Renewable Energy Systems 402

Tutorial 7

Fuel Cell Systems

1. Find the change in enthalpy of formation of methane (CH_4) in kJ/mol and kJ/kg when it is oxidized to CO_2 and liquid H_2O at Standard Temperature and Pressure (STP). The enthalpy of formation of reactants and products at STP are given below.
   CH_4 (g) = -74.9 kJ/mol; O_2 (g) = 0; CO_2 (g) = -393.5 kJ/mol
   H_2O(l) = -285.8 kJ/mol

   (Ans: -890.2 kJ/mol, -55637.5kJ/kg)

2. The enthalpy of formation (h_f) and entropy (s) of both reactants and products of a hydrogen fuel cell at 100°C and standard pressure are given in Table-1. Calculate the following per cell at the standard pressure.

   (i) Change in Gibbs Free Energy of formation (Δg_f)
   (ii) Maximum Efficiency
   (iii) Maximum EMF
   (iv) Maximum EMF as a percentage of that at STP.

   Table-1

	Enthalpy of Formation (J/mol)	Entropy (J/mol/K)
Hydrogen (H_2)	2188	131
Oxygen (O_2)	2271	206
Steam (H_2O)	-239276	187.4

   Note: Faraday constant is F = 96485 Coulombs.

   (-225217.7 J/mol, 92.83%, 1.167 V, 5.12%,)

3. The pressure of reactants and products given in Problem 2 are changed as given below while maintaining the temperature at 100°C. Calculate the percentage change in maximum EMF, with respect to the value at standard pressure calculated in Problem 2, part (iii).
   (a) Partial Pressure of Hydrogen = 10 bar, the partial pressures of others remaining unchanged.
   (b) Overall pressure at both anode and cathode increased to 10 bar.

   (3.17%, 1.58%)