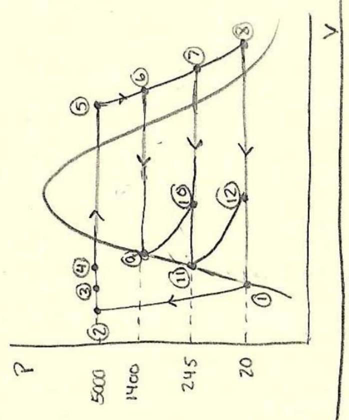
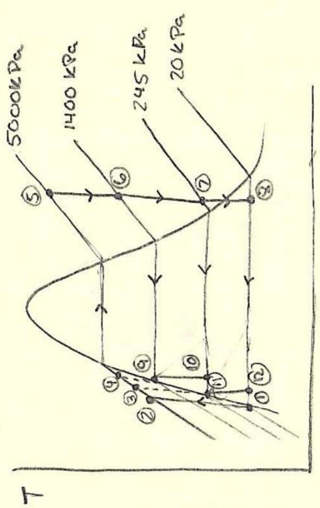
MET350 : Thermo Apps | HW 2.2 | 6-3-2019 Carter Fishback

10-57)

a.) T-s diagram





- Pressure in kPa
- T = °C
- h = kJ/kg

① Isent → ② Pconst → ③ Pconst → ④ Pconst → ⑤ Isent → ⑥ Isent → ⑦ Isent → ⑧ ⑨ Isetalpic → ⑩ Pconst → ⑪ Isentalpic → ⑫

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫
$P_1 = 20$	$P_2 = 5000$	$P_3 = 5000$	$P_4 = 5000$	$P_5 = 5000$	$P_6 = 1400$	$P_7 = 245$	$P_8 = 20$	$P_9 = 1400$	$P_{10} = 245$	$P_{11} = 245$	$P_{12} = 20$
$X_1 = 0$	$h_2 = 256.08$	$h_3 = 533$	$h_4 = 830$	$T_5 = 700°$	$h_6 = 3406$	$h_7 = 2918$	$h_8 = 2477$	$X_9 = 0$	$h_{10} = 830$	$X_{11} = 0$	$h_{12} = 533$
$h_1 = 251$				$h_5 = 3900$	$S_6 = 7.512$	$S_7 = 7.512$	$S_8 = 7.512$	$h_9 = 830$		$h_{11} = 533$	
				$S_5 = 7.512$							

$h_1 = h_{f@\,20\,kPa} = 251\ kJ/kg$

$V_1 = V_{f@\,20\,kPa} = .00102\ m^3/kg$

$h_2 = h_1 + v_1(P_2 - P_1) = 251 + .00102(5000-20) = 256.08$

$X_9 = 0 \longrightarrow h_9 = 830$

$X_{11} = \longrightarrow h_{11} = 533$

$S_9 = S_4 = S_{10} \longrightarrow h_9 = h_4 = h_{10}$

$S_3 = S_{11} = S_{12} \longrightarrow h_3 = h_{11} = h_{12}$

b.) $6 \rightarrow 9 = y = .1446$

$7 \rightarrow 11 = z$

$8 \rightarrow 1 = 1 - y - z$

Analysis of CWH I:

$h_3 + (y+z)h_{11} = h_2 + zh_7 + y\,h_{10}$

$533 + (.1446 + z)533 = 256.08 + z(2918) + (.1446)(830)$

$533 + 77.07 + 533z = 256.08 + 2918z + 120.02$

$233.97 = 2385z$

$z = .098$

c.) Cooling flow rate.

