Example

A moist air mixture has the following measured properties
- $T = 86°F$
- $T_{wb} = 78°F$
- $P = 14.7$ psia

ASSUME $\quad T_{as} \approx T_{wb}$

(a) Find the humidity ratio.
(b) Find the relative humidity.
(c) Find the mixture specific enthalpy (per lbm dry air)
(d) Find the mixture specific volume (per lbm dry air)

(a) $\quad \omega = \dfrac{C_{pa}(T_{wb} - T) + \omega' h_{fg}(T_{wb})}{h_g(T) - h_f(T_{wb})}$

Why this T?

$C_{pa} = C_{pa}(T = \boxed{82°F}) = 0.240 \ \text{Btu/lbm·°R}$

$h_{fg}(78°F) = 1049.4 \ B/lb$

$h_g(86°F) = 1099 \ "$

$h_f(78°F) = 46.09 \ "$

$\omega' = 0.622 \dfrac{P_g(78°F)}{P - P_g(78°F)} = 0.622 \dfrac{0.4750}{14.7 - 0.4750}$

$= 0.020769$

$\therefore \boxed{\omega = 0.0189}$

(b) $\quad \omega = 0.622 \dfrac{P_v}{P - P_v} = 0.622 \dfrac{\phi P_g}{P - \phi P_g}$

$\phi = \dfrac{\omega}{0.622 + \omega} \dfrac{P}{P_g}$

$P_g(T = 86°F) = 0.6158 \ \text{psia}$

$\therefore \boxed{\phi = 0.704}$

(c) $h = h_a + \omega h_v \approx h_a + \omega h_g$

$h_g(86°F) = 130.5 + 0.0189 \cdot 1099 = 151.25$ Btu/lbm$_a$

(NOTE: EES GIVES $41.42 \frac{B}{lbm}$. DIFFERENT REF. STATE FOR AIR!!)

(d) $P_a v_a = R_a T$

$$v_a = \frac{R_a T}{P_a} = \frac{R_a T}{P - P_v} = \frac{R_a T}{P - \phi P_g(T)}$$

$$= \frac{\left(0.069 \frac{Btu}{lbm \cdot °R}\right)(86 + 460)°R}{(14.7 - (0.704)(0.6158)) \frac{lbf}{in^2} \left\langle \frac{144 in^2}{ft^2} \right\rangle \left\langle \frac{Btu}{778 \ ft\text{-}lbf} \right\rangle}$$

$$= \boxed{14.3 \ ft^3/lbm}$$

Example

Moist air at 14.7 psia has the following properties:
- $\omega = 0.0031$ (What are the units?)
- $T = 70°F$

Find the adiabatic saturation temperature.

$$\omega = \frac{C_{pa}(T_{as} - T) + \omega' h_{fg}(T_{as})}{h_g(T) - h_f(T_{as})}$$

GUESS T_{as}, LOOK UP PROPERTIES & CALCULATE ω. KEEP GUESSING UNTIL $\omega = 0.0031$!

WHERE $\omega' = 0.622 \dfrac{P_g(T_{as})}{P - P_g(T_{as})}$

$--$OR USE EES

ANSWER: $\boxed{T_{as} = 50°F}$