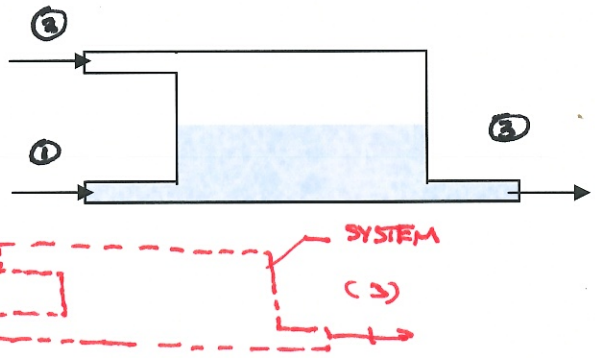
Example

A steady-state mixing chamber operates at a constant pressure of 800 kPa. 4.52 kg/s of compressed liquid water enters at a temperature of 35°C, while 1 kg/s of superheated steam enters at an unknown temperature. Water leaves the device as a saturated liquid. Assuming that the process is adiabatic, determine the temperature of the superheated steam.



1) LIQ. 35°C, 8 MPa
2) SHV $T_2 = ?$ $P = 0.8$ MPa
3) SL $P = 0.8$ MPa $\quad x_3 = ? = 0$

STATE	KNOWN	UNKNOWN
1	✓	
2		✓
3	✓	

Conservation of Energy →

$$\frac{dE_{sys}}{dt}^{\nearrow 0\ (SS)} = \dot{Q}^{\nearrow 0} + \dot{W}_{IN}^{\nearrow 0} + \sum_{IN} \dot{m}(h + \dots) - \sum_{OUT} \dot{m}(h + \dots)$$

$$0 = \dot{m}_1 h_1 + \dot{m}_2 h_2 - \dot{m}_3 h_3 \qquad [1]$$

What is $\dot{m}_3$?

Conservation of Mass →

$$\frac{dm_{sys}}{dt}^{\nearrow 0} = \sum \dot{m}_{in} - \sum_{OUT} \dot{m}$$

$$0 = \dot{m}_1 + \dot{m}_2 - \dot{m}_3$$

$$\dot{m}_3 = \dot{m}_1 + \dot{m}_2 = 4.52 + 1 = 5.52 \ \frac{kg}{s}$$

(1) $h_1 \approx h_f(T) + v_f(P - P_{sat}(T))$

$= 146.68 + (0.001006)[800 - 5.628] = 147.50 \ kJ/kg$

(3) $h_3 \equiv h_f(P_3) = 721.11 \ kJ/kg$

$$0 = (4.52\ \tfrac{kg}{s})(1475\ \tfrac{kJ}{kg}) + (1\ \tfrac{kg}{s})(h_2) - (5.52\ \tfrac{kg}{s})(721.11\ \tfrac{kJ}{kg})$$

$$h_2 = 3313.8\ kJ/kg$$

(2) $h_2 = 3313.8\ kJ/kg$, $P_2 = 0.8\ MPa$ → S.H.V. . . . $T_2 = 421.9°C$