Problem Set 9, PS9 due Wednesday June 9

PS9-1

4-106 In an open feed water heater vessel, feed water at 50 °C and 800 kPa is heated by superheated steam at 200 °C, 800 kPa. The leaving heated water is saturated liquid water at 800 kPa. Determine the ratio of the mass flow rate of the feed water to the flow rate of superheated steam.

PS9-2

4-96 Saturated R-143a liquid at 800 kPa is throttled to a pressure of 140 kPa. Determine the temperature drop of this process and the final specific volume.
\[ h_{\text{steam}} = h_{\text{sat}}(50^\circ \text{C}, 800 \text{ kPa}) = 2839.3 \text{ kJ/kg} \]
\[ h_{\text{water}} = h_{\text{f}}(50^\circ \text{C}) = 209.33 \text{ kJ/kg} \]
\[ h_{\text{mix}} = h_{g}(800 \text{ kPa}) \]

**Open System**

\[ Q = 0 \]
\[ W = 0 \]
\[ \Delta E = \Delta H \]

**Energy Balance**

\[ m_{\text{water}} h_{\text{water}} + m_{\text{steam}} h_{\text{steam}} = m_{\text{mix}} h_{\text{mix}} \]

**Mass Balance**

\[ m_{\text{water}} + m_{\text{steam}} = m_{\text{mix}} \]
\[ \frac{m_{\text{water}}}{m_{\text{steam}}} h_{\text{water}} + \frac{m_{\text{steam}}}{m_{\text{steam}}} h_{\text{steam}} = \left(\frac{m_{\text{water}} + m_{\text{steam}}}{m_{\text{steam}}}\right) h_{\text{mix}} \]

\[ \frac{m_{\text{water}}}{m_{\text{steam}}} = 4.14 \]

PS8-2

200 C

800kPa

steam

\[ 200 \text{ C} \]
\[ 800 \text{kPa} \]

50 C

800kPa

water

\[ 50 \text{ C} \]
\[ 800 \text{kPa} \]

saturated

water

\[ 800 \text{kPa} \]

steam

water
@ 800 kPa, saturated liquid, $h = 93.42 \text{ kJ/kg}, T = -31.33^\circ \text{C}$

@ 140 kPa, $h_f = 25.77 \text{ kJ/kg}, h_{fg} = 210.27$

$v_f = .0007381 \text{ m}^3/\text{kg}, v_g = .1396 \text{ m}^3/\text{kg}$

open system

$Q = 0, W = 0$

$\Delta h = 0$

$h_1 = h_2$

@ 140 kPa

$x = \frac{h_2 - h_f}{h_{fg}} = \frac{93.42 - 25.77}{210.27} = .3217$

$x = .32 \Rightarrow \text{mixture } T = T_{sat} @ 140 \text{ kPa}$

$T_2 = -18.8^\circ \text{C}$

$\Delta T = 31.33 - (-18.8) = 50.13^\circ \text{C}$

$v = v_f + x \times v_{fg}$

$v = .0007 + .3217(.1395 - .0007)$

$v = .0454 \text{ m}^3/\text{kg}$