 CHEN 531

Corrosion

Chemical Engineering

Faculty of Engineering and Architecture

American University of Beirut

Friday November, 16th, 2012

16.00-18.00

This exam paper has 5 questions

Answer all questions

You have two hours to complete this exam

GOOD LUCK

Q1. (a) Discuss three industrial consequences of corrosion problems. (6 marks)

(b) Give ***two*** practical examples for each of the following:

* 1. Dissimilar metal corrosion
  2. Differential aeration cells
  3. Metals less noble than H2

(6 marks)

(c) Plot a typical graph of the Pourbaix diagram for iron showing the main regions. How can this diagram help you in designing storage tanks for acids? (5 marks)

(d) Draw a schematic diagram illustrating a typical galvanic cell. Identify the different cell components on the diagram. Show typical corrosion reactions (anodic and cathodic) and identify typical applications in industry. (8 marks)

Q2. Explain the following cases that cannot be predicted by EMF.

1. Although iron shows a (–ve) potential, it will not corrode in certain environments.
2. Pb does not dissolve in concentrated H2SO4
3. Al does not dissolve in concentrated HNO3
4. Although Cu and Ag are more noble than hydrogen but they dissolve in KCN with vigorous evolution of H2 forming the complexes: K3 [Cu(CN)4] and K [Ag(CN)2]
5. Although Cu is more noble than hydrogen, it dissolves in HNO3

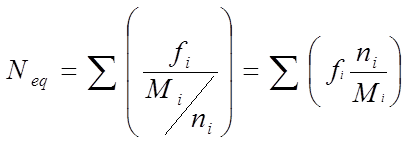
(10 marks)

Q3. A stainless steel alloy has the following composition and elemental properties.

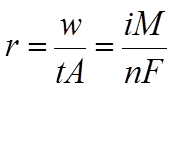
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Metal | Mass % | Atomic Weight | Valency | Density (g/cm3) |
| Fe | 70 | 55.8 | 2 | 7.86 |
| Cr | 18 | 52.0 | 3 | 7.10 |
| Ni | 8 | 58.7 | 2 | 8.90 |
| Mo | 3 | 95.9 | 2 | 10.2 |

Determine the penetration rate of this alloy equivalent to 1 μA/cm2 corrosion current.

r (mpy) = 0.129 M.i/(n.ρ)



*M/n = EW =1/ Neq*



Where:

fi = mass fraction of ith element

ni = electrons exchanged in the ith element

Mi = Molar mass (= atomic weight) of ith element

Neq = number of equivalents in unit mass of alloy

EW = equivalent weight of alloy

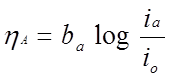
(12 marks)

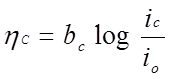
Q4. Explain briefly the three different types of polarization giving examples (one example per type). (9 marks)

Q5. (a) Show that the corrosion potential due to activation polarization and the equivalent current (Icorr) can be determined mathematically according to the following equations. (14 marks)

E corr = (bc Eeq,a –ba Eeq,c)/(bc-ba) + bcba[log10(Io,c)-log10(Io,a)]/(bc-ba)

Log10 (I corr) = (Ecorr-Eeq,a + b log10(Io,a))/ba





*E*eq = equilibrium or Nernst potential

Q5. (b) Find the corrosion potential, Ecorr, and corrosion current, Icorr, for iron (Fe) iron in a deaerated solution at 25**°**C, pH=5 using the equations in part a and graphically (Evans Charts).

(20 marks)

Anode

Surface area =1 cm2

Io = 10-6 A

*ba*  = 0.120 V/decade

Cathode

Surface area = 1 cm2

Io = 10-6 A

*bc*  = 0.120 V/decade

Q5. (c) Show how a limiting current of 1 x 10-4 A might affect both E corr and Icorr.

(10 marks)

END OF EXAM