Analysis of condensor: → $\dot m_{out} = \dot m_{in} = \dot m_w$

$\dot m_1 h_1 + \dot m_{out} h_{out} = \dot m_{12} h_{12} + \dot m_8 h_8 + \dot m_{in} h_{in}$

$(\dot m_{out} h_{out})(\dot m_{in} h_{in}) = \dot m_{12} h_{12} + \dot m_8 h_8 - \dot m_1 h_1$

$\dot m_w (h_{out} - h_{in}) = \dot m_{12} h_{12} + \dot m_8 h_8 - \dot m_1 h_1$

$\dot m_w C_p(\Delta T) =$ ←

$C_p = 4.18$

$\dot m_8 = 1 - y - z = .75741$

$\dot m_{12} = y + z = .2426$

$\dot m_1 = 1$

$$\dot m_w = \frac{(.2426)(533) + (.75741)(2477) - (1)(251)}{(4.18)(10°)}$$

$\dot m_w = 41.97\ kg/s$

MET350: Thermo Apps	HW 2.2	07-03-2019 Carter Fishback / Hannon French

10-57) d. Thermo Efficiency and power

$W_{net} = -\dot{m}_6 h_6 - \dot{m}_7 h_7 - \dot{m}_8 h_8 + \dot{m}_5 h_5 + \dot{m}_1 h_1$ ($-\dot{m}_6 h_6 - \dot{m}_7 h_7 - \dot{m}_8 h_8 \rightarrow W_{out}$; $\dot{m}_5 h_5 + \dot{m}_1 h_1 \rightarrow W_{in}$)

$\dot{m}_6 = y = .1446$ $\quad \dot{m}_1 = 1$

$\dot{m}_7 = z = .098$

$\dot{m}_8 = 1 - y - z = .7574$

$\dot{m}_5 = 1$

$w_{net} = -(.1446)(3406) - (.098)(2918) - .7574(2477) + (1)(3900) + (1)(251) = 1496.45\ kJ/kg$

$w_{out} = 2654.55\ kJ/kg$

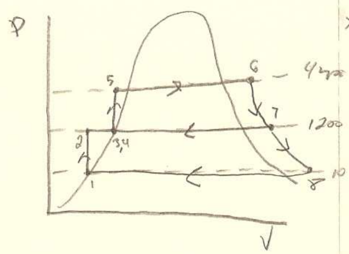
$\boxed{\dot{W}_{out} = 2654.55\,(75\ kg/s) = 199.1\ kW}$

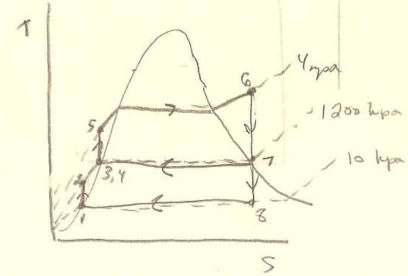
$q_{in} = \dot{m}_4 (h_5 - h_4) = 1(3900 - 830) \rightarrow q_{in} = 3070\ kJ/kg$

$\eta = \frac{w_{net}}{q_{in}} = \frac{1496}{3070}$

$\boxed{\eta_{TH} = .49}$

Hannon Frenzl





$y = .25$

① Isen → ② Pconst → ③ Pconst → ④ Isen → ⑤ Pconst → ⑥ Isen → ⑦ Isen → ⑧ Pconst

①	②	③	④	⑤	⑥	⑦	⑧
$P_1 = 10$ kpa	$P_2 = 1200$ kpa	$P_3 = 1200$ kpa	$P_4 = 1200$ kpa	$P_5 = 4$ mpa	$P_6 = 4$ Mpa	$P_7 = 1200$ kpa	$P_8 = 10$ kpa
$x_0 = 0$	$h_2 = h_1 + V_1(P_2 - P_1)$	$x_3 = 0$ & assume → $x_4 = 0$		$h_5 = h_4 + v_4(P_5 - P_4)$	$T_6 = 500°C$	$S_6 = S_7 = 7.0922$	$S_8 = S_6$
A-5 @ 10 kpa	$= 191.81 + .0010(1200 - 10)$	A-5 @ 1200 kpa	$h_4 = 798.33$ kJ/kg	$= 798.33 + .001138(4000 - 1200)$	from A-6	Interpolate on A-6 (1.2 mpa) between 7.0335 & 7.2139 for h_7	$x_8 = \frac{S_8 - S_{f8}}{S_{fg8}}$
$h_1 = 191.81$ kJ/kg	$h_2 = 193.01$ kJ/kg	$h_3 = 798.33$ kJ/kg		$h_5 = 801.5$ kJ/kg	$h_6 = 3446$ kJ/kg	$h_7 = 3081.4$ kJ/kg	$x_8 = \frac{7.092 - .6492}{7.4996}$
$V_1 = .00101$ m³/kg			$V_4 = .001138$ m³/kg		$S_6 = 7.0922$ kJ/kgK		$x_8 = .85$
							$.85 = \frac{h_8 - h_{8f}}{h_{8fg}}$
							$.85(h_{8fg}) + h_f = h_8$
							$.85(2392.1) + 191.81 =$
							$h_8 = 2225.1$ kJ/kg

