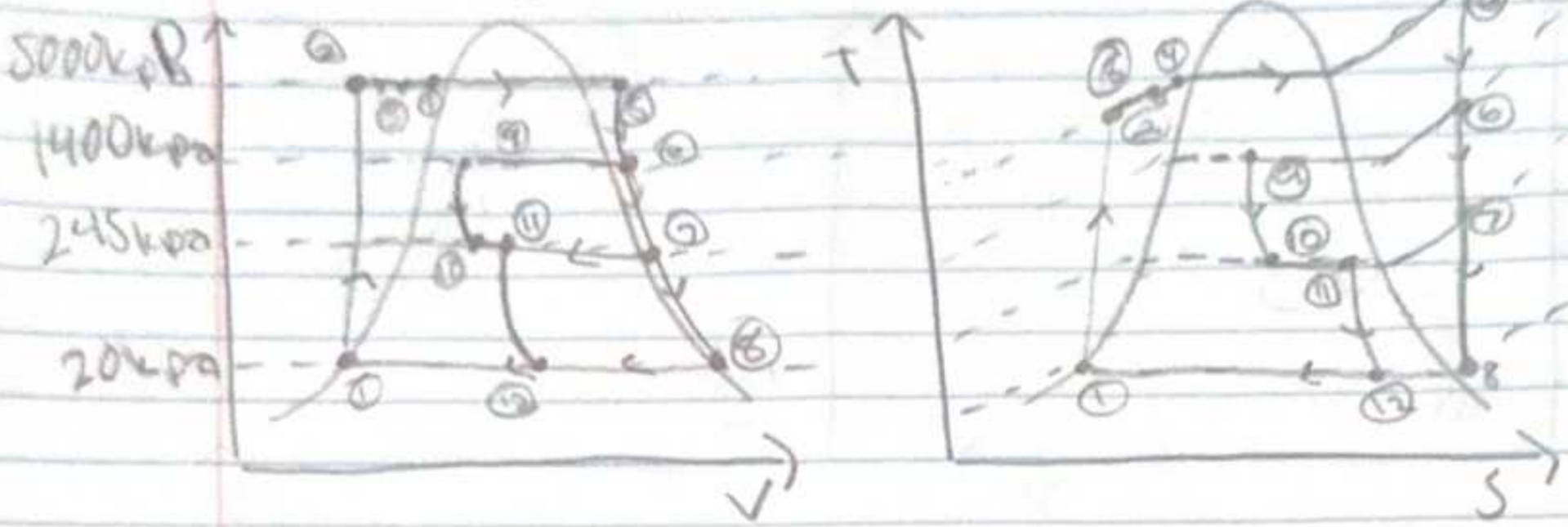
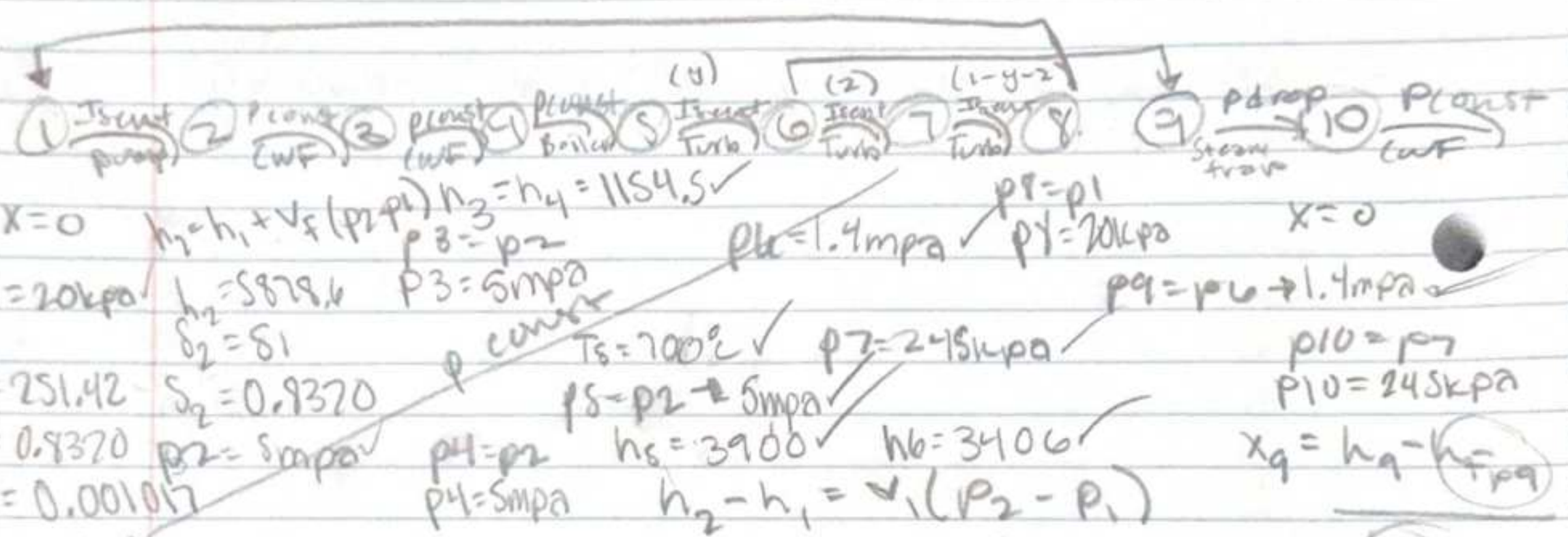
10-87 $y = 0.1446$ $c_p = 4.18\ kJ/kg\cdot K$ $\dot{m}_{steam} = 75\ kg/s$





