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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION

JANUARY 2014 SESSION

SUBJECT CODE	:	**FTB 33103**
SUBJECT TITLE	:	**CORROSION**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**(2 HOURS)**
DATE	:	

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This question paper consists of TWO (2) sections. Section A and B. Answer ALL questions in Section A. For Section B, answer TWO (2) question only.**
6. **Answer all questions in English.**

THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

(a) Corrosion is defined as the destruction or deterioration of a material because of the reaction with its environment such as air and moisture, mine waters, steam or other gases. Explain briefly the factors listed below that need to be consider in corrosion aspects instead of environment.

(i) maintenance and operation cost

(2 marks)

(ii) effects on safety and reliability

(2 marks)

(b) Define rust?

(2 marks)

(c) Using a suitable schematic diagram as in Figure 1, describe **FOUR (4)** conditions that cause rusting.

(5 marks)

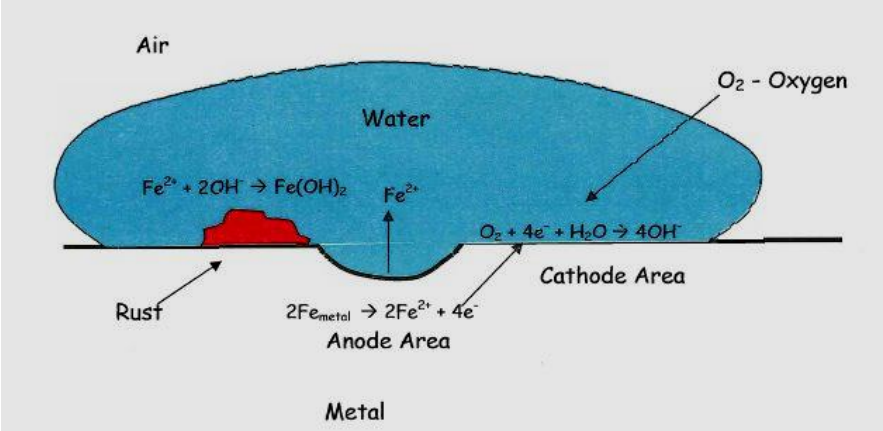

Figure 1 Corrosion mechanism

(b) In corrosion, it is suggested that the higher the temperature, the faster a given chemical reaction will proceed. Quantitatively this relationship between the rate a reaction proceeds and its temperature is determined by the Arrhenius Equation. At higher temperatures, the probability that two molecules will collide is higher. This higher collision rate results in a higher kinetic energy, which has an effect on the activation

energy of the reaction. The activation energy is the amount of energy required to ensure that a reaction happens. The equation is as below:

$$k = A \exp (- Ea/RT)$$

where *k* is the rate coefficient, *A* is a constant, E_a is the activation energy, *R* is the universal gas constant, and *T* is the temperature (in kelvin). *R* has the value of 8.314 x 10^{-3} kJ $mol^{-1}K^{-1}$.

(i) Derive the equation in logarithmic form.

(3 marks)

(ii) Arrhenius plot is useful in extracting activation energy and pre-exponential factor from experimental kinetic data. Sketch and relate the Arrhenius equation in linear plot.

(6 marks)

Question 2

(a) Calculate the oxidation number of listed element.

(i) $\underline{C}_2H_4O_2$

(ii) $H_2\underline{Pt}Cl_6$

(iii) $H_3\underline{P}O_3$

(iv) $Al(\underline{N}O_3)_3$

(4 marks)

(b) Calculate the oxidation number and state whether it is reduction or oxidation.

(i) $HV_2O_4^- \rightarrow V^{6+}$

(ii) $ClO_2^- \rightarrow ClO_4^-$

(iii) $NO_3^- \rightarrow HNO_2$

(iv) $ReO_4^- + IO^- \rightarrow IO_3^- + Re$

(v) $3As_2O_3 + 4NO_3^- + 7H_2O + 4H^+ \rightarrow 6H_3AsO_4 + 4NO$

(10 marks)

(c) Determine the oxidation state of Mn in each of the reactions and identify whether it is being oxidized or reduced.

(i) $MnO_4^- + HSO_3^- \leftrightarrow Mn^{2+} + SO_4^{2-}$

(ii) $MnO_4^- + HSO_3^- \leftrightarrow MnO_2 + SO_4^{2-}$

(iii) $MnO_4^- + HSO_3^- \leftrightarrow MnO_4^{2-} + SO_4^{2-}$

(6 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: Answer TWO (2) questions only.

Please use the answer booklet provided.

Question 3

(a) Figure 2 shows a schematic diagram of the corrosion mechanism.

