MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

MINING AND MINERAL PROCESSING ENGINEERING

PRINCIPLES OF MATERIAL CORROSION/ENGINEERING MATERIAL

CODE: HMIE 514/CHEP 102

SESSIONAL EXAMINATIONS

MARCH. 2021

DURATION: 3 HOURS

LECTURER: MR M MAPOSA

INSTRUCTIONS

1. *Answer all questions*
2. *Each question carries 25 marks*
3. *Total marks 100*

ADDITIONAL MATERIAL

Graph paper

QUESTION 1

(a) Define the following terms as applied to corrosion chemistry

i) Inhibitor

ii) immunity

iii) Cathodic protection

iv) Corrosion rate

v) Polarization [5 marks]

b) i) Sketch a Poubaix diagram to show the potential-pH domains where iron is under immunity, uniform corrosion, pitting and severe pitting.

ii) Briefly explain the significance of the Pourbaix diagram in the study of corrosion and prevention [11 marks]

c) i) State any **five** indirect loses as a result of corrosion. [5 marks]

ii) Briefly explain why the study of corrosion is vital to a mining or chemical engineer [4 marks]

QUESTION 2

a) Compare and contrast wet and dry corrosion [5 marks]

b) A piece of corroded steel plate was found in a submerged ocean vessel. It was estimated that the original area of the plate was 10 m^2 and that approximately 2.6 kg had corroded away during the submersion. Assuming the corrosion penetration rate of 200 mpy for this alloy in sea water, estimate the time of submersion in years. (Density of steel is 7.9 g/cm^3) [5 marks]

c) i) Distinguish between activation and concentration polarization.

ii) Under what conditions would activation polarization be rate determining?

iii) Under what conditions would concentration polarization be rate determining? [9 marks]

d) Briefly explain why

i. Cold worked metals are more susceptible to corrosion than non-cold worked metals
ii. For a small anode to cathode area ratio, corrosion rate is larger than for a larger ratio
iii. In a concentration cell corrosion will take place in an area where electrolyte is more dilute [6 marks]

QUESTION 3

a) i) Briefly describe galvanic corrosion [2 marks]

ii) Give any **two** benefits of galvanic corrosion [2 marks]

iii) State any **four** factors which affect galvanic corrosion [4 marks]

b) i) State the three groups under which the types of corrosion fall and give one example of each. [6 marks]

ii) Give **three** ways of preventing galvanic corrosion [3 marks]

c) Linings of tanks can fail because of salt contamination of the surface that remains after the surface is prepared for the application of the lining. Between 10 % and 80 % of coating failures have been attributed to residual salt contamination. The cost of reworking a failed lining of a specific tank has been estimated at $187000, 00.

i. Calculate the risk due to this type of failure assuming that 25% of failures are caused by residual salt contamination

ii. If the cost of testing and removal of contaminating salts is $6120, 00 is this additional cost justified based on the risk calculation in (i)

iii. Calculate the minimum percentage of failures caused by residual salt contamination at which the additional cost of $6120,00 for testing and removal of these salts is justified. [8 marks]

