HW 2.1

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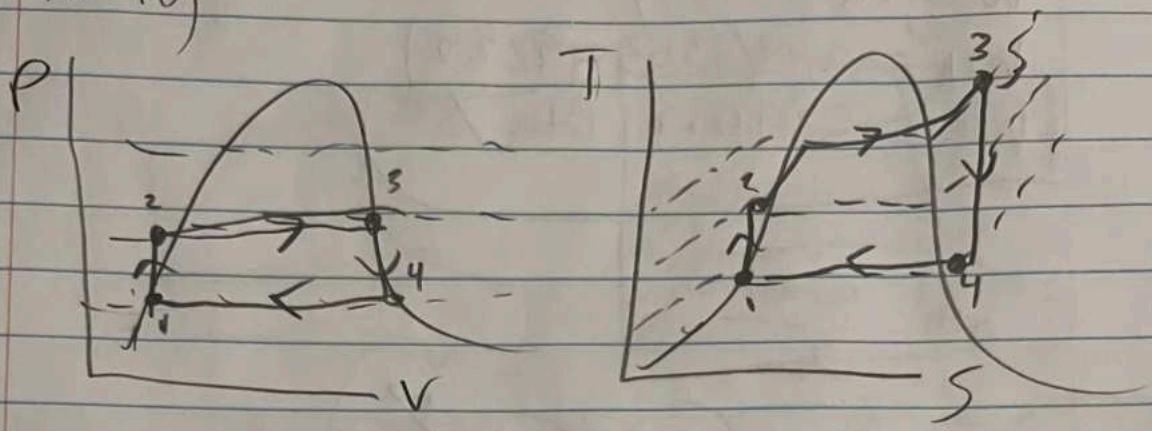
10-18)



