

Exercise 1:

Consider an alkaline water electrolysis cell with a manganese (Mn) coated nickel (Ni) anode and a platinum (Pt) coated Ni cathode submerged in a KOH solution and separated by a porous diaphragm.

Assume the following values:

$R_{cat} = 0.2 \, \Omega \, cm^2$ for the cathodic resistance

$R_{an} = 2 \, \Omega \, cm^2$ for the anodic resistance

$R_s = 1 \, \Omega \, cm^2$ for the serial resistance composed of the diaphragm and the KOH electrolyte

$C_{cat} = 10 \, \mu F \, cm^{-2}$ for the cathodic capacitance

$C_{an} = 1 \, mF \, cm^{-2}$ for the anodic capacitance

- Construct the equivalent circuit of the electrolysis cell.
- Using the assumed parameters, formulate the total impedance of the system Z_{tot} .
- Using the formula developed in part b, Plot the Nyquist and Bode diagrams for the frequencies ranging from 1 MHz to 10 mHz (use Excel/MATLAB).
- Assume the anode was replaced by a $NiFeO_x$ anode, and the anodic capacitance and resistance are now changed to $C_{an} = 100 \, \mu F \, cm^{-2}$ and $R_{an} = 2 \, \Omega \, cm^2$ respectively. Replot the Nyquist and Bode diagrams and conclude.

Exercise 2:

Exercise about charge/energy density, comparison fuel cell with battery.

- Compute the energy density of a portable polymer electrolyte fuel cell (PEFC), weighing 100 g, including a 30 ml metal-hydride tank which stores 3 g of hydrogen (molar mass $H_2 = 2 \, g/mol$). The working discharge voltage of the fuel cell is admitted to be constant throughout at 0.6 V.
- Same computation as before, but this time with a 30 ml methanol storage tank instead of hydrogen (LHV MeOH = 5 kWh/L).
- If we run a portable electronic device from this fuel cell, consuming on average 10 We, for how long can it run until full discharge from H_2 , respectively methanol, before a refill is necessary ?
- compare to a 100 g battery with an energy density of 200 Wh/kg.