$$\dot{W}_{pt} = \dot{m}_6(h_6 - h_7) + \dot{m}_8(h_1 - h_8) - \dot{m}_1(h_2 - h_1) - \dot{m}_4(h_4 - h_3)$$

($\dot{m}_6 \to 1\dot{m}_{net}$, $\dot{m}_8 \to 3/4\,\dot{m}_{net}$, $\dot{m}_1 \to 3/4\,\dot{m}_{net}$, $\dot{m}_4 \to 1\dot{m}_{net}$)

$$\dot{W}_{net} = 55\tfrac{kg}{s}(3446\,kJ/kg - 3081.4\,kJ/kg) + (3/4(55\tfrac{kg}{s}))(3081.4\,kJ/kg - 2225.1\,kJ/kg) - (3/4(55\tfrac{kg}{s}))(193.01 - 191.81\,kJ/kg) - 55\tfrac{kg}{s}(798.33\,kJ/kg - 801.5)$$

$$\dot{W}_{net} = 20053 + 35322.37 - 49.5 - 174.35$$

$$\boxed{\dot{W}_{net} = 55151.52\ kW}$$

$$\epsilon = \frac{\dot{W}_{net} + \dot{Q}_{process}}{\dot{Q}_{in}}$$

$\dot{Q}_{process} \to \dot{m}_7(h_7 - h_3) = \frac{55}{4}(3081.4 - 798.33) = \dot{Q}_{proc} = 31392.2$ kW ($\dot{m}_7 = 1/4\,\dot{m}_{net}$)

$\dot{Q}_{in} \to \dot{m}_5(h_6 - h_5) \to 55(3446 - 801.5) = \dot{Q}_{in} = 145447.5$ kW ($\dot{m}_5 = \dot{m}_{net}$)

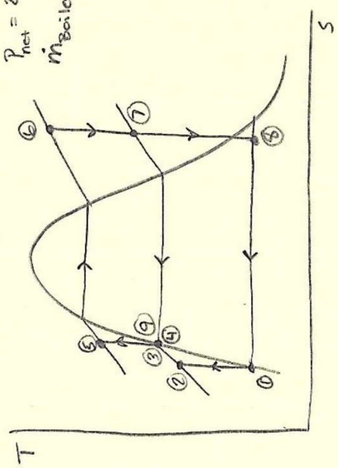
$$\epsilon = \frac{55151.52\,kW + 31392.2\,kW}{145447.5\,kW}$$

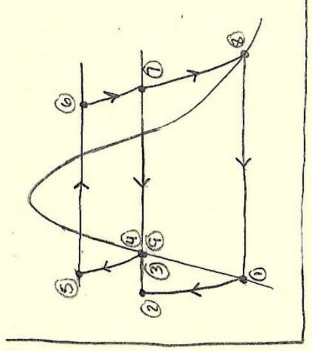
$$\boxed{\epsilon = .59}$$

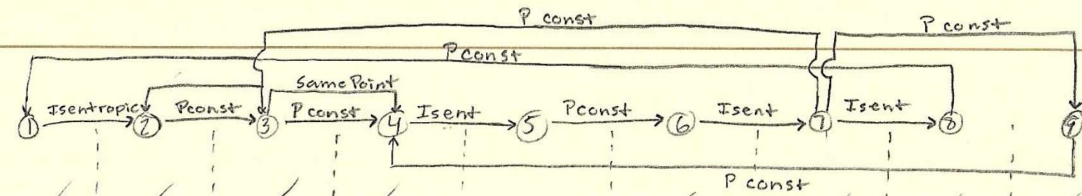
10-72)