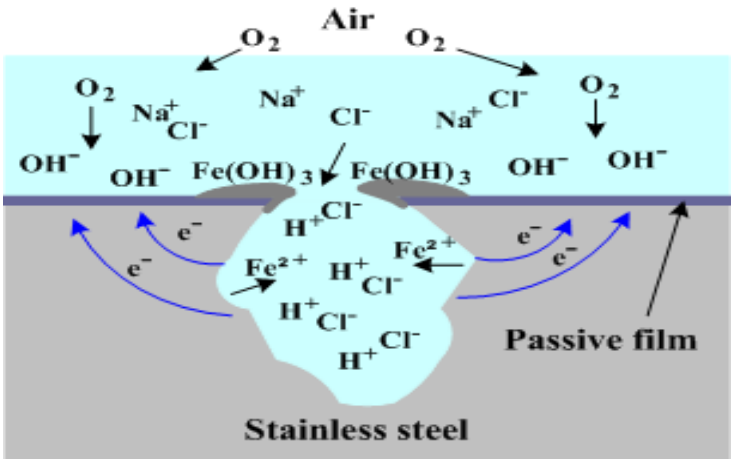

Figure 2 Schematic diagram of corrosion mechanism

(i) Identify the type of corrosion according to the schematic diagram shown in Figure 2.

(2 marks)

(ii) Describe **FOUR (4)** environmental conditions that could promote corrosion shown in Figure 2.

(8 marks)

(iii) Briefly explain how to prevent corrosion shown in Figure 2.

(8 marks)

(b) List **FOUR (4)** places where corrosion inhibitor commonly applied?

(4 marks)

(c) Briefly explain using data in Figure 3, whether carbon steel with stress relieving and non stress relieved storage tanks appropriate for NaOH solutions.

(8 marks)

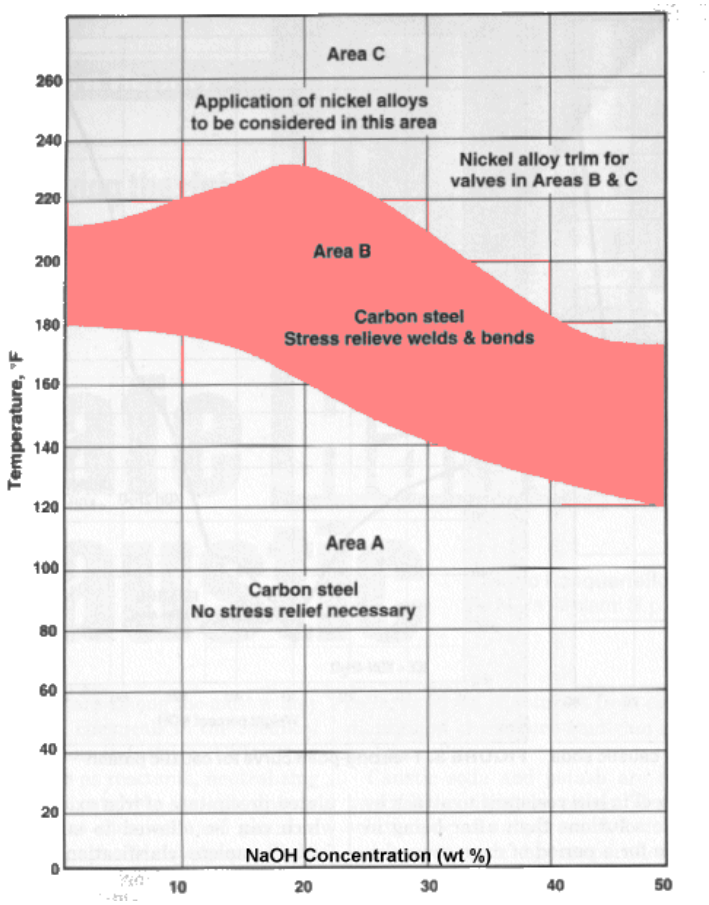

Figure 3 Stress relieved diagram

Question 4

(a) Define cathodic protection?

(4 marks)

(b) Using a suitable schematic diagram, briefly explain the principle of the following techniques.

(i) Sacrificial anode technique.

(10 marks)

(ii) Impressed current technique.

(10 marks)

(c) Describe the advantages and disadvantages of sacrificial anode against impressed current techniques.

(6 marks)

Question 5

(a) Define protective coating.

(2 marks)

(b) Describe **FOUR (4)** types of protective coating which usually used for corrosion control.

(4 marks)

(c) Hot dip coating is one of the method used to withstand the corrosion attack. Briefly define and explain the process of this technique.

(8 marks)

(d) Discuss the advantages and disadvantages of this technique.

(6 marks)

(e) Compare cathodic and anodic protections in term of applicability, environmental condition, operation cost, and equipment.

(10 marks)

END OF QUESTIONS