$x = 0$

$p_1 = 20kpa$

$h_1 = 251.42$

$s_1 = 0.8370$

$v_1 = 0.001017$

$h_2 = h_1 + v_f(p_2 - p_1)$

$h_2 = 5879.6$

$s_2 = s_1$

$s_2 = 0.8370$

$p_2 = 5mpa$

$p_3 = p_2$

$p_3 = 5mpa$

$h_3 = h_4 = 1154.5$

$p_4 = p_2$

$p_4 = 5mpa$

$T_5 = 700°C$

$p_5 = p_2 \rightarrow 5mpa$

$h_5 = 3900$

$p_6 = 1.4mpa$

$p_7 = 245kpa$

$h_6 = 3406$

$p_8 = p_1$

$p_8 = 20kpa$

$h_2 - h_1 = v_1(p_2 - p_1)$

$s_5 = 7.512$

$s_5 = s_6 = s_7 = s_8$

Interpolate

$s_3 = s_4 = 2.9707$

$p_9 = p_6 \rightarrow 1.4mpa$

$x = 0$

$p_{10} = p_7$

$p_{10} = 245kpa$

$x_9 = \frac{h_9 - h_{f\,p9}}{h_{fg\,p9}}$

Table

$h_9 = h_{10}$

$h_9 = 829.96$

$h_7 = 2918$

$h_8 = 2477$

$h_{10} = 829.96$

$h_{fg} = 1958.9$

$s_9 = 2.28$

$s_{10} = 1.59$

$x_9 = 0.57$

$p_{11} = p_7$

$p_{11} = 245kpa$

$p_{12} = 20kpa$

$h_{11} = 531.6$

$s_{11} = 1.59$

Interpol

$h_3 - h_2 = z(h_9) + y(h_{10}) - (z+y)(h_{11})$

$h_4 - h_3 = y(h_9 - h_6)$

$y(h_6) + z(h_9) - (h_2) = h_4 + (y+z)(h_{11})$

$h_{11} = h_{12} \rightarrow 531.6$

$s_{12} = 0.832$

$\dot{m}_t = (1-y)\dot{m}_s$

$\dot{m} = (1-0.1446)75$

$= 64.155$

$2 = \frac{h_3 - h_2}{h_{10} - h_3}$

$2 = \frac{1145.5 - 5828.6}{829.94 - 1145.5} = \frac{-4,683.1}{-315.54}$

b) $2 = 236.68$

c) $\Delta T = 10^\circ C \quad Cp = 4.18$

$\dot{m}_{\text{cooling water}} = \frac{\dot{m}_{\text{steam}}(h_{in} - h_{out})}{Cp\Delta T}$

