

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

A 100 L container contains 4 kg of R-134a at a pressure of 160 kPa.

Required:

Determine the temperature, the quality, and the enthalpy of the refrigerant.

Solution:

The total volume and mass, and the pressure are defined as

$$V_{\text{tot}} := 100\text{L} = 0.1 \cdot \text{m}^3 \quad m_{\text{tot}} := 4\text{kg} \quad P_1 := 160\text{kPa}$$

The specific volume at the state point is found by

$$\nu_1 := \frac{V_{\text{tot}}}{m_{\text{tot}}} = 0.025 \frac{\text{m}^3}{\text{kg}}$$

Going to Table A-12 @ $P := P_1 = 160\text{kPa}$ shows

$$\begin{aligned} T_{\text{sat}} &:= (-15.60)^\circ\text{C} & \nu_f &:= 0.0007437 \frac{\text{m}^3}{\text{kg}} & \nu_g &:= 0.12348 \frac{\text{m}^3}{\text{kg}} \\ h_f &:= 31.21 \frac{\text{kJ}}{\text{kg}} & h_g &:= 241.11 \frac{\text{kJ}}{\text{kg}} \end{aligned}$$

Note: Mathcad does not handle negative relative temperature units as one would expect. A simple fix for this is to encapsulate the negative sign and number within parentheses and then enter in the units as shown above.

Since $\nu_f < \nu_1 < \nu_g$, the state point occurs in the two-phase region. Thus the temperature at the state point is the saturation temperature or

$$T_1 := T_{\text{sat}} = -15.6^\circ\text{C}$$

The quality may be found by using the state point specific volume and the ν_f and ν_g values found from the table. This is shown below.

$$x_1 := \frac{\nu_1 - \nu_f}{\nu_g - \nu_f} = 0.198$$

The specific enthalpy at the state point is found by

$$h_1 := h_f + x_1 \cdot (h_g - h_f) = 72.692 \frac{\text{kJ}}{\text{kg}}$$

The enthalpy at the state point is then

$$H_1 := m_{\text{tot}} \cdot h_1 = 290.8 \cdot \text{kJ}$$