

MASTER OF MATERIALS ENGG. EXAMINATION, 2009
MASTER OF METALLURGY ENGG. EXAMINATION, 2009
 (Second Semester)

ENVIRONMENTAL DEGRADATION OF MATERIALS

Time : Three hours

Full Marks : 100

Answer any *five* questions. All questions carry equal marks.

1. Explain the phenomena occurring at metal/ electrolyte interface with diagram indicating outer Helmholtz plane, inner Helmholtz plane, charge separation, occurrence of double layer capacitance and contact adsorption. Draw randle circuit. In the study of electrochemical impedance spectroscopy, how Nyquist and Bode plots are plotted. Explain how the polarization resistance and capacitance of the randle circuit can be estimated from these plots. What is Warburg impedance? When does it occur? 6+2+4+4+2+2

2.a Explain what is passivity and how this passivity breaks down due to localized corrosion such as occurrence of pitting. How pitting potential and pit protection potential can be determined from cyclic polarization curve. What is the significance of hysteresis of this curve. 4+ 3+3

2b. Discuss the Hydrogen Induced cracking, hydrogen blistering and hydrogen embrittlement 10

3. Express i_{corr} by Butler Volmer Equation and explain how corrosion rate is dependent on several parameters. What is Overvoltage? Justify the fact, "the rate of corrosion is controlled by charge transfer or mass transfer reactions (activation and concentration polarization)", explain with diagrams and equation. State the influences of exchange current density and limiting current density on corrosion rate and the factors which control them? 4+2+10+4

4.a. What is fuel cell? How it is different from chargeable battery? Justify that fuel cell is more efficient form of pollution free renewable energy compared to chemical combustion engine. Describe with sketch any one type of fuel cell. 1+3+4+3

4.b. Draw a sketch to show aggressiveness of corrosion occurring at different height and depth of an off shore petroleum production unit in an ocean. State the substances responsible for corrosion here. Draw a diagram to show how Cathodic protection is applied here. 4+ 2+3

5.a. What is microbial induced corrosion? Explain how aerobic bacteria and anaerobic bacteria aggravate corrosion rate of metals and alloys in aqueous environment. 2+ 6

5.b. How do the inhibitors function in minimizing corrosion rate? What are the characteristics of an organic inhibitor? Why do they work best at PZC? How to find adsorption percentage from corrosion rate? Draw a sketch to show how the inhibitor is added in the tubing of petroleum production unit. 3+2+2+2+3

6.a. Explain the followings with polarization diagram labeling with E_{corr} , I_{corr} , I_0 , i_L , β , etc wherever necessary
i. Hull of ship docked at port. How the corrosion rate changes when it sails in sea? What change would occur if Cathodic protection is applied? 5

ii. A steel tank containing sulphuric acid is corroding at free corrosion potential and now anodic protection is applied? 3

iii. A Ni-Cd battery of internal resistance R , delivering a current I . Show the charging and discharging potential. State some means to increase its current capacity. 4

6.b. What are the major constituents of an organic paint. Explain their functions. Name an organic coating for a steel bridge and hull of ship. 2+4+2

7. Write short notes on 4+5+4+7

i. Galvanic corrosion and Galvanic series.

ii. Stress corrosion cracking

iii. Atmospheric corrosion and the factors affecting it.

iv. Electrochemical Determination of corrosion rate by Tafel extrapolation and Linear polarization method