PROBLEM 3.21

KNOWN: A closed, rigid container holds different volumes of saturated liquid water and saturated vapor water.

FIND: Determine the quality of the mixture.

SCHEMATIC & GIVEN DATA:

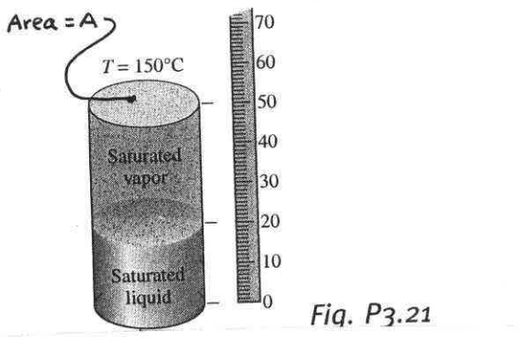

Fig. P3.21

ANALYSIS: $x = \dfrac{m_{vap}}{m_{vap} + m_{LIQ}}$, $m = V/v$. Thus, $m_{vap} = \dfrac{V_{vap}}{v_g}$, $m_{LIQ} = \dfrac{V_{LIQ}}{v_f}$

$$x = \frac{V_{vap}/v_g}{(V_{vap}/v_g) + (V_{liq}/v_f)}$$

$V_{vap} = 30A$ and $V_{LIQ} = 20A$, where area A is in the same units as the vertical measure shown. Then

$$x = \frac{(30A/v_g)}{(30A/v_g) + (20A/v_f)} = \frac{1}{1 + \frac{20}{30}\left(\frac{v_g}{v_f}\right)}$$

Since ratios appear in the last expression, the quantities can be in any consistent units.

(1) Using v_f and v_g from Table A-2 at 150°C,

$$v_f = 1.0905 \times 10^{-3}\ m^3/kg$$

$$v_g = 0.3928\ m^3/kg$$

$$x = \frac{1}{1 + \frac{20}{30}\left(\frac{0.3928}{1.0905 \times 10^{-3}}\right)} = 0.0041\ (0.41\%) \quad \leftarrow x$$

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1. Using v_f and v_g at 302°F (150°C) from Table A-2E: $v_f = 0.017468\ ft^3/lb$, $v_g = 6.292\ ft^3/lb$ gives the same value for x, as can be verified.