PROBLEM 12.26 (Contd.)

Oxygen: initially is at 400 K, 5 bar and finally at 360K and the partial pressure 0.945 bar. With $\bar{s}^\circ$ data from Table A-23

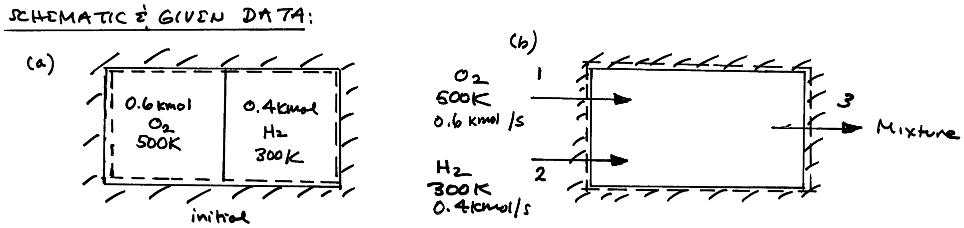
$$(\Delta S)_{O_2} = 0.025\left[210.604 - 213.765 - 8.314 \ln \frac{0.945}{5}\right] = 0.2673 \frac{kJ}{K} \quad \leftarrow (\Delta S)_{O_2}$$

PROBLEM 12.27

KNOWN: Two cases involving the mixing of O_2 and H_2 are specified.

FIND: For each case determine the mixture temperature.

SCHEMATIC & GIVEN DATA:



ASSUMPTIONS: (1) For case (a), a closed system consisting of the O_2 and N_2 is the system. For case (b), a control volume at steady state is the system. (2) For each system, $\dot{Q} = 0$, $\dot{W} = 0$ (except for flow work in (b)), and there are no significant kinetic/potential energy effects. (3) Each gas and the overall mixture behaves as an ideal gas. The Dalton mixture model applies. (4) Appropriate constant specific heats are employed.

ANALYSIS: (a) An energy balance reduces to read $\Delta U = \cancel{Q}^{\,0} - \cancel{W}^{\,0}$, or $\Delta U = 0$. That is

$$[n\,\Delta\bar{u}]_{O_2} + [n\,\Delta\bar{u}]_{H_2} = 0 \qquad (1)$$

Since the initial temperature difference is just 200K, and c_v does not vary significantly over such an interval, an appropriate constant c_v can be used for each gas. Thus, with data from Table A-20 at 400K, Eq. (1) reads

$$[n(c_v M)[T_f - T_i]]_{O_2} + [n(c_v M)[T_f - T_i]]_{H_2} = 0$$

$$\Rightarrow \quad (0.6)(0.681 \times 32)[T_f - 500] + (0.4)(10.352 \times 2.016)[T_f - 300] = 0 \Rightarrow T_f = 422K \leftarrow$$

(b) An energy rate balance reduces to read

$$0 = \cancel{\dot{Q}_{cv}}^{\,0} - \cancel{\dot{W}_{cv}}^{\,0} + \dot{n}_{O_2}\bar{h}_{O_2}(T_1) + \dot{n}_{H_2}\bar{h}_{H_2}(T_2) - [\dot{n}_{O_2}\bar{h}_{O_2}(T_3) + \dot{n}_{H_2}\bar{h}_{H_2}(T_3)]$$

or

$$0 = \dot{n}_{O_2}[\bar{h}_{O_2}(T_1) - \bar{h}_{O_2}(T_3)] + \dot{n}_{H_2}[\bar{h}_{H_2}(T_2) - \bar{h}_{H_2}(T_3)] \qquad (2)$$

Then, with c_p for each gas from Table A-20 at 400K we get

$$0 = \dot{n}_{O_2}[(c_p M)_{O_2}[T_1 - T_3]] + \dot{n}_{H_2}[(c_p M)_{H_2}[T_2 - T_3]]$$

$$0 = (0.6)[(0.941 \times 32)[500 - T_3]] + (0.4)[(14.476)(2.016)[300 - T_3]] \Rightarrow T_f = 422K \leftarrow$$