ise,may03/oct10

Hints and answers, Exercice 4

(note: decimal sign here is comma) (note2: the numbers depend to some extent on round-off errors)

Problems

a) Determine the temperature after compression as in Exercise 2, Problem 1 (707 K). Then, energy balance for the combustion chamber. Answer: 1695 K
b) Calculate physical (thermomechanical) exergi. (Gas constant approx. as for air). Neglect chemical exergy in the flue gas (cf. problem text). Answer: 56,1 MJ/kg fuel.
c) Put up the exergy balance (neglect chemical exergy in flue gas). Answer: 15,3 MJ/kg fuel.
d) 20,9 MJ/kg fuel
e) 280 kJ/kg flue gas; 12,9 MJ/kg fuel
f) In relation to other quantities, the pump work (from 1 to 3 bar) is very small and can be neglected. First, find the saturation temperature for water/steam at 3 bar. The limiting temperature difference i usually at the state of saturated water (i.e. before evaporation). At this point, the flue gas temp should be 20 K higher. The maximum amount of steam is found from the energy balance for the evaporation and superheating. The remaining thermal energy of the flue gas is used to preheat this amount of water to saturation. Check whether this cools the flue-gas temperature becomes lower than 60 ºC. (ok here; otherwise the limiting temperature difference would be at the outlet). Answer: 0,22 kg steam/kg flue gas; 10,2 kg steam/kg fuel.
g) Use exergy balance or entropy balance. Answers: fuel compressor 29,8 kJ/kg fuel; air compressor 1341 kJ/kg fuel; turbine 1651 kJ/kg fuel; boiler 6040 kJ/kg fuel; lost w, flue gas 107 kJ/kg fuel.

Hints and answers, Exercice 5

Problem 1

a) 44525 kJ/kg, 46434 kJ/kg ; b) 1587 K; c) 23,3 kJ/kg; d) 13038 kJ/kg

Problem 2

- Here, it is convenient to calculate all quantities per kmol of CH4.
- Put up an energy balance to determine how much air that is used. Use heating values from App.A in Kotas (or from some other book, alternativly calculate from ethalpies of formation) and specific heats from App.D (notice that there is one table of Cp for calculating enthalpy differences and one for calculating entropy differences – these are almost equal). Use an average value or the value for the temperature in the middle of the relevant interval.
- Determine the physical (thermomechancal) and chemical exergy in the reactant mixture and in the product, and the change of (physical) eksergy in the air.
- Put up the exergy balance and determine the irreversibility:

Answer, per kmol CH4: a) 12,2MJ (1,45% of the chem. exergy of methane) b) 19,8 MJ (2,3 %).
(The exact answers will depend on the chosen values for Cp, etc.)