$P_{net} = 25\ MW$

$\dot{m}_{Boiler} = ?$







1	2	3	4	5	6	7	8	9
✓	✓	✓	✓	✓	✓	✓	✓	✓
$P_1 = 10\ kPa$	$P_2 = 1.6\ MPa$	$P_3 = 1.6\ MPa$	$P_4 = 1.6\ MPa$	$P_5 = 9\ MPa$	$P_6 = 9\ MPa$	$P_7 = 1.6\ MPa$	$P_8 = 10\ kPa$	$P_9 = 1.6\ MPa$
$x_1 = 0$	$h_2 = 193.42$	$x_3 = 0$	$x_4 = 0$	$h_5 = 1363.71$	$T_6 = 400°C$	$s_7 = s_6$	$s_8 = s_6$	$x_9 = 0$
$h_1 = 191.81$		$h_3 = 1363.7$	$h_4 = 1363.7$		$x_6 > 1$	$h_7 = 2742.76$	$h_8 = 1990.19$	$h_9 = 1363.7$
$v_1 = .001010$			$v_4 = .001418$		$h_6 = 3118.8$			

$x_1 = 0 \Rightarrow$ sat tables $\longrightarrow h_1, v_1$

for pumps:

$h_2 = h_1 + v_1(P_2 - P_1)$

$h_2 = 191.81 + .001010(1600-10) = 193.42\ kJ/kg$

$x_{3/4/9} = 0$ sat liquid $\longrightarrow h$

$h_5 = 1363.7 + .001418(9-1.6) = 1363.71$

$x_6 > 1 \longrightarrow h_6 = 3118.8$

$s_6 = 6.2876 = s_7$

$> s_{f@1.6} < s_7 < s_{g@1.6}$

$$s_{f_7} = \frac{(1600-1500)(2.3844-2.3143)}{(1750-1500)} + 2.3143 = 2.34234$$

$$s_{fg_7} = \frac{(1600-1500)(4.0033-4.1287)}{1750-1500} + 4.1287 = 4.07854$$

$$x_7 = \frac{6.2876 - 2.3143}{4.07854} = .9742$$

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

$$h_{f_7} = \frac{(1600-1500)(878.16-844.55)}{(1750-1500)} + 844.55 = 857.99$$

$$h_{fg_7} = \frac{(1600-1500)(1917.1-1946.4)}{(1750-1500)} + 1946.4 = 1934.68$$

$h_7 = 857.99 + (.9742)(1934.68)$

$h_7 = 2742.76\ kJ/kg$

$s_8 = s_6$

$$x_8 = \frac{s_8 - s_{f_8}}{s_{fg_8}}$$

$$x_8 = \frac{6.2876 - 0.6492}{7.4996} = .7518$$

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

$h_8 = 191.81 + (.7518)(2392.1) = 1990.19$

10-72) $\dot{W}_{net} = 25 MW$

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

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

$y = .35$

$1 - y = .65$

$$25 MW = \dot{m}\left((3118.8 - 1363.71) + .65(2742.76 - 1990.19) - .65(193.42 - 191.81) - (1363.71 - 1363.7)\right)$$

$\boxed{\dot{m} = 11.14 \text{ kg/s}}$

10- 18 Grading)

All questions were correctly answered and process looked good but there was no P-v diagram.

Suggested grade: 95%

Jean and Gonzalez

HW 2.1: Problem 25 recommendations

It appears that your answers are correct, however the work to get those answers was difficult to follow from states to state. Your processes and math is right but you still failed to provide the P-v diagram and summary of properties at each state. This assists the grader, as well as yourself during the test, to follow your work to solve future problems. Finding the properties and BOTH diagrams are required by Dr. Ayala for us to solve the problems as we are still learning. I understand that it can be irritating to do, but it does help teach you the concepts better.

Recommended grade: 80