QUESTION 4

a) Figure 1 shows one of the methods used in the prevention of corrosion

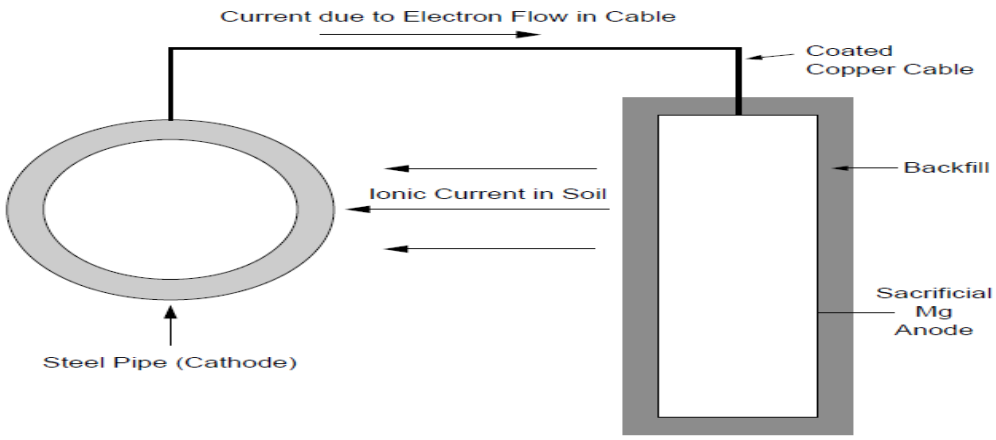


Figure 1

i) Identify and briefly explain the method of corrosion protection illustrated on the diagram [3 marks]

ii) State any two advantages and two disadvantages of this type of corrosion protection [4 marks]

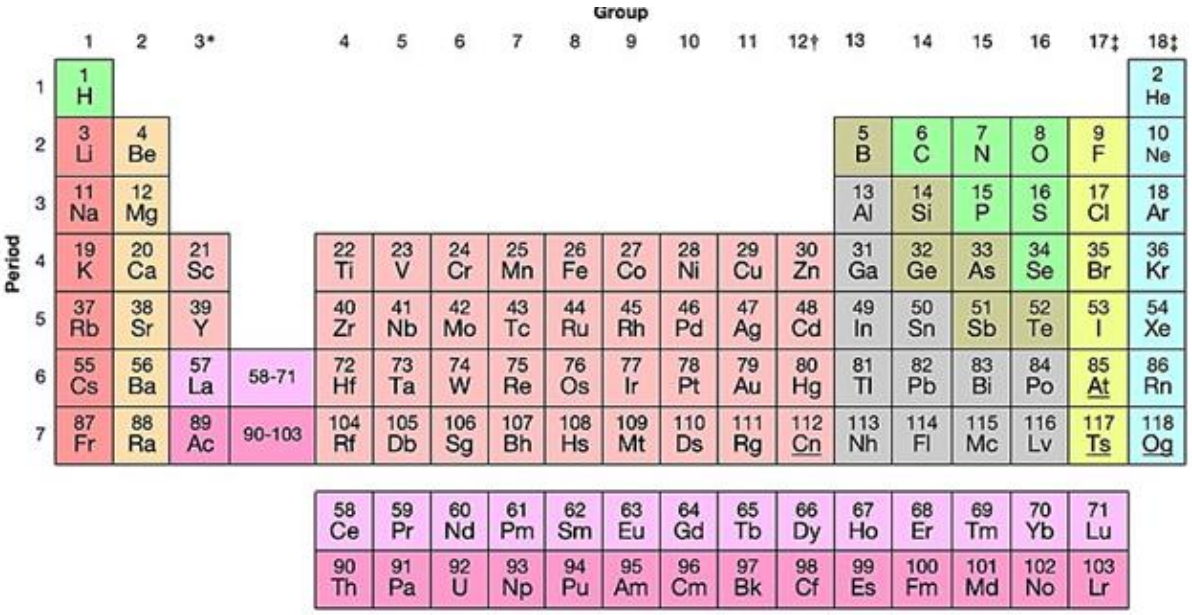
iii) Explain how alloying can also protect a metal from corrosion [2 marks]

b) i) What is high temperature corrosion? [2 marks]

ii) State and explain any four problems associated with high temperature corrosion. [8 marks]

c) Explain why pitting corrosion is most likely to provoke a more catastrophic failure than uniform corrosion. [3 marks]

d) Water entering a steel pipeline at the rate of 50 liters/min contains 6.50 mols O_2 per liter (25 °C, 1 atm).Water leaving the pipe contains 1.15 mols O_2 per liter. Assuming that all corrosion is concentrated at a heated section 40 m^2 in area forming Fe_2O_3, what is the corrosion rate in (grams per cubic meter per day) gmd? [Density of Fe is 7.87g/cm^3] [3 marks]



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