① Isent → ② Const → ③ Isent → ④ Const

$P_1 = 2psi$ $P_2 = 1500psi$ $P_3 = 1500psi$ $P_4 = 2psi$

$h_1 = 94.0^2$ $h_2 = 99$ $H_3 = 1363$ $H_4 = 922.7$

$V_1 = 0.0162$ $V_2 =$ $V_3 = 0.435$ $S_4 = S_3$

$S_1 = 0.175$ $S_2 = S_1$ $T_3 = 800F$

$S_3 = 1.606$

$Q_{in} = h_3 - h_2$

$Q_{in} = 1363 - 99 = 1264$ Btu/lbm

$Q_{out} = h_4 - h_1$

$Q_{out} = 922.7 - 94.0^2 = 828.7$ Btu/lbm

$W_{net} = Q_{in} - Q_{out}$

$W_{net} = 1264 - 828.7 = 435.3$ Btu/lbm

$\dot{m} = \frac{\dot{W}_{net}}{W_{net}}$

$= \frac{2364.6}{435} = \boxed{5.44 \text{ lbm/s}}$

$\dot{W}_t = \dot{m}(h_3 - h_4)$

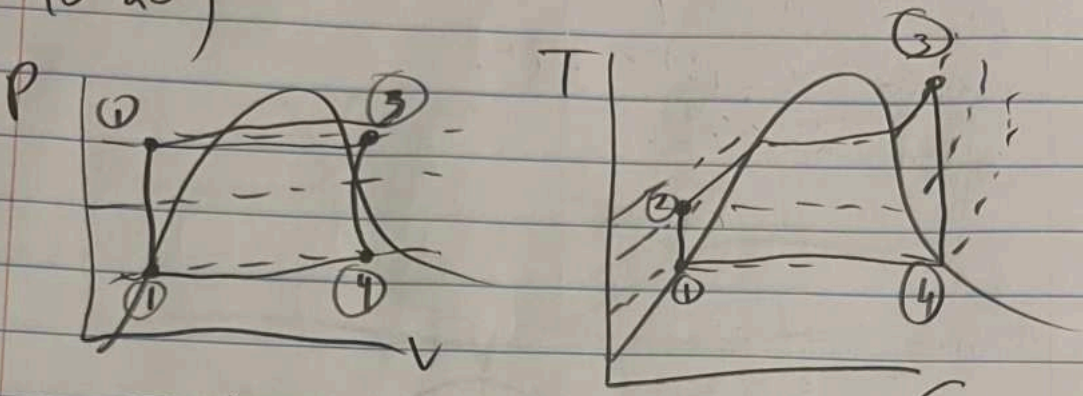
$\dot{W}_t = 5.44(1363 - 922.7)$

$\dot{W}_t = 2396.8 \text{ Btu/s}$

$\eta_{th} = \frac{W_{net}}{Q_{in}}$

$= \frac{2369.5}{5.44 \cdot 1264} = 34.4\%$

10-25)



① Isent ② const ③ Isent ④ const

①	②	③	④
$P_1 < 410$ kPa	$P_2 = 3250$ kPa	$P_3 = 3250$ kPa	$P_4 = 410$ kPa
$h_1 = 273$	$h_2 = 278.88$	$h_3 = 761.5$	$h_4 = 689.7$
$v_1 = 0.0018$		$v_3 =$	$s_4 = s_3$
		$T_3 = 147°C$	$T_4 = 179.5$
		$s_3 = 2.5457$	

$$\eta_T = \frac{h_3 - h_4}{h_3 - h_{4s}}$$

$$\eta_t = \frac{761.5 - 689.7}{761.5 - 670.4} = 78.8\%$$

$$h_2 = (v_1 (P_2 - P_1)/\eta) + h_1$$

$$h_2 = (0.0018 \cdot (3280 - 410)/0.9) + 273$$

$$h_2 = 278.68$$

$$W_{net} = W_T - W_c = \dot{m}(h_3 - h_4) - \dot{m}(h_2 - h_1)$$

$$W_{net} = 305.6(761.5 - 689.7) + (278.68 - 273)$$

$$\boxed{W_{net} = 20,206 \text{ kW}}$$

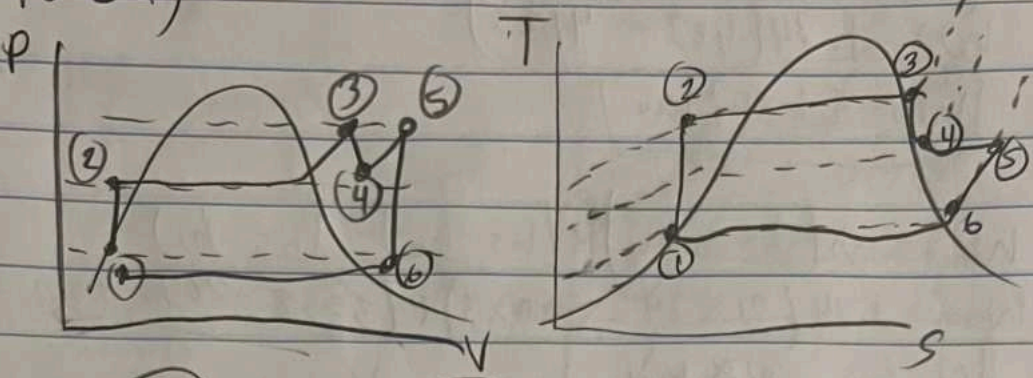
$$Q_{in} = 555.9(4.18 \cdot 160 - 90)$$

$$Q_{in} = 162,656 \text{ kW}$$

$$\eta_{th} = \frac{W_{net}}{Q_{in}} \qquad \eta_{th} = \frac{20206}{162656}$$

$$\boxed{= 12.4\%}$$

10-34)



(1) Isent (2) const (3) Isat (4) const (5) Isat (6)

$T_1 = 99.61°C$ $T_2 =$ $T_3 = 450°C$ $T_4 = 212°C$ $T_5 = 450°C$

$P_1 = 100$ kPa $P_2 = 15000$ kPa $P_3 = 15000$ kPa $P_4 = 2000$ kPa $P_5 = 2000$ kPa

