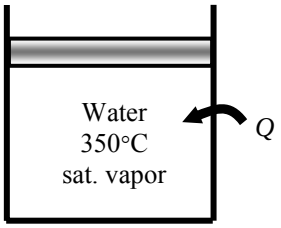
4-95 Water vapor is heated at constant pressure. The final temperature is to be determined using ideal gas equation, the compressibility charts, and the steam tables.

Properties The gas constant, the critical pressure, and the critical temperature of water are, from Table A-1,

$R = 0.4615$ kPa·m^3/kg·K, $T_{cr} = 647.1$ K, $P_{cr} = 22.06$ MPa

Analysis (*a*) From the ideal gas equation,

$$T_2 = T_1 \frac{\nu_2}{\nu_1} = (350 + 273\,\text{K})(2) = \mathbf{1246\ K}$$



(*b*) The pressure of the steam is

$$P_1 = P_2 = P_{\text{sat@350°C}} = 16{,}529\ \text{kPa}$$

From the compressibility chart at the initial state (Fig. A-15),

$$\left.\begin{aligned} T_{R1} &= \frac{T_1}{T_{cr}} = \frac{623\,\text{K}}{647.1\,\text{KR}} = 0.963 \\ P_{R1} &= \frac{P_1}{P_{cr}} = \frac{16.529\,\text{MPa}}{22.06\,\text{MPa}} = 0.749 \end{aligned}\right\} \ Z_1 = 0.593,\ \nu_{R1} = 0.75$$

At the final state,

$$\left.\begin{aligned} P_{R2} &= P_{R1} = 0.749 \\ \nu_{R2} &= 2\nu_{R1} = 2(0.75) = 1.50 \end{aligned}\right\} \ Z_2 = 0.88$$

Thus,

$$T_2 = \frac{P_2\nu_2}{Z_2 R} = \frac{P_2}{Z_2}\frac{\nu_{R2}T_{cr}}{P_{cr}} = \frac{16{,}529\,\text{kPa}}{0.88}\frac{(1.50)(647.1\,\text{K})}{22{,}060\,\text{kPa}} = \mathbf{826\ K}$$

(*c*) From the superheated steam table,

$$\left.\begin{aligned} T_1 &= 350°\text{C} \\ x_1 &= 1 \end{aligned}\right\} \ \nu_1 = 0.008806\ \text{m}^3/\text{kg} \qquad \text{(Table A-4)}$$

$$\left.\begin{aligned} P_2 &= 16{,}529\ \text{kPa} \\ \nu_2 &= 2\nu_1 = 0.01761\ \text{m}^3/\text{kg} \end{aligned}\right\} \ T_2 = 477°\text{C} = \mathbf{750\ K} \qquad \text{(from Table A-6 or EES)}$$

PROPRIETARY MATERIAL. © 2008 The McGraw-Hill Companies, Inc. Limited distribution permitted only to teachers and educators for course preparation. If you are a student using this Manual, you are using it without permission.