MSE 6406: CORROSION OF MATERIALS

Objective: To introduce students to basic thermodynamic and kinetic phenomena associated with the corrosion of materials by gases and liquids.

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Class Hours/ Location: 4 credit hours.

Textbook: List of required reading for this course will be provided separately for each section. Relevant information will also be posted on the web site for this course

Grading: 60% - 3 Exams
20% - Quizzes or Homework
20% - Term Paper + Presentation

Learning Objectives: Upon completion of this course, students will be able to:

(1) Understand thermodynamics and kinetics of aqueous and high temperature gaseous corrosion phenomenon
(2) Understand basic electrochemical principles and apply them to aqueous corrosion
(3) Understand mechanisms of different forms of corrosion
(4) Apply understanding of corrosion to their research projects or to mitigate corrosion in their professional career.

Exams: Exams will be given in class at the scheduled time. Exceptions (only for very good reasons) will require making prior arrangements with the instructor.

Research Topics and Presentations:

This will involve writing a group term paper on a topic approved by the instructor and a final oral presentation. Groups will have 2 or 3 students each (groups to be approved by the instructor). Term paper topics should be finalized by the end of January. The paper must have single spacing and be maximum 10 pages of text (i.e. not including references, figures and tables). Paper should have an abstract, an introduction, body and summary. The paper should have at-least ten (10) references. The research paper must contain figures or data to support your conclusions or explanations. During the final weeks of class, each group will give a 20-minute presentation based on their research paper, and be prepared to answer any questions from the class.

TOPICS

A. Introduction - Reactivity in Aqueous Environments
   1. Introduction to electrochemical processes
   2. Electrochemical nature of corrosion

B. Thermodynamics
   1. Reversible electrode potentials
   2. Electromotive Force Series
   3. Pourbaix Diagrams

C. Kinetics
   1. The laws of electrolysis
   2. Double Layer, Exchange Current
   3. Corrosion Current, Polarization
   4. Mixed Potential Theory
   5. Passivity

D. Measurement Techniques
   1. DC Polarization Methods
   2. AC Impedance Method

E. Types of Corrosion
   1. Galvanic Corrosion
   2. Dealloying
   3. Concentration Cell
   4. Pitting, Crevice Corrosion
   5. Erosion Corrosion, Cavitation
   6. Environment Induced Cracking (Stress corrosion cracking, Corrosion fatigue, Hydrogen embrittlement)

F. Other Related Applications
   1. Metal Extraction Processes
   2. Electroplating, Electropolishing and Electro-machining

G. High Temperature Oxidation
   1. Introduction
      i. Thermodynamics of Oxidation
      ii. Point Defect Equilibria (Role of Defects)
   2. Measurement of Kinetics/Oxidation Rate Laws
   3. External Oxidation
   4. Internal Oxidation