14-110 Two airstreams are mixed steadily. The temperature and the relative humidity of the mixture are to be determined.

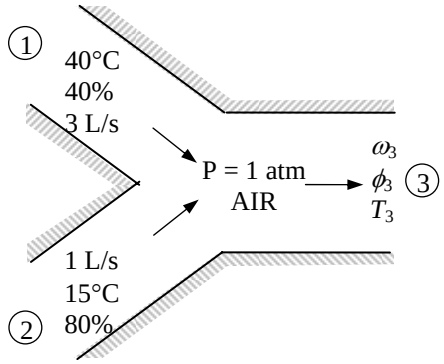
Assumptions **1** Steady operating conditions exist **2** Dry air and water vapor are ideal gases. **3** The kinetic and potential energy changes are negligible. **4** The mixing section is adiabatic.

Properties Properties of each inlet stream are determined from the psychrometric chart (Fig. A-31 or from EES) to be

$$h_1 = 88.5 \text{ kJ/kg dry air}$$
$$\omega_1 = 0.0187 \text{ kg H}_2\text{O/kg dry air}$$
$$\nu_1 = 0.914 \text{ m}^3\text{/kg dry air}$$

and

$$h_2 = 36.7 \text{ kJ/kg dry air}$$
$$\omega_2 = 0.0085 \text{ kg H}_2\text{O/kg dry air}$$
$$\nu_2 = 0.828 \text{ m}^3\text{/kg dry air}$$



Analysis The mass flow rate of dry air in each stream is

$$\dot{m}_{a1} = \frac{\dot{V}_1}{\nu_1} = \frac{0.003 \text{ m}^3/\text{s}}{0.914 \text{ m}^3/\text{kg dry air}} = 0.003282 \text{ kg/s}$$
$$\dot{m}_{a2} = \frac{\dot{V}_2}{\nu_2} = \frac{0.001 \text{ m}^3/\text{s}}{0.828 \text{ m}^3/\text{kg dry air}} = 0.001208 \text{ kg/s}$$

From the conservation of mass,

$$\dot{m}_{a3} = \dot{m}_{a1} + \dot{m}_{a2} = (0.003282 + 0.001208) \text{ kg/s} = 0.00449 \text{ kg/s}$$

The specific humidity and the enthalpy of the mixture can be determined from Eqs. 14-24, which are obtained by combining the conservation of mass and energy equations for the adiabatic mixing of two streams:

$$\frac{\dot{m}_{a1}}{\dot{m}_{a2}} = \frac{\omega_2 - \omega_3}{\omega_3 - \omega_1} = \frac{h_2 - h_3}{h_3 - h_1}$$
$$\frac{0.003282}{0.001208} = \frac{0.0085 - \omega_3}{\omega_3 - 0.0187} = \frac{36.7 - h_3}{h_3 - 88.5}$$

which yields

$$\omega_3 = 0.0160 \text{ kg H}_2\text{O/kg dry air}$$
$$h_3 = 74.6 \text{ kJ/kg dry air}$$

These two properties fix the state of the mixture. Other properties of the mixture are determined from the psychrometric chart:

$$T_3 = \mathbf{33.4°C}$$
$$\phi_3 = 0.493 = \mathbf{49.3\%}$$