$= \frac{75(2608.9 - 531.6)}{4.18(10^\circ)} = \frac{155,797.5}{41.8}$

$\dot{m}_{\text{cooling water}} = 3727.21$

D) $W_{net} = W_{turb} - W_{pumps}$

$W_{turb} = \dot{m}(h_{in} - h_{out})$

$= 75(3900 - 2918)$

$= 73,650$

$W_{pump} = \dot{m}(h_{out} - h_{in})$

$W_{pump} = 75(5828.6 - 251.42)$

$= 418,288.5$

$Q_{in} = \dot{m}(h_3 - h_1)$

$75(3900 - 251.42)$

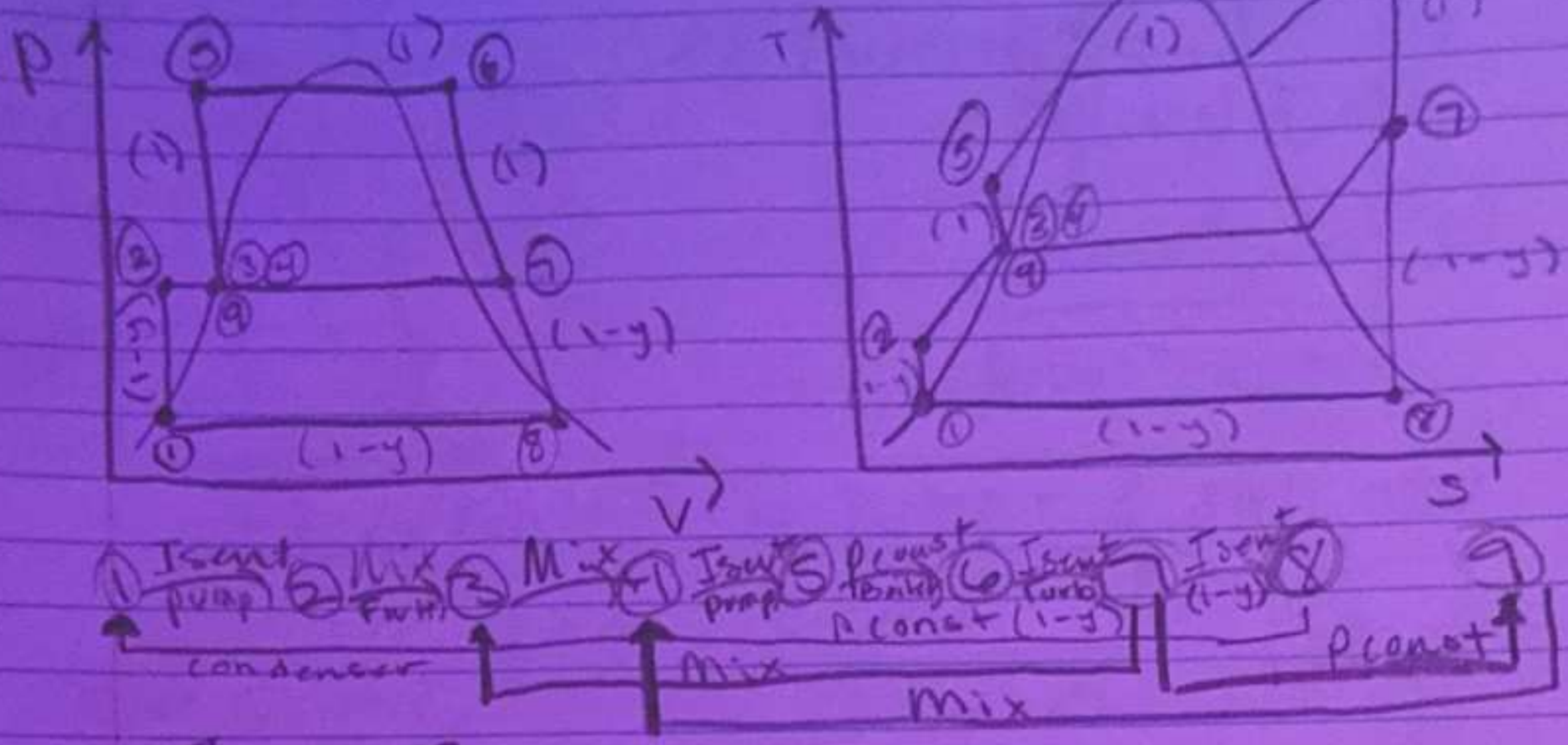
$\eta = \frac{W_{net}}{Q_{in}}$

W_{net}

$\eta = \frac{344,638.5}{273,643.5}$

$\eta = 1.2594$

10-72 | $y = 0.35$



$p_1 = p_7$ $p_2 \sim p_7$

$p_1 = 10\text{kpa}$ $p_2 = 1.6\text{mpa}$

$x_1 = 0$ $h_2 = h_1 + v_1(p_2 - p_1)$

From Table $h_2 = 193.416$

$T_1 = 45.81^\circ C$

$h_1 = 191.81$

$v_f = 0.001010$

$p_3 = p_2 = p_7$

$p_3 = 1.6\text{mpa}$

$p_5 \sim p_6$

$p_5 = 9\text{mpa}$

$h_5 = h_4 + v_4(p_5 - p_4)$

