Ministry of Higher Education and Scientific Research
University of Biskra
Faculty of Science and Technology
Department of Electrical Engineering

Practical work $N^{\circ} - 4$

Fuel cell modeling

1 Static model

The following equation expresses the DICK model:

$$V = E_0 - A\log\left(\frac{I+i_n}{i_0}\right) - R_m(I+i_n) - B\log\left(1-\frac{I+i_n}{i_{Lim}}\right) \quad (1)$$

Where:
E_0 :Reversible voltage without loss of the fuel cell.
$i_0 = 0.36$is the exchange current, $A = 0.05$ is the slope of the Tafel line, $i_{Lim} = 100A$ is the limiting current,$B = 0.205$ is the constant in the mass transfer, $i_n = 0.5$ is the internal current and $R_m = 1.4\ mohm$ is the membrane and contact resistances.

1.1 Questions

① Realize equation 1 with simulink Matlab ?

② Draw the (I-V) characteristic of the fuel cell in the scope ?

③ Draw the (I-P) characteristic of the fuel cell in the scope ?

④ Plot (I-V) and (I-P) features in high quality ?

⑤ Interpret the 2 characteristics (I-V) and (I-P) zones?

⑥ Explain the different zones?

⑦ Study the influence of each parameter on the (I-V) characteristic?

⑧ Modify the program and deduce the losses?

⑨ Plot the (If(t)) and (Vf(t)) characteristics in high quality, and interpret the curves?

⑩ What is the point of this model, and what's your conclusion ?

2 Dynamic model

model is shown in Figure 1 It models the activation polarization, the concentration polarization, the ohmic polarization $R_{ohm} = 0.0024ohm$ and the Nernst voltage $E_{nerst} = 0.84$. The activation losses and concentration losses $R1 = Ract + Rconc = 0.0013ohm$, is related to double layer capacitance. Rohmic is related to the flow of hydrogen and electrons. The capacitor C is the charge double layer, which delays the dissipation of electronic charges near electrolyte/electrode interface $C1 = 0.1F$.

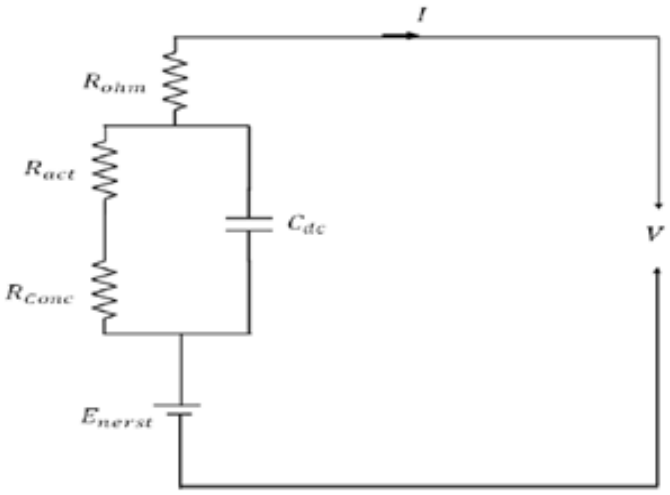

Figure 1: Equivalent circuit dynamic model .

2.1 Questions

❶ Demonstrate the expression for the voltage across the fuel cell?

❷ Realize this expression in Simulink , and plot the (I-V) and (I-P) characteristics in high quality?

❸ Interpret the 2 characteristics (I-V) and (I-P)?

❹ Study the influence of each parameter on the (I-V) characteristic?

❺ Deduce possible losses?

❻ What is the interest of this model?

❼ What is your conclusion?