$h_1 = 417.51$ $h_2 = 433$ kJ/kg $h_3 = 3157.9$ $h_4 = 2703.3$ $h_5 = 335.8$

$s_1 = 1.30$ $s_2 = s_1$ $s_3 = 6.143$ $s_4 = s_3$ $s_5 = 7.28$

$v_1 = 0.00104$

$h_2 = v_1 (P_2 - P_1)_{+h_1}$

$h_2 = 0.001043 (15000 - 100) + 417.51$

$h_2 = 433.$ kJ/kg

$x_4 = \frac{s_4 - s_f}{s_{fg}}$

$x_4 = \frac{6.143 - 2.44}{3.892}$

$x_4 = 0.9497$

$h_4 = h_f + x_4 + h_{fg}$

$h_4 = 908.4 + 0.949 (1889.8)$

$h_4 = 2703.3$ kJ/kg

$x_6 = \frac{s_4 - s_f}{s_{fg}}$

$x_6 = \frac{7.28 - 1.303}{6.056}$

$x_6 = 0.987$

$h_g = h_f + x_6 (h_{fg})$

$h_6 = 417.5 + 0.987 (225)$

$h_6 = 2646.1$ kJ/kg

$W_p = \dot{m}(h_2 - h_1)$

$\dot{W}_p = 1.74(433 - 417.5)$

$\boxed{\dot{W}_p = 26.97 \text{ kw}}$

$W_{net} = \dot{m}(h_3 - h_4) + (h_5 - h_6) - (h_2 - h_1)$

$W_{net} = 1.74(3157.9 - 2703.3) + (3358 - 2646) - (433 - 417.5)$

$\boxed{W_{net} = 2003 \text{ kw}}$

$Q_R = \dot{m} Q_{in} = \dot{m}(h_5 - h_4)$

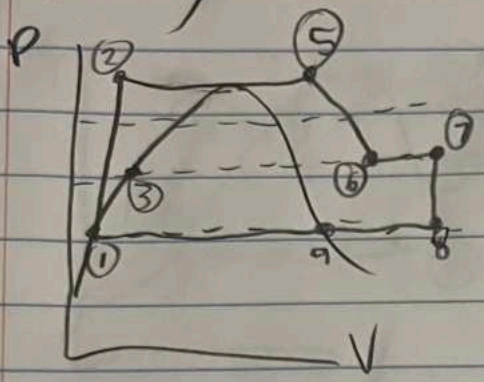
$Q_R = 1.74(3358 - 2703.3)$

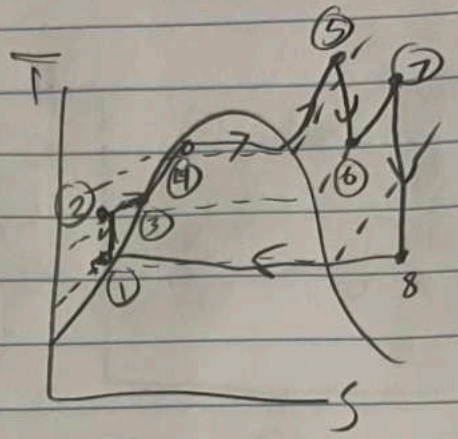
$\boxed{Q_R = 1140 \text{ kw}}$

$\eta_{th} = \frac{W_{net}}{Q_{in}}$

$\eta_{th} = \frac{1151}{3375} = \boxed{34\%}$

10-48)