$h_5 = 8166.567$

$p_4 = p_3 = p_9$

$p_4 = 1.6\text{mpa}$

$p_9 = 1.6\text{mpa}$

$x_9 = 0$

Tables

$T_9 = 201.2$

$h_9 = 857.9$

$h_3 = h_4 = h_9 = 857.994$

$v_4 = 0.001158$

$p_6 = 9\text{mpa}$

$T_6 = 400^\circ C$

Tables

$h_6 = 3117.8$

$s_6 = 6.2976$

$p_7 = 1.6\text{mpa}$

$s_7 = s_6$

$s_7 = 6.28$

$s_7 > s_{g@1.6\text{mpa}}$

$\therefore$ mixture

$h_7 = h_{f_7} + x_7 h_{fg_7}$

$= 997.9 + 0.467(1934.6)$

$h_7 = 2779.43$

$x_7 = \dfrac{s_7 - s_{f_7}}{s_{fg_7}} = 0.9673$

$6.28 - 2.34 = 4.07$

$p_8 = 10\text{kpa}$

$s_8 = s_6$

$s_8 = 6.2976$

$x_8 = \dfrac{s_8 - s_{f_8}}{s_{fg_8}} = 0.7518$

$h_8 = h_{f_8} + x_8 h_{fg_8}$

$h_4 = 1990.863$

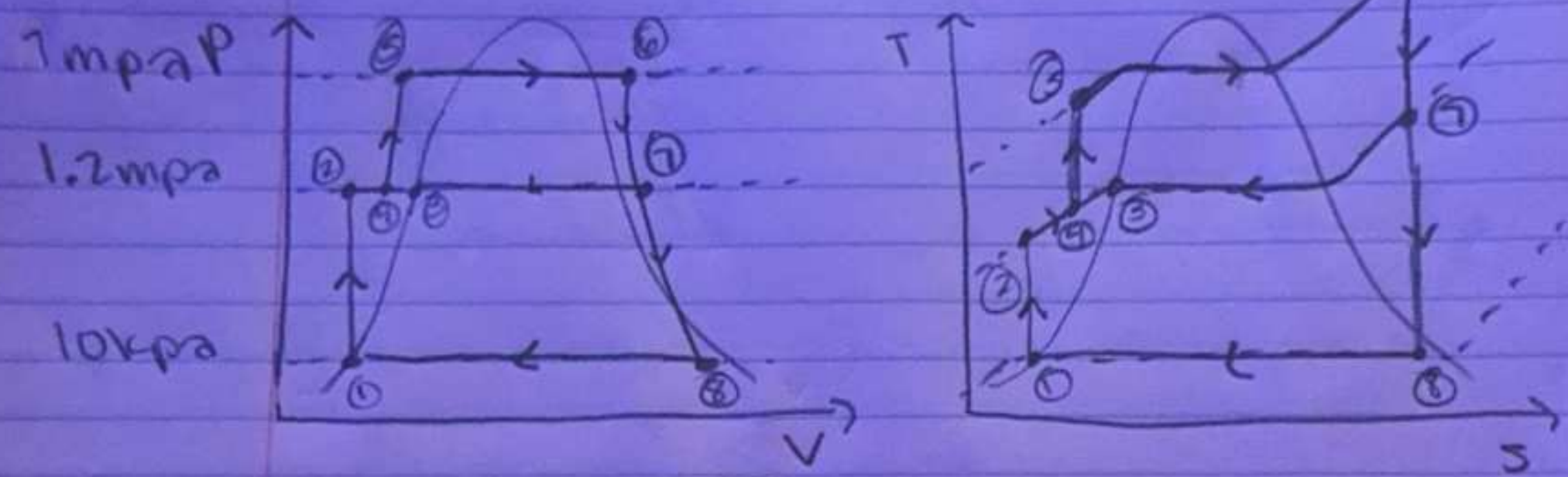
$$\dot{W}_{net} = \dot{m}_T(h_6 - h_7) - \dot{m}_{(1-y)}(h_7 - h_8) - \dot{m}_{(1-y)}(h_2 - h_1) - \dot{m}_T(h_5 - h_4)$$

