5-37 A cylinder is initially filled with R-134a at a specified state. The refrigerant is cooled at constant pressure. The amount of heat loss is to be determined, and the process is to be shown on a *T*-v diagram.

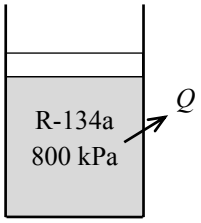
Assumptions **1** The cylinder is stationary and thus the kinetic and potential energy changes are zero. **2** There are no work interactions involved other than the boundary work. **3** The thermal energy stored in the cylinder itself is negligible. **4** The compression or expansion process is quasi-equilibrium.

Analysis We take the contents of the cylinder as the system. This is a closed system since no mass enters or leaves. The energy balance for this stationary closed system can be expressed as

$$\underbrace{E_{\text{in}} - E_{\text{out}}}_{\substack{\text{Net energy transfer}\\ \text{by heat, work, and mass}}} = \underbrace{\Delta E_{\text{system}}}_{\substack{\text{Change in internal, kinetic,}\\ \text{potential, etc. energies}}}$$

$$-Q_{\text{out}} - W_{b,\text{out}} = \Delta U = m(u_2 - u_1) \quad \text{(since KE = PE = 0)}$$

$$-Q_{\text{out}} = m(h_2 - h_1)$$

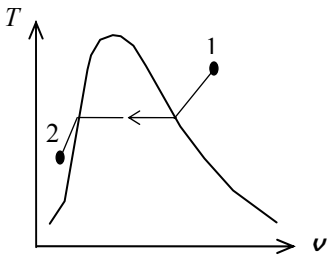


since $\Delta U + W_b = \Delta H$ during a constant pressure quasi-equilibrium process. The properties of R-134a are

(Tables A-11 through A-13)

$$\left.\begin{matrix} P_1 = 800 \text{ kPa} \\ T_1 = 70°\text{C} \end{matrix}\right\} h_1 = 306.88 \text{ kJ/kg}$$

$$\left.\begin{matrix} P_2 = 800 \text{ kPa} \\ T_2 = 15°\text{C} \end{matrix}\right\} h_2 \cong h_{f@15°\text{C}} = 72.34 \text{ kJ/kg}$$



Substituting,

$$Q_{\text{out}} = -(5 \text{ kg})(72.34 - 306.88) \text{ kJ/kg} = \mathbf{1173 \text{ kJ}}$$