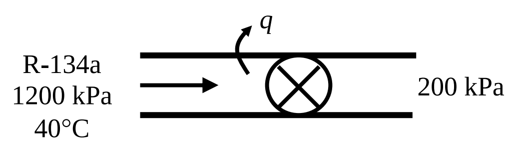
7-147 Heat is lost from Refrigerant-134a as it is throttled. The exit temperature of the refrigerant and the entropy generation are to be determined.

Assumptions **1** Steady operating conditions exist. **2** Kinetic and potential energy changes are negligible.

Analysis The properties of the refrigerant at the inlet of the device are (Table A-13)

$$\left.\begin{array}{l} P_1 = 1200 \text{ kPa} \\ T_1 = 40°\text{C} \end{array}\right\} \begin{array}{l} h_1 = 108.23 \text{ kJ/kg} \\ s_1 = 0.39424 \text{ kJ/kg} \end{array}$$



The enthalpy of the refrigerant at the exit of the device is

$$h_2 = h_1 - q_{\text{out}} = 108.23 - 0.5 = 107.73 \text{ kJ/kg}$$

Now, the properties at the exit state may be obtained from the R-134a tables

$$\left.\begin{array}{l} P_2 = 200 \text{ kPa} \\ h_2 = 107.73 \text{ kJ/kg} \end{array}\right\} \begin{array}{l} T_2 = \mathbf{-10.09°C} \\ s_2 = 0.41800 \text{ kJ/kg.K} \end{array}$$

The entropy generation associated with this process may be obtained by adding the entropy change of R-134a as it flows in the device and the entropy change of the surroundings.

$$\Delta s_{\text{R-134a}} = s_2 - s_1 = 0.41800 - 0.39424 = 0.02375 \text{ kJ/kg.K}$$

$$\Delta s_{\text{surr}} = \frac{q_{\text{out}}}{T_{\text{surr}}} = \frac{0.5 \text{ kJ/kg}}{(25 + 273) \text{ K}} = 0.001678 \text{ kJ/kg.K}$$

$$s_{\text{gen}} = \Delta s_{\text{total}} = \Delta s_{\text{R-134a}} + \Delta s_{\text{surr}} = 0.02375 + 0.001678 = \mathbf{0.02543 \text{ kJ/kg.K}}$$