UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING : METALLURGY*
SUBJECT	:	**CORROSION III**
CODE	:	**TKR31-1**
DATE	:	EXAMINATION 2014 8th NOVEMBER 2014
DURATION	:	08:30 - 11:30
WEIGHT	:	60 : 40
TOTAL MARKS	:	140
FULL MARKS	:	140

EXAMINER	:	MR GA COMBRINK
MODERATOR	:	MR J PROZZI 5070
NUMBER OF PAGES	:	4 PAGES

INSTRUCTIONS

1. ALL THE ANSWERS MUST BE COMPLETED IN THE EXAMINATION SCRIPT.
2. ONE POCKET CALCULATOR ALLOWED.
3. **NO** CORRECTION FLUID SHALL BE USED.

INSTRUCTIONS TO STUDENTS

PLEASE ANSWER ALL THE QUESTIONS.

QUESTION 1

1.1. What is relative humidity? And how does it change?

1.2. On clean steel what is the typical critical level of relative humidity in a normal air atmosphere?

1.3. How does pollution in the air (such as SO_2 and Soot) influence corrosion? (i.e. what effect does pollution have on the corrosion rate of steel)

[12]

QUESTION 2 Inhibitors

2.1. What is VCI and how does it work? And where and how are they typically used? (6)

2.2. Draw an Evans diagram showing how an anodic inhibitor works. (4)

2.3. On a separate sketch show using the Evans diagram depiction, how a cathodic inhibitor can typically change activity controlled cathodic reaction curve on an Evans diagram. (4)

[14]

QUESTION 3 Electrochemical Nature of Metallic Corrosion

3.1. Explain by means of a labeled diagram how a simple battery works using Cu as the cathode and zinc as the cathode and how the electrochemical nature of the reactions cause the battery to provide electrical energy for use in other devices such as a radio or cell phone or torch. Give a typical example of the half reactions that take place. (12)

3.2. Explain what half reaction is the driving force (cause) of the electrochemical reactions and why is this so? What can you do to or with this half-reaction to increase the corrosion rate and conversely how would you slow down the rate of corrosion in the same system (8)

[20]

QUESTION 4

4.1. You drop a piece of bare zinc metal into the water of a shallow fresh water river that has a pH of around 6.8 . What do you expect will happen to the zinc? (explain)

4.2. Zinc is an amphoteric element which means that it can be oxidized or reduced. Draw the Pourbaix diagram of zinc in water. On the diagram identify the various regions and indicate where corrosion occurs, where passivity may occur and also where the zinc does not react.

4.3. Give and explain three shortcomings of Pourbaix diagrams.

4.4. When zinc is placed into seawater (water with around 3.5% salt dissolved in it and a pH of around 8.2) it corrodes quite fast but when you put it in a dry place such as on the roof of a building it corrodes slowly. Explain why that is so.

[24]

QUESTION 5

5.1. When referring to the cathodic corrosion half reaction, when one says that the reaction is under diffusion control what is meant by this? Explain by means of sketching a polarization curve (potential versus the logarithm of the current density due to the reactions taking place) how the rate of corrosion versus potential is influenced.

5.2. Consider a corrosion system that is a piece of grade 316L austenitic stainless steel that is submerged in some salty water. The water is saturated with oxygen i.e. it has lots of dissolved oxygen in it. How is the system affected when the dissolved oxygen dissolved in the water is increased and explain why this is so.

5.3. If the dissolved oxygen in the water is reduced (by for instance the water is heated up or there is rotting biomass like sewage in the water that uses up all the dissolved oxygen by the action of bacteria) Show by means of a sketch how this will influence the rate of corrosion of the stainless steel.

[30]

QUESTION 6

6.1. Draw a sketch showing what knife-line-attack (KLA) is. On austenitic stainless steel what is the cause of it (KLA) and how can you prevent it from happening. (10)

6.2. What (and how much thereof) alloying element when added to iron and carbon, turns the iron base metal into stainless steel? Explain why this is so? (There are two main reasons.) Also explain how stainless steel resists atmospheric corrosion. (10)

[20]

QUESTION 7 ECSA ELO: Problem identification and solving:

Sasol hires you as part of a survey team to monitor the cathodic protection of a 50km long section of one of their 20 year old buried pipeline that conveys natural gas from Mozambique to the Sasol plant in Secunda. This involves you walking along where the pipeline is buried and taking potential measurements of the pipeline at predetermined locations where potential test posts have been erected above ground shielded wire end terminals of a wire that has the opposite end electrically connected to the buried pipe. As you walk along the pipe you find that at most points the potential that you measure is -550mV against a copper/copper sulphate reference electrode. But at a few test posts you get a zero reading. What does your survey report recommend should be done and what could have caused the values that you measured…explain in detail (one page)? [20]

TOTAL MARKS = 140
FULL MARKS = 140