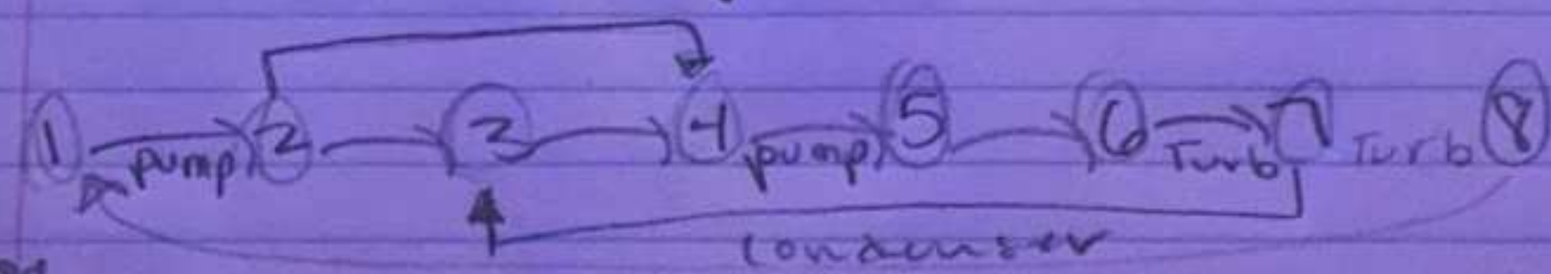
$$= \dot{m}_T\left[(h_6 - h_7) - (1-y)(h_7 - h_8) - (1-y)(h_2 - h_1) - (h_5 - h_4)\right]$$

$$= \dot{m}_T\left[399.36 + 0.65(739.17) - 0.65(1.606 - 8.575)\right]$$

$$\boxed{\dot{m}_T = 79.063\ kg/s}$$

10-69| $\dot{m} = 55 kg/s$ $y = 0.25$





$P_1 = P_8$

$P_1 = 10kpa$ $P_2 = 1.2mpa$ $P_3 = 1.2mpa$ $P_4 = 1.2mpa$ $P_5 = 7mpa$

$T_1 = 45.81$

Tables $\begin{cases} h_1 = 191.81 & h_2 = 191.801 & h_3 = 191.801 & h_4 = 191.801 & h_5 = 191.95 \\ S_1 = 0.6492 & S_2 = 0.6492 & S_3 = 0.6492 & S_4 = 0.6492 & S_5 = 5.81 \\ V_1 = 0.001010 \end{cases}$

$h_2 = h_1 + V_1(P_2 - P_1)$ $S_6 = S_7 = S_8$ $h_5 = h_4 + V_4(P_5 - P_4)$

$h_5 = 191.801 + V_4(7 - 1.2)$

$P_6 = 4mpa$ $P_7 = 1.2mpa$ $P_8 = 10kpa$

$t_6 = 500°C$ Interpolate → $V_4 = 0.02723$ ← Tables

Tables $\begin{cases} h_6 = 3446.0 & h_7 = 3099.87 & h_8 = 191.81 \\ S_6 = 7.0922 & S_7 = 7.0922 & S_8 = 7.0922 \end{cases}$

$P_2 = P_3 = P_4 = P_7$

$\dot{m}_{extracted} = (55)\,0.25$

$= 13.75$

$\dot{m}_{Turbine} = (55)\,0.75$

$= 41.25$

$W_{turb} = \dot{m}_{turb}(h_{in} - h_{out})$

$= 41.25\,(3446 - 191.81)$

$W_{pump} = \dot{m}_{extr}(h_{out_{pump}} - h_{in_{pump}})$

$= 13.75(191.81 - 191.801)$

$= 13.75\,(0.009)$

$= .12375$

Net: $W_{turb} - W_{pump}$

$= 41.25 - .12375$

$= 41.106$