PAUL SCHERRER INSTITUT

Elektrochemie – P. Novák WS 2019/2020

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Übung 12: Corrosion

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Please send the solved exercise in **English** by e-mail or by post, to be received before the **15.01.2020**.

Exercise 1. General questions: (10 points)

a) Explain what is corrosion and what is the difference with erosion. Give an example for both processes.

b) Schematically draw an iron surface in contact with water (pH = 7). Which reactions are occurring on the iron surface? Where are the cathode and the anode?

c) What is the mixed potential?

d) What is the Flade potential? Draw the current-voltage curve.

e) Briefly explain a method that you can use to protect from corrosion an iron rod exposed to atmosphere.

Exercise 2. Pourbaix diagram: (5 points)

Given the Pourbaix diagram in Figure 1, answer the following questions:

a) Describe what the vertical, horizontal and diagonal lines mean.

b) What are the dashed lines? Why are they shown?

c) Write the equilibria reactions for points A, B and C.

d) Given the following parameters, which processes will occur? Write the expected product.
   i. pH = 12, E = -1.2 V :
   ii. pH = neutral, E = 0.8 V :
   iii. solution of HCl 0.0025 M, E = 0 V :

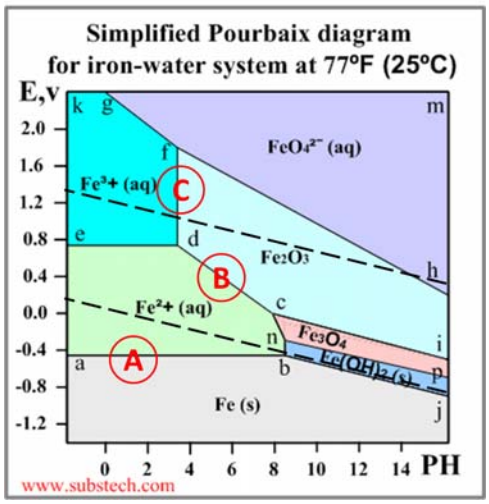

Figure 1: Pourbaix diagram of the Fe-water system.

Exercise 3. (3 points)

An iron piece is connected to a copper one and both parts are immersed in a solution containing both Fe^{2+} and Cu^{2+} ions. Answer the following questions.

a) Which metal corrodes? Give an explanation.

b) Which one is the cathode? Write the equations occurring at each electrode, assuming each metal has a valence of 2.

c) Calculate the standard reversible potential of the resulting corrosion cell.

Exercise 4. (2 points)

After keeping a steel plate for 10 years in seawater, you observe a thickness reduction of 3 mm. Considering that the dissolution reaction is mainly $Fe \rightarrow Fe^{2+}+2e^{-}$, and that the density and the atomic weight of iron are 7.8 g/cm^3 and 56, respectively, calculate the average corrosion current.

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'RUST'S A MUST'

Mighty ships upon the ocean
Suffer from severe corrosion,
Even those that stay at dockside
Are rapidly becoming oxide.
Alas, that piling in the sea
Is mostly Fe2O3.
And where the ocean meets the shore,
You'll find there's Fe3O4.
'Cause when the wind is salt and gusty,
Things are getting awful rusty.

We can measure, we can test it,
We can halt it or arrest it.
We can gather it and weigh it,
We can coat it, we can spray it.
We examine and dissect it,
We cathodically protect it
We can pick it up and drop it.
But heaven knows we'll never stop it!
So here's to rust, no doubt about it,
Most of us would starve without it.

T.R.B. WATSON (DECEASED)
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