Metals corrosion

1. The scope of the material:

Definition and types of corrosion, voltage series of metals, normal potential, types of galvanic micro-cells, passive and active states of metals.

2. Literature:

Z. Kurzawa, Chemia – skrypt PP
G. Wranglen, Podstawy korozji i ochrony metali
M. Weller, T. Overton, J. Rourke, F. Armstrong, Inorganic chemistry, Oxford University Press, 2018
C.E. Housecroft and A.G. Sharpe, Inorganic chemistry, Pearson, 2018

3. Execution of the exercise:

Aparature: Millivoltmeter
Laboratory equipment: beakers, graduated cylinder, laboratory pliers, dryer, analytic balance
Reagents: 6% NaCl, 0.6% H_2O_2, ferroxyl indicator, 1M H_2SO_4

The cleaning, etching and degreasing of the tiles is carried out at stations specially set up for this purpose.

a. Corrosion with hydrogen depolarisation

1. Measure the geometric dimensions of the carbon and acid-resistant steel with using a ruler.
2. Clean the steel surfaces with sandpaper, degrease with alcohol, etch in hydrochloric acid and dry with a dryer.
3. Next the samples are weighed on an analytical balance with an accuracy of 0.0001 g and placed in a beaker containing sulfuric acid (VI) with a concentration of 1M or 0.1M. After 30 minutes, remove the samples, wash with water, alcohol, dry with a dryer and weigh again.
4. Calculate the corrosion rate and give the corrosion rates Vc and Vp assuming an iron density of d=7.87 g/cm^3, using the formulas:

$$v_C = \frac{\Delta m}{s \cdot t} \qquad v_P = \frac{v_C \cdot 365}{1000 \cdot d}$$

Vc – [g/m^2·24 hours]
Vp – [mm/year]

b. Corrosion with oxygen depolarization

1. Prepare 200 cm^3 of a solution with the composition of 3% NaCl and 0.3% H_2O_2 by mixing equal volumes of 6% NaCl and 0.6% H_2O_2 and 100 cm^3 of the second solution by mixing 50 cm^3 of distilled water and 50 cm^3 of 6% NaCl. Divide the first solution into two beakers.
2. Next clean one plain steel plate and one stainless steel plate with sandpaper, degrease in methanol, wash with distilled water, dry with blotting paper, weigh to the accuracy 0.001 g and place in the prepared solutions for 45 minutes. Observe the changes occurring on the surface of the plates,

describe the reactions taking place. Place a similarly prepared carbon steel plate in a 3% NaCl solution. After 45 minutes, wash the plates with water, dry with a drier. All samples should be cleaned of corrosion products and weighed.

3. Calculate the corrosion rates as in the point above and assess the effect of oxygen from decomposition H_2O_2.

c. Preparing an oxygen concentration cell (Evans test)

On a plain steel plate cleaned with sandpaper, apply a few drops of ferroxide indicator and observe the color changes in the drops. The ferroxide indicator is a mixture of two indicators: for the detection of Fe^{2+} ions - it turns blue and for the detection of OH^- ions - it turns raspberry. Describe the phenomenon and explain the action of oxygen. Write down the corresponding reactions.

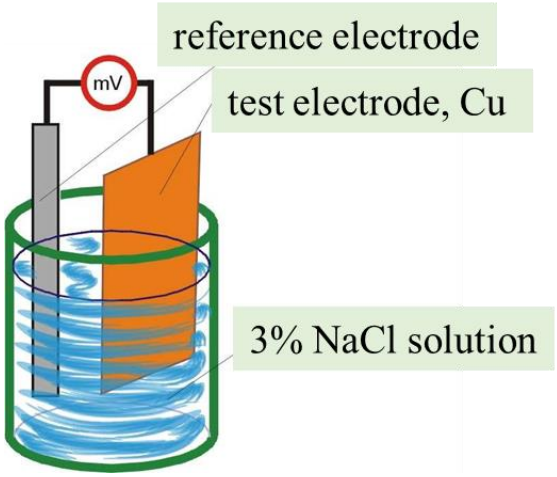
d. Determination of electrode potentials (Fe, Cu, Ni, Al)

After mechanical cleaning and degreasing of Fe, Cu, Ni and Al plates (do not etch in HCl), build a cell from them and from the calomel electrode according to the scheme (1).
Measure the SEM of the constructed cells every 15 s from the moment the electrodes are immersed in the 3% NaCl solution for a period of 4 minutes.
The results put in a table and prepare a graph (x-axis - time, y-axis - electrode potential relative to the reference electrode).
Calculate and record the normal potentials of the metals relative to the hydrogen electrode and compare them with the normal potentials contained in the tables.

Perform calculations using the formula:

$$E = E_1 - E_2$$

E_1 - potential of the positive electrode,
E_2 - potential of the negative electrode.



Scheme (1)