

Given and Required: $\text{kJ} := 1000\text{J}$

Determine the specific volume of R-134a at 1 MPa and 50°C. Use the ideal gas equation and also use the compressibility chart. What is it listed as in the tables in the back of your textbook?

$$P_1 := 1\text{MPa} \quad T_1 := 50^\circ\text{C}$$

Solution:

Going to Table A-1 @ R-134a shows

$$R_{\text{R134a}} := 0.08149 \frac{\text{kJ}}{\text{kg}\cdot\text{K}} \quad T_{\text{cr}} := 374.2\text{K} \quad P_{\text{cr}} := 4.059\text{MPa}$$

Beginning with the IGL.

$$P \cdot V = m \cdot R \cdot T$$

Solving for specific volume yields

$$\nu = \frac{V}{m} = \frac{R \cdot T}{P} \quad \text{or} \quad \boxed{\nu_a := \frac{R_{\text{R134a}} \cdot T_1}{P_1} = 0.02633 \frac{\text{m}^3}{\text{kg}}}$$

To use the compressibility chart, the reduced temperature and pressure values, T_R and P_R , must be calculated. This is shown below.

$$T_R := \frac{T_1}{T_{\text{cr}}} = 0.864 \quad P_R := \frac{P_1}{P_{\text{cr}}} = 0.246$$

Going to Figure A-15 @ $T_R = 0.864$ & $P_R = 0.246$ shows

$$z := 0.84$$

Now the specific volume may be calculated with the compressibility factor accounted for. This is shown below.

$$\nu = \frac{V}{m} = z \cdot \frac{R \cdot T}{P} \quad \text{or} \quad \boxed{\nu_b := z \cdot \frac{R_{\text{R134a}} \cdot T_1}{P_1} = 0.02212 \frac{\text{m}^3}{\text{kg}}}$$

To look up the specific volume from the table, we start at Table A-12 @ $P := P_1 = 1000\text{kPa}$ showing

$$T_{\text{sat}} := 39.37^\circ\text{C}$$

Since the temperature is greater than the saturation temperature at the pressure given (i.e. $T_1 > T_{\text{sat}}$), the state is superheated. Going to Table A-13 @ $P := P_1 = 1\text{MPa}$ & $T := T_1 = 50^\circ\text{C}$ shows

$$\boxed{\nu_c := 0.021796 \frac{\text{m}^3}{\text{kg}}}$$

Comparing the results of using the IGL and the method using compressibility chart to the table values shows the percent error as

$$\%e_a := \left| \frac{\nu_a - \nu_c}{\nu_c} \right| = 20.818\% \quad \%e_b := \left| \frac{\nu_b - \nu_c}{\nu_c} \right| = 1.487\%$$

It should be noted that the table value is considered the most accurate of the three methods and for this reason the other two methods are compared to it.