ME 417
Design of Alternative Energy Systems

Quiz #3 Solution

A direct methane-water fuel cell operates with the following overall reaction

$$CH_4 + 2O_2 + 2(3.76)N_2 \rightarrow CO_2 + 2H_2O + (7.52)N_2$$

Determine the specific electric work and ideal voltage of this fuel cell at 320 K.

Equations and Data for Quiz #1

Enthalpy and Entropy Data

	CH_4	O_2	N_2	CO_2	H_2O
$\bar{h}_f\,(kJ/kmole)$	-74,850	0	0	-393,520	-241,820
$\bar{h}^o_{298}\,(kJ/kmole)$	8,248	8,682	8,669	9,364	9,904
$\bar{h}^o_{320}\,(kJ/kmole)$	9,046	9,325	9,306	10,186	10,639
$\bar{s}^o_{298}\,(kJ/kmole\cdot K)$	186.16	205.04	191.61	213.80	188.83

$$\bar{h} = \bar{h}_f + \Delta\bar{h}$$

$$\bar{s}_i = \bar{s}_i^o - R_u \ln(y_i) \quad \text{with } R_u = 8.314 \text{ kJ/(kmole·K)}$$

$$y_i = \frac{\nu_i}{\sum_j \nu_j}$$

$$\bar{w}_{elec} = \sum_{reactants} \nu_i \bar{h}_i - \sum_{products} \nu_j \bar{h}_j - T_{FC}\left\{\sum_{reactants} \nu_i \bar{s}_i - \sum_{products} \nu_j \bar{s}_j\right\}l$$

$$V_{ideal} = \frac{\bar{w}_{elec}}{(96{,}487)N_e}$$

Fro a general hydrocarbon fuel, $C_xH_yO_z$

$N_e = 4x+y-2z$