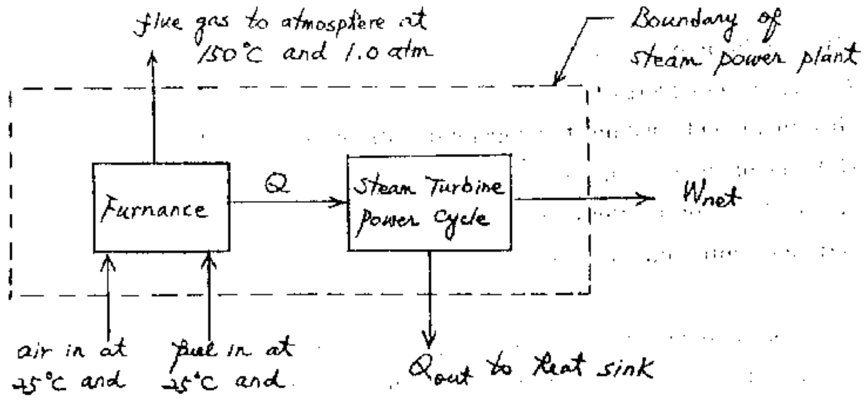
國立中央大學八十七學年度碩士班研究生入學試題卷

所別: 機械工程研究所 丙組 科目: 熱力學 共 2 頁 第 1 頁

1. Let us divide a steam power plant into two parts, the furnance and the steam turbine power cycle, as shown below. The specification are as follows: (a) net power output = 10^6 kW, (b) thermal efficiency of steam turbine power cycle = 40%, (c) temperature of air supply = 25°C, (d) pressure of air supply = 1.0 atm, (e) temperature of fuel (CH_4) supply = 25°C, (f) pressure of fuel supply = 1.0 atm, (g) excess air used for combustion = 10%, (h) temperature of flue gas = 150 °C, (i) pressure of flue gas = 1.0 atm. Determine: (1) the chemical equation, (2) heat transferred out of the furnance for each kgmole of fuel burned, (3) fuel consumption (in kg/hour) of such a power plant. Follow data may be found to be useful:
   (a) enthalpy of formation (kJ/kgmole) for different gases are: CO_2: -393,790, CH_4: -74,920, $H_2O(g)$: -242,000.
   (b) assume the flue gas is an ideal-gas mixture, with constant specific heats. The specific heats, kJ/(kgmole·K), for different gases are: CO_2: 37.2539, H_2O: 33.6693, O_2: 29.4315, N_2 = 29.0784. (20%)
   (c) 1 W = 1 J/s.



2. If we have a mixture of CH_4, CO_2, OH, CO, H_2O and O_2 in equilibrium, write out all possible chemical reaction equations involved. (Note: take independent variables in the order of CH_4, CO_2, OH, CO, etc, as given above.) (10%)

3. A supply line of saturated ammonia liquid at 0°C, 430 kPa (enthalpy of 180.36 kJ/kg) is used to fill a 0.05 m^3 container initially storing ammonia at 20°C, 100 kPa (specific volume of 1.4153 m^3/kg; enthalpy of 1516.1 kJ/kg). The supply line valve is closed when the pressure inside reaches 290.9 kPa. Find the final mass and temperature in the container. (Hint: assuming there is no heat loss.) (20%)

TABLE A.2SI *Thermodynamic Properties of Ammonia*
TABLE A.2.1SI *Saturated Ammonia (SI Units)*

