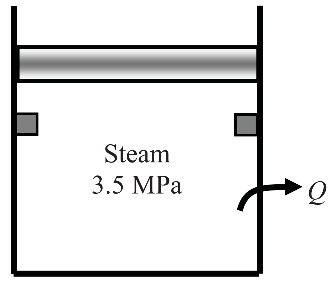
4-64 Heat is lost from a piston-cylinder device that contains steam at a specified state. The initial temperature, the enthalpy change, and the final pressure and quality are to be determined.

Analysis (*a*) The saturation temperature of steam at 3.5 MPa is

$$T_{sat@3.5\ MPa} = 242.6°C \quad \text{(Table A-5)}$$



Then, the initial temperature becomes

$$T_1 = 242.6 + 5 = \mathbf{247.6°C}$$

Also,
$$\left.\begin{array}{l} P_1 = 3.5\ \text{MPa} \\ T_1 = 247.6°C \end{array}\right\} h_1 = 2821.1\ \text{kJ/kg} \quad \text{(Table A-6)}$$

(*b*) The properties of steam when the piston first hits the stops are

$$\left.\begin{array}{l} P_2 = P_1 = 3.5\ \text{MPa} \\ x_2 = 0 \end{array}\right\} \begin{array}{l} h_2 = 1049.7\ \text{kJ/kg} \\ \boldsymbol{v}_2 = 0.001235\ \text{m}^3/\text{kg} \end{array} \quad \text{(Table A-5)}$$

Then, the enthalpy change of steam becomes

$$\Delta h = h_2 - h_1 = 1049.7 - 2821.1 = \mathbf{-1771\ kJ/kg}$$

(*c*) At the final state

$$\left.\begin{array}{l} \boldsymbol{v}_3 = \boldsymbol{v}_2 = 0.001235\ \text{m}^3/\text{kg} \\ T_3 = 200°C \end{array}\right\} \begin{array}{l} P_3 = \mathbf{1555\ kPa} \\ x_3 = \mathbf{0.0006} \end{array} \quad \text{(Table A-4 or EES)}$$

The cylinder contains saturated liquid-vapor mixture with a small mass of vapor at the final state.

4-65E The error involved in using the enthalpy of water by the incompressible liquid approximation is to be determined.

Analysis The state of water is compressed liquid. From the steam tables,

$$\left.\begin{array}{l} P = 1500\ \text{psia} \\ T = 400°F \end{array}\right\} h = 376.51\ \text{Btu/lbm} \quad \text{(Table A - 7E)}$$

Based upon the incompressible liquid approximation,

$$\left.\begin{array}{l} P = 1500\ \text{psia} \\ T = 400°F \end{array}\right\} h \cong h_{f\ @\ 400°F} = 375.04\ \text{Btu/lbm} \quad \text{(Table A - 4E)}$$

The error involved is

$$\text{Percent Error} = \frac{376.51 - 375.04}{376.51} \times 100 = \mathbf{0.39\%}$$

which is quite acceptable in most engineering calculations.