⑧⑨學年度 國立成功大學
碩士班招生考試 化學工程系所（甲組） 化工熱力學 試題 共 1 頁 第 1 頁

1. A reversible compression of 1 mol of an ideal gas in a piston/cylinder device results in a pressure increase from 1 bar to P_2 and a temperature increase from 300 K to 900 K. The path followed by the gas during compression is given by

$$PV^{1.5} = constant$$

and the molar heat capacity of the gas is given by

$$C_P / R = 3.5 + 0.5 \times 10^{-3} T \qquad [T = K]$$

Determine the final pressure, the heat transferred and the work done on the surrounding during the process.

(16%)

2. An ideal gas, C_P=(7/2)R, is heated in a steady-flow heat exchanger from 70℃ to 190℃ by another stream of the same idea; gas which enters at 320℃. The flow rates of the two streams are the same, and the heat losses from the exchanger are negligible.
   (a) Calculate the molar entropy changes of the two gas streams for both parallel and countercurrent flow in the exchanger.
   (b) What is ΔS_{total} in each case?

(18%)

3. The excess Gibbs energy of a binary liquid mixture at T and P is given by

$$\frac{G^E}{RT} = (ax_1 + bx_2)x_1x_2$$

Derive the expressions for lnγ_1 and lnγ_2 for the given T and P.
(γ_1 and γ_2 : activity coefficients)

(16%)

4. (a) An inventor claims to have developed a power cycle capable of delivering a net work output of 410 kJ for an energy input by heat transfer of 1000 kJ. The system undergoing the cycle receives the heat transfer from hot gases at a temperature of 500 K and discharges energy by heat transfer to the atmosphere at 300 K. Evaluate the claim. (8%)

   (b) A house requires 5×10^5 Btu per day to maintain its temperature at 70 °F when the outside temperature is 50 °F. If a heat pump cycle (similar to a refrigeration cycle) is used to supply the energy, determine the minimum theoretical work input for one day of operation, in Btu. (8%)

5. Steam enters an adiabatic turbine steadily at 3 MPa and 400 °C and discharges at 50 kPa. (a) If the actual discharging temperature is found to be 100 °C, determine the (isentropic) efficiency of the turbine. (b) If the power output of the turbine is 2000 kJ/s, determine the mass flow rate of the steam flowing through the turbine.

(20%)

steam properties

3 MPa, 400 °C: superheated, H = 3231 kJ/kg, S = 6.92 kJ/(kg K)
50 kPa: at saturation, T = 81 °C, H^{liq} = 341 kJ/kg, S^{liq} = 1.09 kJ/(kg K)
H^{vap} = 2646 kJ/kg, S^{vap} = 7.59 kJ/(kg K)
50 kPa, 100 °C: superheated, H = 2683 kJ/kg, S = 7.70 kJ/(kg K)

6. Derive the entropy change of mixing in terms of the mole fractions for ideal gases at constant temperature and pressure. A stream of nitrogen flowing at the rate of 2 kg/s and a stream of hydrogen flowing at the rate of 0.5 kg/s mix adiabatically in a steady-flow process. If the gases are assumed ideal, what is the rate of entropy increase as a result of the process? (14%)