HOMEWORK VI Solution

1)

One can get the equilibrium fuel cell voltage from the following equation:

$$\varepsilon = \frac{-\Delta G_r(T,P)}{n_e F} \qquad \text{Eq.(1)}$$

Note that ΔG_r is the function of *T* and *P*. Using Equil, one can get $-\Delta G_r(T=353K, P=150kPa)$=230kJ/(mole of H2). Using Eq.(1), we get

$$\varepsilon = \frac{230kJ/mole}{2*96485C/mole} = 1.19Volt$$

2)

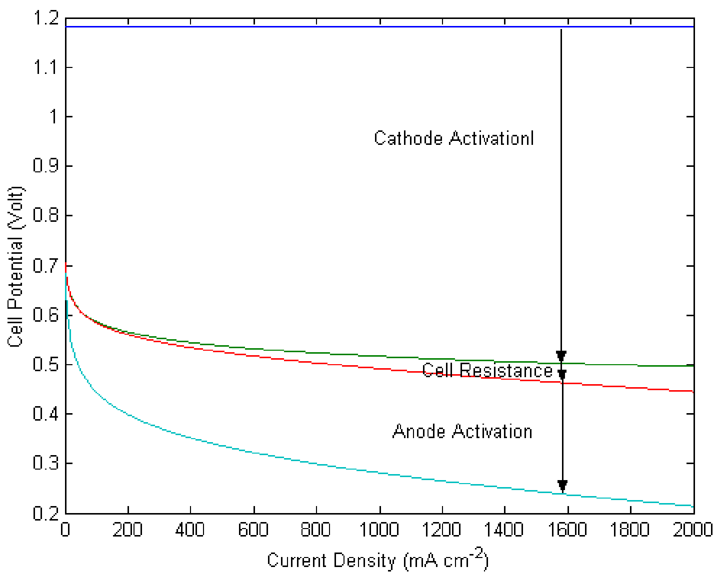
$$\eta_{a,\text{cathode}} = \frac{RT}{\alpha n_e F}\ln\left(\frac{i_{o,cathode}/A}{i/A}\right)$$

$$\eta_{a,\text{anode}} = -\frac{RT}{(1-\alpha)n_e F}\ln\left(\frac{i_{o,anode}/A}{i/A}\right)$$

$$\eta_\Omega = i\cdot R_\Omega = \frac{i}{A}\cdot R_\Omega A$$

$$\varepsilon_{cell} = \varepsilon_r - \eta_\Omega - |\eta_{a,\text{cathode}}| - |\eta_{a,\text{anode}}|$$

Assuming α =0.5 , we get the following plot



3)

$$\eta_{second} = \frac{W_{out}}{\Delta H_r} = \frac{\dot{W}_{out} / A}{\Delta \dot{H}_r / A}$$

$$\Delta \dot{H}_r / A = \Delta \hat{h}_r \cdot \frac{i}{A} \cdot \frac{1}{2F} = 284 kJ / mol \cdot \frac{1}{2 \cdot 96485 C / mol} \cdot \frac{i}{A} = 1.47 \cdot 10^{-3} \frac{i}{A} (W / m^2)$$

$\dot{W}_{out}$ = current density x cell potential (W/m^2)