

**CHG 8191L  
Electrochemical Engineering  
Winter 2016**

**Professor: Dr. Elena Baranova**

**January 19, 2016**

**DATE DUE: January 27, 2016 before the lecture at 8:30 am**

**Assignment 1**

**Problem 1**

Calculate the output potential and current of a stack of 10 PEM fuel cells operating at  $80^{\circ}\text{C}$  and atmospheric pressure with pure  $\text{H}_2$  and pure  $\text{O}_2$  and producing a power of 6 kW with an electrochemical efficiency of 60%.

Neglect the effect of gas saturation by water vapour pressure.

**Problem 2**

Calculate the hydrogen supply (mol/h) needed to operate at  $75^{\circ}\text{C}$  and atmospheric pressure a stack composed of 20 PEM fuel cells fed with pure  $\text{H}_2$  and air, when it produces a power of 1 kW with an electro-chemical efficiency of 65% and a conversion efficiency of 50%.

Neglect the effect of gas saturation by water vapour pressure.

**Problem 3**

Calculate the amount of heat (Q) released to the environment during 2 hour of isothermal operation of a 500W PEM fuel cell working with pure  $\text{H}_2$  and pure  $\text{O}_2$  at 0.75 V ( $T = 25^{\circ}\text{C}$ ).

**Problem 4**

In a unit the same cell serves as electrolyzer (production then storage of the formed hydrogen as a hydride) and fuel cell (production of electricity using the stored hydrogen). Given that both units operate at the same current density, the electrolysis potential was 2.7 V and the fuel cell potential was 0.7 V, calculate the total efficiency of the system considering 100% conversion efficiency.

Note: consider the following numerical data when solving problems from Module 1

## General

	$\Delta H_f^\circ$	$S^\circ$	$C_p^\circ$
	kJ / mol	J / mol K	J / mol K
C	0	5.73	8.52
H <sub>2</sub>	0	130.5	28.8
O <sub>2</sub>	0	204.8	29.3
CH <sub>4</sub>	-74.6	186.3	35.3
CO	-110.5	197.7	29.1
H <sub>2</sub> O (l)	-285.8	69.9	75.2
H <sub>2</sub> O (g)	-241.8	188.8	33.5

Standard (1 atm, 298 K) equilibrium potential :  $E_{eq}^\circ = 1.229V$

Consider : 1 atm  $\approx$  1 bar valid for  $H_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons H_2O(l)$

Water vapor pressure (at  $40^\circ C \leq T \leq 60^\circ C$ ) :  $p_{H_2O}(mbar) = 1.286 \cdot 10^{-5} e^{0.04966T(K)}$