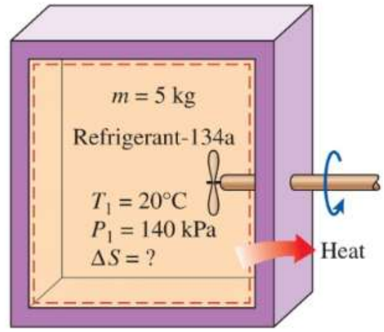
Given: $kJ := 1000J$

A rigid tank contains 5 kg of R-134a initially at 20°C and 140 kPa. The R-134a is now cooled while being stirred until its pressure drops to 100 kPa.

Required:

Determine the entropy change of the R-134a during this process.



Solution:

The mass of the R-134a is defined as

$$m_{R134a} := 5kg$$

The initial conditions are defined as

$$T_1 := 20\,°C = 293.15\,K \qquad P_1 := 140kPa$$

The final pressure is defined as

$$P_2 := 100kPa$$

Going to Table A-11 @ $T_1 = 20 \cdot °C$ shows

$$P_{sat} := 572.07kPa$$

Since $P_{sat} > P_1$ the state is superheated. Going to Table A-13 @ $T_1 = 20 \cdot °C$ and $P_1 = 0.14 \cdot MPa$ shows

$$\nu_1 := 0.16544\,\frac{m^3}{kg} \qquad s_1 := 1.0624\,\frac{kJ}{kg \cdot K}$$

Since the control volume is a closed system and the tank is rigid,

$$\nu_2 := \nu_1 = 0.16544\,\frac{m^3}{kg}$$

Going to Table A-12 @ $P_2 = 100 \cdot kPa$ shows

$$\nu_f := 0.0007259\,\frac{m^3}{kg} \qquad \nu_g := 0.19254\,\frac{m^3}{kg} \qquad s_f := 0.07188\,\frac{kJ}{kg \cdot K} \qquad s_g := 0.95183\,\frac{kJ}{kg \cdot K}$$

Since $\nu_f < \nu_2 < \nu_g$ the state is in the two phase region so

$$x_2 := \frac{\nu_2 - \nu_f}{\nu_g - \nu_f} = 0.859$$

The specific entropy at state 2 is then

$$s_2 := s_f + x_2 \cdot (s_g - s_f) = 0.828 \cdot \frac{kJ}{kg \cdot K}$$

The entropy change for the process is then

$$\boxed{\Delta S := m_{R134a} \cdot (s_2 - s_1) = -1.174 \cdot \frac{kJ}{K}}$$