ME 200 Homework 5

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1.

$$\begin{aligned} W &= m(h_i + V_i^2/2 + gz) - m(h_e + V_E^2/2 + gz) \\ &= m((h_i - h_e) + (V_i^2 - V_e^2)/2) \\ &= 11.95((3015.4 \times 10^3 - 2431.7 \times 10^3) + ((10^2 - 90^2)/2)) \\ &= 6.91 \times 10^6 \text{ W} = 691 \text{ kW} \end{aligned}$$

2.

$$\begin{aligned} 0 &= Q - W + m_i(\Delta h + \Delta V^2/2 + \Delta(gz)) \\ m &= \frac{-(Q - W)}{h_i - h_e} \\ m &= \frac{-20 + 150}{503.2 - 300.19} \\ m &= 0.6403 \text{ kg/s} \end{aligned}$$

3.

$$\begin{aligned} \Delta h &= v_f(T)(p_1 - p_2) \\ &= 1.009 \times 10^{-3}(-2 \times 10^5) \\ &= -2.018 \times 10^2 \\ m &= \frac{W}{\Delta h + \Delta U} \\ m &= \frac{-0.52 \times 10^3}{-2.018 \times 10^2 - 15 \times 9.81} \\ m &= 1.49018 \text{ kg/s} \end{aligned}$$

4. a)

$$\begin{aligned} h_f &= \frac{173.88 - 151.53}{0.08 - 0.07} * 0.01 + 151.53 = 162.705 \\ h_g &= \frac{2577 - 2567.4}{0.08 - 0.06} * 0.01 + 2567.4 = 2572.2 \\ 2431.6 &= x(2572.2) + (1 - x)162.705 \\ x &= 0.941648 \end{aligned}$$

Quality is 0.9416

b)

$$Q = m_s(\Delta h_s) + m_a c_a(\Delta T)$$
$$Q = 1.5(162.705 - 2431.6) + 100 \times 1.005 \times (30)$$
$$Q = -388.343\text{kJ/min} = -6.47\text{kW}$$

5.

$$\Delta h = \Delta ke$$
$$c\Delta T + \frac{\Delta p}{\rho} = \Delta ke$$
$$0.001 \times (275 - 300) = -0.025\text{kJ/kg}$$