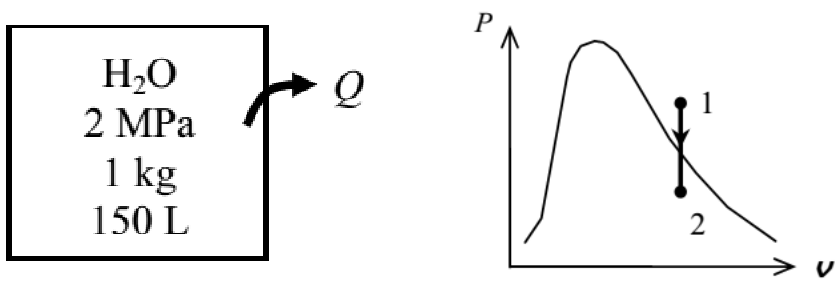
Homework-3 Solutions

Q 3-32

Analysis: This is a constant volume process. The specific volume is



$$\boldsymbol{v}_1 = \boldsymbol{v}_2 = \frac{\boldsymbol{V}}{m} = \frac{0.150\ \text{m}^3}{1\ \text{kg}} = 0.150\ \text{m}^3/\text{kg}$$

The initial state is superheated vapor. The temperature is determined to be

$$\left.\begin{array}{l} P_1 = 2\ \text{MPa} \\ \boldsymbol{v}_1 = 0.150\ \text{m}^3/\text{kg} \end{array}\right\} T_1 = \mathbf{395°C} \quad \text{(Table A - 6)}$$

This is a constant volume cooling process ($\boldsymbol{v} = \boldsymbol{V}/m$ = constant). The final state is saturated mixture and thus the pressure is the saturation pressure at the final temperature:

$$\left.\begin{array}{l} T_2 = 40°\text{C} \\ \boldsymbol{v}_2 = \boldsymbol{v}_1 = 0.150\ \text{m}^3/\text{kg} \end{array}\right\} P_2 = P_{\text{sat @ 40°C}} = \mathbf{7.385\ kPa} \quad \text{(Table A - 4)}$$

Q3-57

Analysis Compressed liquid can be approximated as saturated liquid at the given temperature. Then from Table A-4**,**

$$T = 80°\text{C} \quad \Rightarrow \quad \begin{array}{ll} \boldsymbol{v} \cong \boldsymbol{v}_{f\,@\,80°\text{C}} = 0.001029\ \text{m}^3/\text{kg} & (0.90\%\ \text{error}) \\ u \cong u_{f\,@\,80°\text{C}} = 334.97\ \text{kJ/kg} & (1.35\%\ \text{error}) \\ h \cong h_{f\,@\,80°\text{C}} = 335.02\ \text{kJ/kg} & (4.53\%\ \text{error}) \end{array}$$

From compressed liquid table (Table A-7),

$$\left.\begin{array}{l} P = 20\ \text{MPa} \\ T = 80°\text{C} \end{array}\right\} \begin{array}{l} \boldsymbol{v} = 0.00102\ \text{m}^3/\text{kg} \\ u = 330.50\ \text{kJ/kg} \\ h = 350.90\ \text{kJ/kg} \end{array}$$

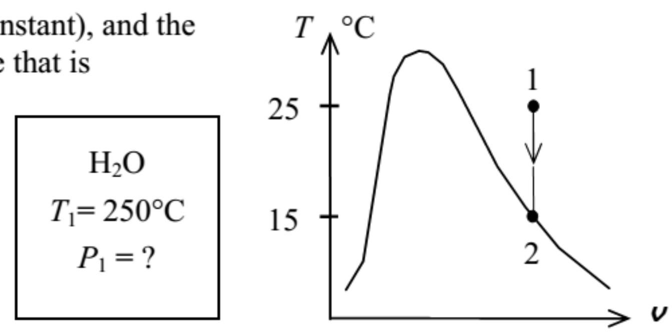
The percent errors involved in the saturated liquid approximation are listed above in parentheses.

Q 3-60

Analysis This is a constant volume process ($v = V/m$ = constant), and the initial specific volume is equal to the final specific volume that is

$$v_1 = v_2 = v_{g@124°C} = 0.79270 \text{ m}^3/\text{kg} \quad \text{(Table A-4)}$$

since the vapor starts condensing at 150°C. Then from Table A-6,



$$\left.\begin{array}{l} T_1 = 250°\text{C} \\ v_1 = 0.79270 \text{ m}^3/\text{kg} \end{array}\right\} P_1 = \mathbf{0.30\ MPa}$$

Q 3-61

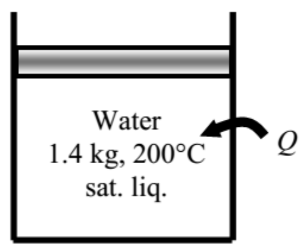
Properties The saturated liquid properties of water at 200°C are: v_f = 0.001157 m³/kg and u_f = 850.46 kJ/kg (Table A-4).

Analysis (*a*) The cylinder initially contains saturated liquid water. The volume of the cylinder at the initial state is

$$V_1 = m v_1 = (1.4 \text{ kg})(0.001157 \text{ m}^3/\text{kg}) = 0.001619 \text{ m}^3$$

The volume at the final state is

$$V = 4(0.001619) = \mathbf{0.006476\ m^3}$$



(*b*) The final state properties are

$$v_2 = \frac{V}{m} = \frac{0.006476 \text{ m}^3}{1.4 \text{ kg}} = 0.004626 \text{ m}^3/\text{kg}$$

$$\left.\begin{array}{l} v_2 = 0.004626 \text{ m}^3/\text{kg} \\ x_2 = 1 \end{array}\right\} \begin{array}{l} T_2 = \mathbf{371.3°C} \\ P_2 = \mathbf{21{,}367\ kPa} \\ u_2 = 2201.5 \text{ kJ/kg} \end{array} \quad \text{(Table A-4 or A-5 or EES)}$$

(*c*) The total internal energy change is determined from

$$\Delta U = m(u_2 - u_1) = (1.4 \text{ kg})(2201.5 - 850.46) \text{ kJ/kg} = \mathbf{1892\ kJ}$$