Department of Energy and Prosess Engineering, NTNU
TEP4125 Energy management and -technology, Thermodynamics-part
EP8110 Exergy analysis

ise,apr03/nov08

Hints and answers, Exercise 6

(note: decimal sign here is comma)

a) put up the 1st law for the heat exchanger (adiabatic: enthalpy only; no reaction, $\Delta\dot{H} = \dot{m}C_p\Delta T$ for each stream). The only unknown is T_7 = 1155 K (For2); similarly T_8 = 357 K (For1).

b) Extract from spreadsheet:

Stream No.	m/m_1	T (K)	(H-H0)/m1	(S-S0)/m1	E_tm/m1	E/m1
1	1	298	0	0	0	118298,6
2	205	298	0	0	0,0	0,000
3	1	1100	11388,4	18,54	5862,0	124160,7
4	205	1100	164410,0	267,72	84628,2	84628,2
5	206	1200	185812,0	286,95	100299,5	112530,8
6	206	1210	187872,0	288,66	101850,1	103209,7
7	206	1154,7	176483,6	279,03	93332,5	94692,1
8	206	356,6	12073,6	36,99	1051,5	2411,0

Reaction i fuel cell (FC) and afterburner(AB)
H2+lambda*0,5*(O2+3,76N2) -> (1-a)H2 + a H2O + (lambda-a)*0,5*O2+lambda*1,88*N2
excess air ratio=lambda =6, fuel conversion=a=0,9 after FC, a=1 after AB

lambda=	6	a_5=	0,9				
	M_i (kg/kmol)	x_i,e	e_ch,i (kJ/kmol)	n_i,5/n1	x_i,5	n_i,6/n1	x_i,6
H2	2,016		238490	0,1	0,007	0	0,000
H2O	18,015		11710	0,9	0,061	1	0,068
O2	32,00	0,21	3866,62	2,55	0,172	2,50	0,169
N2	28,01	0,79	584,02	11,28	0,761	11,28	0,763
sum				14,83	1,000	14,78	1,000

Stream No.	x_H2	x_H2O	x_O2	x_N2	molar mass	sum(x_i*lnx_i)	e_ch (kJ/kmol)	e_ch (kJ/kg)
1,3	1	0	0	0	2,016	0	238490	118298,6
2,4	0	0	0,21	0,79	28,848	-0,5140	0	0,0
5	0,007	0,061	0,172	0,761	27,914	-0,7146	1657,4	59,4
6,7,8	0	0,068	0,169	0,763	28,009	-0,6890	184,9	6,6

c-e) extract from spreadsheet

	(everything per kg of stream 1) dH(in-out)	dS(in-out)	dE(in-out)	Irrev	Irrev/dH	W	Q
For1Cold	-164410,0	-267,7	-84628,2				
For1Hot	164410,0	242,0	92281,1	7652,9	0,0465	0	0
For2Cold	-11388,4	-18,5	-5862,0				
For2Hot	11388,4	9,6	8517,6	2655,5	0,2332	0	0
FC fu.conv.	0,9						
FC	97986,4		96258,1	2771,7		93486,4	-4500
AB	9940		9320,9	9320,9		0	-9940
total balance			115887,4	22401,0		93486,4	