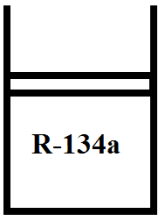
Çankaya University
Mechanical Engineering Department
ME 211 Thermodynamics I
Quiz 3-Solution

A frictionless piston-cyclinder device initially contains 200 L of saturated liquid refrigerant R-134a. The piston is free to move, and its mass is such that it maintains a pressure of 800 kPa on the refrigerant. The refrigerant is now heated until its temperature rises to 50 °C. Calculate the heat transfer for this process.



Solution:

Refrigerant-134a in a cylinder is heated at constant pressure until its temperature rises to a specified value.

Assumptions The process is quasi-equilibrium.

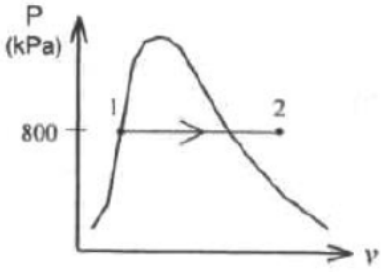
Properties Noting that the pressure remains constant during this process, the specific volumes at the initial and the final states are

$$\left.\begin{array}{l} P_1 = 800\ \text{kPa} \\ \text{Sat.liquid} \end{array}\right\} v_1 = v_{f@800\text{kPa}} = 0.0008454\text{m}^3/\text{kg}$$ and h_{f1}=93.42 kJ/kg

Superheated Vapor:

$$\left.\begin{array}{l} P_2 = 800\text{kPa} \\ T_2 = 50^\circ\text{C} \end{array}\right\} v_2 = 0.02846\text{m}^3/\text{kg}$$ and h_2=284.39 kJ/kg

$$m = \frac{V_1}{v_1} = \frac{0.2\ \text{m}^3}{0.0008454\ \text{m}^3/\text{kg}} = 236.6\ \text{kg}$$



The boundary work:

$$W_{b,\text{out}} = \int_1^2 P\,dV = P(V_2 - V_1) = mP(v_2 - v_1)$$

From 1st law:

$$Q_{12} = \Delta U + W_{b,out} = m(u_2 - u_1) + m(P_2 \cdot v_2 - P_1.v_1) = m(u_2 + P_2 \cdot v_2 - u_1 - P_1.v_1)$$
$$Q_{12} = m(h_2 - h_1) = 236.6(284.39 - 93.42) = 45183.5\ \text{kJ}$$