

6-69 Steam is throttled from a specified pressure to a specified state. The quality at the inlet is to be determined.

Assumptions **1** This is a steady-flow process since there is no change with time. **2** Kinetic and potential energy changes are negligible. **3** Heat transfer to or from the fluid is negligible. **4** There are no work interactions involved.

Analysis There is only one inlet and one exit, and thus $\dot{m}_1 = \dot{m}_2 = \dot{m}$. We take the throttling valve as the system, which is a control volume since mass crosses the boundary. The energy balance for this steady-flow system can be expressed in the rate form as

$$\dot{E}_{\text{in}} - \dot{E}_{\text{out}} = \Delta \dot{E}_{\text{system}} \stackrel{\approx 0 \text{ (steady)}}{=} 0$$

$$\dot{E}_{\text{in}} = \dot{E}_{\text{out}}$$

$$\dot{m}h_1 = \dot{m}h_2$$

$$h_1 = h_2$$



since $\dot{Q} \cong \dot{W} = \Delta ke \cong \Delta pe \cong 0$.

The enthalpy of steam at the exit is (Table A-6),

$$\left. \begin{array}{l} P_2 = 100 \text{ kPa} \\ T_2 = 120^\circ\text{C} \end{array} \right\} h_2 = 2716.1 \text{ kJ/kg}$$

The quality of the steam at the inlet is (Table A-5)

$$\left. \begin{array}{l} P_2 = 2000 \text{ kPa} \\ h_1 = h_2 = 2716.1 \text{ kJ/kg} \end{array} \right\} x_1 = \frac{h_2 - h_f}{h_{fg}} = \frac{2716.1 - 908.47}{1889.8} = \mathbf{0.957}$$