials that will exhibit adequate corrosion resistance in a particular environment.
    g. Be able to propose economically viable remedial actions that will eliminate or reduce corrosion to a tolerable level.

Course Contents

5. Free energy and the criterion for a reaction to occur at constant T, P. Definition of electrical potential. Hydration of Ions. Structure of Interface between Metal/Aq. Soln. Existence of Interface Potential Difference. Rate of Electrochemical Reaction. Use of Red-Ox curves to "predict" corrosion. Mechanism of oxidation of metals in aqueous solutions. Equilibrium Reduction Potential. Reduction reactions during corrosion of metals. Thermodynamic Driving Force for Corrosion. Behavior of

Noble Metals. Stability of Anions in Aqueous Solutions. Exchange Current Density. Galvanic coupling. Measurement of kinetics of Red-Ox reactions as a function of potential. Reference electrodes. Mechanism of active corrosion of iron. Effect of specific anions on the corrosion of iron. Formation of solid corrosion products. Pourbaix Diagrams. Corrosion Inhibitors. Corrosion protection by coatings. Passivity, Pitting Corrosion. Crevice corrosion. Influence of microstructure on corrosion (sensitization of stainless steel). Stress corrosion cracking. Corrosion fatigue. Hydrogen assisted cracking. Fretting corrosion. Atmospheric corrosion. Corrosion in concrete. Anodic protection. Cathodic protection. Stray current corrosion.

Recommended books:

1. M G Fontana, Corrosion Engineering, 3rd Edition, McGraw-Hill, (1986)
2. K R Trethewey & J Chamberlain, Corrosion for Science & Engineering, 2nd Edition, Longman, (1995)
3. Pierre R Roberge, Corrosion Engineering; Principles and Practice, McGraw Hill Professional, (2008)