Temp. °C	Abs. Press. kPa P	Specific Volume, m³/kg Sat. Liquid v_f	Evap. v_{fg}	Sat. Vapor v_g	Enthalpy, kJ/kg Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Entropy, kJ/kg K Sat. Liquid s_f	Evap. s_{fg}	Sat. Vapor s_g
-40	71.72	0.001450	1.55124	1.55269	0	1388.82	1388.82	0	5.9568	5.9568
-38	79.74	0.001455	1.40482	1.40627	8.81	1383.13	1391.94	0.0376	5.8820	5.9196
-36	88.48	0.001460	1.27461	1.27607	17.64	1377.39	1395.03	0.0749	5.8082	5.8831
-34	97.98	0.001465	1.15857	1.16004	26.49	1371.58	1398.07	0.1120	5.7353	5.8473
-32	108.29	0.001471	1.05496	1.05643	35.36	1365.70	1401.06	0.1489	5.6634	5.8123
30	119.46	0.001476	0.96226	0.96374	44.26	1359.76	1404.01	0.1856	5.5924	5.7780
-28	131.54	0.001482	0.87916	0.88064	53.17	1353.74	1406.92	0.2220	5.5223	5.7443
-26	144.59	0.001487	0.80453	0.80602	62.11	1347.66	1409.77	0.2582	5.4530	5.7113
24	158.65	0.001493	0.73738	0.73887	71.07	1341.51	1412.58	0.2942	5.3846	5.6788
-22	173.80	0.001498	0.67685	0.67835	80.05	1335.29	1415.34	0.3301	5.3170	5.6470
-20	190.08	0.001504	0.62220	0.62371	89.05	1329.00	1418.05	0.3657	5.2501	5.6158
-18	207.56	0.001510	0.57277	0.57428	98.08	1322.64	1420.71	0.4011	5.1840	5.5851
-16	226.29	0.001516	0.52800	0.52951	107.12	1316.20	1423.32	0.4363	5.1187	5.5550
-14	246.35	0.001522	0.48737	0.48889	116.19	1309.68	1425.88	0.4713	5.0541	5.5254
-12	267.79	0.001528	0.45045	0.45197	125.29	1303.09	1428.38	0.5061	4.9901	5.4963
-10	290.67	0.001534	0.41684	0.41837	134.41	1296.42	1430.83	0.5408	4.9269	5.4676
-8	315.08	0.001540	0.38621	0.38775	143.55	1289.67	1433.22	0.5753	4.8642	5.4395
-6	341.07	0.001546	0.35824	0.35979	152.72	1282.84	1435.56	0.6095	4.8023	5.4118
4	368.72	0.001553	0.33268	0.33423	161.91	1275.93	1437.84	0.6437	4.7409	5.3846
2	398.10	0.001559	0.30928	0.31084	171.12	1268.94	1440.06	0.6776	4.6801	5.3577

注意:背面有

4. One kg of saturated water at 100˚C is condensed to a saturated liquid at 100˚C in a constant-pressure process by heat transfer to the surrounding air, which is at 300 K. What is the increase in entropy of the water plus surroundings? Suppose that an engine operating on the Carnot cycle received heat from the water and rejected heat to the surroundings. Therefore the heat transfer from the water to the surroundings is taken place reversibly. What is the work output of the Carnot-cycle engine. (Note that at 100˚C, h_{fg}=2257.0 kJ/kg and s_{fg}=6.0480 kJ/kgK) (15%)

5. Please check the following descriptions that appropriately related to "Heat Transfer" or "Thermodynamics". (6%)

	Heat Transfer	Thermodynamics
(i) equilibrium process	☐	☐
(ii) amount of energy transfer	☐	☐
(iii) energy in transit due to temperature difference	☐	☐
(iv) rate of energy transfer	☐	☐
(v) end state of transfer process	☐	☐
(vi) nonequilibrium process	☐	☐

6. You are requested to design an experimental facility to determine the average convection heat transfer coefficient for water heating in a copper tube of uniform cross section area. (19%)
(i) Sketch a complete schematic diagram of the experimental facility. Describe all of the components of this test system. (5%)
(ii) List all of the data to be taken. (4%)
(iii) Write down all data reduction equations to obtain the average convection heat transfer coefficient from original data you measured. (10%)

7. The variation of temperature in a flat plate with heat generation rate s is during a steady state process. The conductivity of that wall is 1.0 W/mK. (10%)
(i) Estimate the heat flux q"1 and q"2 on both side of the wall.
(ii) What is the heat generation rate s per unit volume of the plate?