MSE 4010: Environmental Degradation of Materials

Credit hours and contact hours: 3-0-0-3

Instructor: Preet Singh

Textbook: D. A. Jones, *Principles and Prevention of Corrosion,* Pearson, 2nd Edition, 1995.

Specific course information

Catalog description: Theory of environmental degradation of metals, ceramics, polymers, and biomaterials. Emphasis on the scientific principles of corrosion and physical degradation.

Prerequisites: MSE 2001 – Principles & Applications of Engineering Materials

Course: Selected Elective

Specific goals for the course

Outcomes of instruction:

1. Understand the thermodynamic and electrochemical principles behind corrosion reactions.
2. Identify different forms of corrosion and describe mechanisms of different forms of corrosion
3. Be able to use electrochemical principles to understand corrosion test procedures and be able to analyze data and to solve problems
4. Be able to apply knowledge to select appropriate materials and design to mitigate corrosion under different environments
5. Prepare a term paper and present a lecture on a specific topic on corrosion problem, its mechanism, prevention strategies, and its economic/environmental impact

Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
(3) An ability to communicate effectively with a range of audiences.
(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Topics covered:

1. Basics of Corrosion
2. Electrochemical corrosion
3. Thermodynamic principles of electrochemical reactions - Electromotive Force Series, Pourbaix Diagrams, Evans diagrams,
4. Kinetics of corrosion, Mixed potential theory, Passivity
5. Electrochemical methods to measure corrosion: DC Polarization, AC Impedance,
6. Environmentally Induced Cracking - Stress Corrosion Cracking, Corrosion Fatigue, Hydrogen Induced Cracking, Application of Fracture mechanics
7. Different forms of corrosion, their mechanisms and prevention methods (concentration cell, crevice corrosion, pitting, galvanic corrosion, intergranular corrosion, erosion corrosion)
8. High Temperature Corrosion - Oxidation in gaseous environments, Ellingham Diagrams, Role of Protective Scale, Molten Salt Corrosion
9. Environmental degradation of Ceramics and Polymeric Materials
10. Corrosion Prevention methods – Electrochemical protection (anodic and cathodic protection)

Correlation between Outcomes of Instruction and Student Outcomes:

Outcomes of Instruction	**Student Outcomes**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1. Understand the thermodynamic and electrochemical principles behind corrosion reactions.	X	X					
2. Identify different forms of corrosion and describe mechanisms of different forms of corrosion	X	X					
3. Be able to use electrochemical principles to understand corrosion test procedures and be able to analyze data and to solve problems	X	X					
4. Be able to apply knowledge to select appropriate materials and design to mitigate corrosion under different environments	X	X		X			
5. Prepare a term paper and present a lecture on a specific topic on corrosion problem, its mechanism, prevention strategies, and its economic/environmental impact	X		X	X	X		

School of Materials Science and Engineering Student Outcomes:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration for public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
(3) An ability to communicate effectively with a range of audiences.
(4) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
(6) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
(7) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.