SP 33. Two separate fluid streams enter a constant-pressure flow reactor. One stream contains pure liquid n-octane (C₈H₁₈) with a molar flow rate of 1.0 kmol/s. The other entering stream contains pure gaseous O₂ with a molar flow rate of 25 kmol/s. For the input streams, the pressure is 1.7 bars. The liquid octane enters as a liquid at 298.15 K. The O₂ enters at 450 K. The fuel and oxygen react, and the temperature and pressure of the exit stream are 1900 K and 1.7 bars, respectively. In the exit stream, the major product species are O₂, CO₂, and H₂O.

Given:

- $p_1 = 1.7$ bars
- $T_1 = 298.15$ K
- $\dot{n}_{1,C8H18} = 1.0$ kmol/s
- $p_2 = 1.7$ bars
- $T_2 = 450$ K
- $\dot{n}_{2,O2} = 25.0$ kmol/s
- $p_3 = 1.7$ bars
- $T_3 = 1900$ K
- Product species: O₂, CO₂, H₂O
- $T_0 = T_b = 298.15$ K

Find:

(a) Calculate the heat transfer rate $\dot{Q}_{CV}$ (in kW) for the flow reactor. Is the heat transfer to or from the reactor?

(b) Calculate the exergy destruction rate $\dot{E}_{d, CV}$ (in kW) for the control volume shown, with the boundary temperature of 298.15 K equal to the ambient temperature.

SP 35. From the data given in Table A-23, calculate the standard Gibbs free energy of reaction $\Delta G^o_T$ and the equilibrium constant $K(T)$ for the reaction $CO_2 \rightleftharpoons CO + \frac{1}{2}O_2$ at temperatures of 500 K, 1600 K, and 3000 K. Compare with the values calculated from Table A-27. For the universal gas constant, use a more precise value of $\bar{R} = 8.31447 \text{ kJ/(kmol K)}$. 

$$\Delta G^o_T = \text{...}$$

$$K(T) = \text{...}$$