ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2019 SESSION

Open-book examination Calculators : only authorized models Duration : 3 hours

14-MT-A7 – CORROSION AND OXIDATION

Question 1 (10 points)

a) Give all the advantages and limitations of using the **Pourbaix** diagram for pure iron in predicting the corrosion resistance of a carbon steel in a marine atmosphere with chloride ions. (5 points)

b) Knowing that the electromotive forces of the half-cells are:
Sn ⇨ Sn^{2+} + + 2e- ..... - 0.136 V, and Fe ⇨ Fe^{2+}+ 2e- ..... - 0.440 V.
Calculate the ratio of tin and iron ion activities so that the tin could be the anode in a tin-iron cell at 25°C. (5 points)

Question 2 (10 points)

A commemorative copper plate fastened by steel bolts (consider pure iron for calculation) is exposed to the atmosphere of Quebec City. After 5 years, the plate support is missing.

a) Explain the possible electrochemical reactions of the corrosion cell and calculate the electromotive force of the cell at 25 ^{o}C considering:
The activity of iron ions divalent at the surface equal to unity; pH = 4 because of acid rain; the reduction reaction of hydrogen in the presence of oxygen = 1.23-0.0592 pH
(6 points)

b) Schematize the Evans diagram and the four possible elementary curves of this cell on the reduction scale and specify the two dominant curves of the corrosion cell. (4 points)

QUESTION 3 (10 points)

a) Explain the six or the seven forms of corrosion and mention the principal advantages of this classification. (7 points).

b) Explain the reasons: "The sulphur impurity or sulfur gas compound effect on steel at high temperature is more serious than the effect of oxidation with oxygen". (3 points)

QUESTION 4 (10 points)

Explain, and give examples:

a) The requirements (Material and media) that may contribute to localized galvanic corrosion rather than a uniform attack of the anode in a corrosion cell. (5 points)

b) Explain and comment on the selective dissolution of zinc or dezincification of brass (Cu-Zn) in a pH medium of hydrochloric acid at room temperature. (5 points)

QUESTION 5 (10 points)

a) Explain the phenomenon of impingement of the corrosion-erosion form and comment on the sum of different damages that are caused by this type of corrosion. (5 points)

b) Explain the harmful modalities and effects of corrosion influenced by microorganisms. (5 points)

Question 6 (10 points)

a) Explain the difference between fatigue corrosion and stress corrosion with respect to the corrosive environment, the required stresses and the morphology of crack propagation. (6 points)

b) Explain and schematize the mechanism of embrittlement by molecular hydrogen which leads to the formation of a blister. (4 points)