①	②	③	④	⑤	⑥	⑦	⑧
$P_1 = 20 kPa$	$P_2 = 8 MPa$	$P_3 = 1 MPa$	$P_4 = 3 MPa$	$P_5 = 1 MPa$	$P_6 = 20 kPa$	$P_7 = 1 MPa$	
$x = 0$	$h_2 = 254.5$	$x_3 = 0$	$T_4 = 350$	$h_5 = 2852$	$h_6 = 2221.7$	$T_7 = 204$	
$h_1 = 251.4$	$s_2 =$	$h_3 = 762$	$h_4 = 3116$	$s_5 = s_4$	$s_6 = s_4$	$h_7 = 762$	
$s_1 = 0.832$	$v_2 =$	$s_3 = 2138$	$s_4 = 6.745$			$s_7 = 7.235$	
$v_1 = 0.001017$		$v_3 = 0.00112$					

$$w_p = h_2 - h_1$$

$$w_p = v_1 (P_2 - P_1)$$

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

$$h_2 = 0.001643 (15000 - 100) + 417.51$$

$$h_2 = 433 \text{ kJ/kg}$$

$$x_4 = \frac{s_4 - s_f}{s_{fg}}$$

$$h_4 = 908.4 + 0.9447 (1839.8)$$

$$h_4 = 2703.3 \text{ kJ/kg}$$

$$x_6 = \frac{s_4 - s_f}{s_{fg}}$$

$$x_6 = \frac{7.28 - 1.303}{6.056}$$

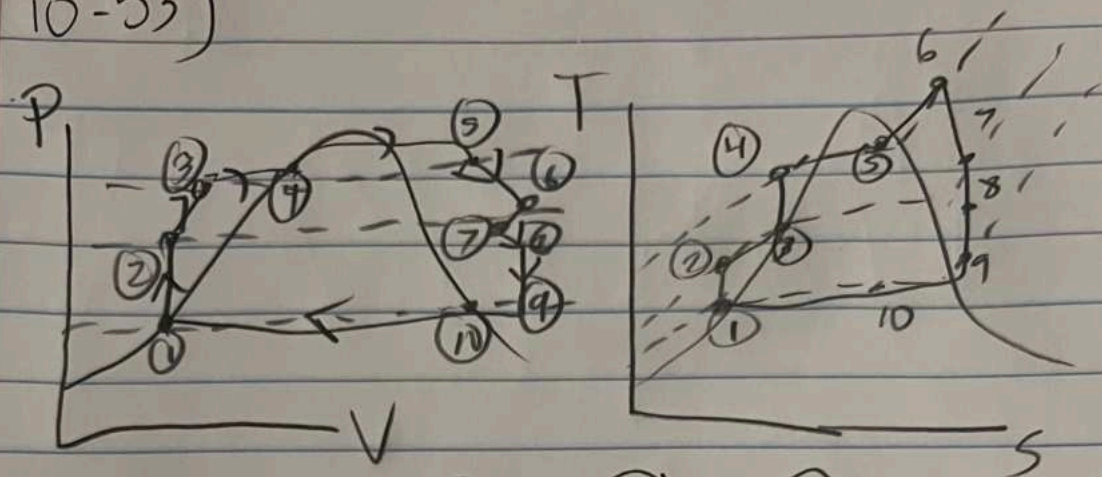
$$x_6 = 0.987$$

$$h_6 = h_f + x_6 h_{fg}$$

$$h_6 = 417.6 + 0.987 (2257$$

$$h_6 = 2646.1 \text{ kJ/kg}$$

10-53)



(1) Isent (2) Isent (3) Isent (4) const (5) pump (6) Isent (7) cond (8) Isen (9) (10)

$h_1 = 3580$ $h_2 = 3090$ $h_3 = 2960$ $h_4 = 2390$ $h_5 = 191.8$ $h_6 = 192$

$s_1 = 6.6$

$h_7 = 670$

$h_8 = 680$

$h_9 = 800$

$y_2 h_3 + y_1 h + (1 - y_1 - y_2) h_6 = h_7$

$y_2 = 0.16$

$Q_{in} = h_1 - h_9$

$Q_{in} = 3580 - 800$

$Q_{in} = 2780$ kJ/kg

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

$\eta = \frac{830}{2780}$

$\eta = 0.30$

$\eta = 30\%$

$\dot{m} = \frac{\text{Power}}{W_{net}}$

$\dot{m} = \frac{400\,000}{830}$

$\dot{m} = 480$ kg/s