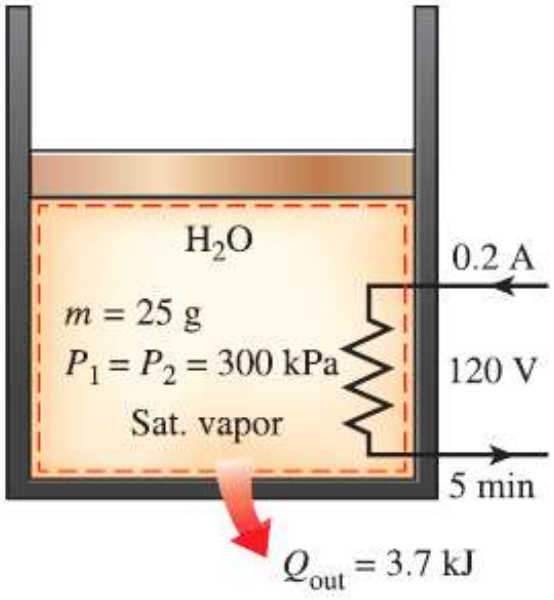
Given: $kJ := 1000J$

A piston cylinder device contains 25 g of saturated water vapor that is maintained at a constant pressure of 300 kPa. A resistance heater running of 0.2 A and 120 V is used to heat the vapor for 5 minutes. At the same time, the system experiences a heat loss of 3.7 kJ.

$m := 25gm$ $P_1 := 300kPa$

$I_s := 0.2A$ $V_s := 120V$

$\Delta t := 5min$ $Q_{out} := 3.7kJ$



Required:

Determine the final temperature.

Solution:

Since the water initially a saturated vapor, the quality is

$x_1 := 1$

The total heat supplied by the heat is

$Q_{in} := V_s \cdot I_s \cdot \Delta t = 7.2 \cdot kJ$

1st Law for closed system with no KE or PE

$\Delta E_{sys} = \Sigma E_{in} - \Sigma E_{out}$

$\Delta U + \Delta KE + \Delta PE = Q_{in} - Q_{out} - W_b$

$\Delta U + W_b = \Delta H = Q_{in} - Q_{out}$

$m \cdot \Delta h = Q_{in} - Q_{out}$

Going to Table A-5 @ $P_1 = 300 \cdot kPa$ and $x_1 = 1$ shows

$h_1 := 2724.9 \frac{kJ}{kg}$

Rearranging the 1st Law equation, the enthalpy at state may be found

$m \cdot (h_2 - h_1) = Q_{in} - Q_{out}$

$h_2 := \frac{Q_{in} - Q_{out}}{m} + h_1 = 2864.9 \cdot \frac{kJ}{kg}$

Going to Table A-5 @ $P_1 = 300 \cdot kPa$ shows

$h_g := 2724.9 \frac{kJ}{kg}$

Solution (contd.):

Since $h_2 > h_g$, state 2 is superheated. Going to Table A-6 @ $P_1 = 0.3 \cdot MPa$ and $h_2 = 2864.9 \cdot \frac{kJ}{kg}$ shows that interpolating is needed.

$T_a := 150\,°C \qquad T_b := 200\,°C$

$h_a := 2761.2\,\frac{kJ}{kg} \qquad h_b := 2865.9\,\frac{kJ}{kg}$

$$T_2 := \frac{h_2 - h_a}{h_b - h_a} \cdot \left(T_b - T_a\right) + T_a = 199.5 \cdot °C \qquad T_2 = 472.7\,K$$