Examination Period 3: 2017/18

ENG301918N

Module Title: Corrosion Engineering
Level: Six
Time Allowed: Two hours

Instructions to students:

- Enter your student number not your name on all answer books.
- Answer all questions.
- All questions are equally weighted and carry 25% of the overall marks.
- Begin each question on a separate page; label each page clearly with the number of the question you are answering.
- The use of an electronic non-programmable calculator is permitted.

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Question 1

Describe an electrochemical test procedure that could be used to assess either general corrosion or an organic coating.

a. Produce a fully labelled diagram of the test equipment and corrosion cell.  
(10 marks)

b. Explain how the test is conducted and the parameters used.  
(10 marks)

c. Relate what you are measuring to your understanding of corrosion or corrosion protection and degradation mechanisms.  
(5 marks)

Total: 25 marks

Question 2

a. Name and give examples of the four categories of people identified as secondary mechanisms in corrosion control. How does each of these groups influence the management and control of a system?  
(20 marks)

b. The probability of materials failure $P_m$ is 0.02 due to stringent inspection and quality control procedures. The probability of the environment changing to produce a corrosive environment ($P_e$) is 0.15. What is the probability of failure ($P_{sf}$), when there is an aggravating factor rated at 1.5? Show all working.  
(3 marks)

c. Comment on the answer you arrived at as your probability of failure.  
(2 marks)

Total: 25 marks

Question 3

a. Using a sketch or schematic labeled Evans Diagram and mixed potential theory explain what happens with regards to Corrosion potential ($E_{corr}$) and Corrosion Current ($I_{corr}$) when two dissimilar metals are joined as a couple in the presence of an electrolyte environment.  
(15 marks)
b. Using copper and steel as an example with free potentials of 0.35 and -0.72 respectively, estimate the Couple potential.

(5 marks)

c. Using the Evans Diagram you have produced indicate what happens to the Corrosion current?

(1 mark)
d. How does this relate to corrosion rate?

(1 mark)
e. List three factors affecting galvanic or dissimilar metal corrosion that make calculating exact corrosion rates difficult when data is extrapolated into large scale engineering situations.

(3 marks)

Total: 25 marks

Question 4

a. If the cathode in a corrosion cell has an area of 480 cm$^2$ and the current density is 20 $\mu$A/cm$^2$, what will be the total electrical current flowing in the corrosion cell? What will be the current density on the anode assuming an active anode area of 5 cm$^2$? Show all working.

(6 marks)

b. Calculate the rate constant $K_{corr}$ for a corrosion reaction at 15$^\circ$C, where the free energy of activation; $\Delta G^\circ = 43$ kJ mol$^{-1}$ (ignoring constant “C”). Show all working.

(6 marks)

$$K_{corr} = C \cdot e^{-\frac{-\Delta G^\circ}{RT}}$$

c. Why is the surface profile produced by grit blasting so important with regards to coating life? (You can use a diagram to help explain this answer).

(6 marks)

d. If salt compounds form beneath a coating that has poor adhesion, explain the mechanism by which failure occurs.

(4 marks)

e. Why would the pH of a solution within a coating blister become very high?

(3 marks)

Total: 25 marks

End of Paper