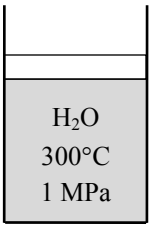
3-59 Superheated steam in a piston-cylinder device is cooled at constant pressure until half of the mass condenses. The final temperature and the volume change are to be determined, and the process should be shown on a T-v diagram.

Analysis (*b*) At the final state the cylinder contains saturated liquid-vapor mixture, and thus the final temperature must be the saturation temperature at the final pressure,

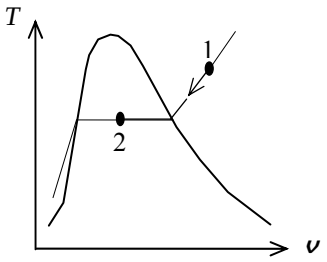
$$T = T_{\text{sat@1 MPa}} = \mathbf{179.88°C} \qquad \text{(Table A-5)}$$



(*c*) The quality at the final state is specified to be $x_2 = 0.5$. The specific volumes at the initial and the final states are

$$\left.\begin{matrix} P_1 = 1.0 \text{ MPa} \\ T_1 = 300^\circ\text{C} \end{matrix}\right\} v_1 = 0.25799 \text{ m}^3/\text{kg} \qquad \text{(Table A-6)}$$

$$\left.\begin{matrix} P_2 = 1.0 \text{ MPa} \\ x_2 = 0.5 \end{matrix}\right\} \begin{aligned} v_2 &= v_f + x_2 v_{fg} \\ &= 0.001127 + 0.5 \times (0.19436 - 0.001127) \\ &= 0.09775 \text{ m}^3/\text{kg} \end{aligned}$$



Thus,

$$\Delta V = m(v_2 - v_1) = (0.8 \text{ kg})(0.09775 - 0.25799)\text{m}^3/\text{kg} = \mathbf{-0.1282\ m^3}$$

3-60 The water in a rigid tank is cooled until the vapor starts condensing. The initial pressure in the tank is to be determined.

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

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

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

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