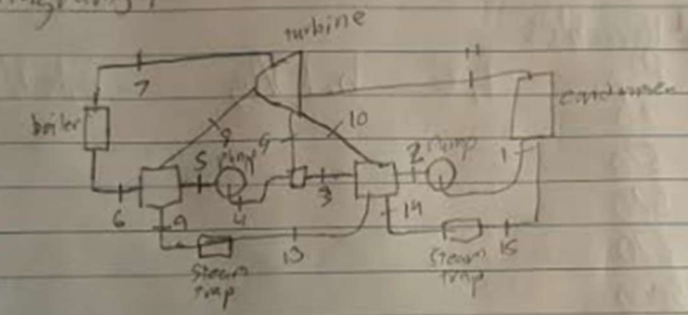
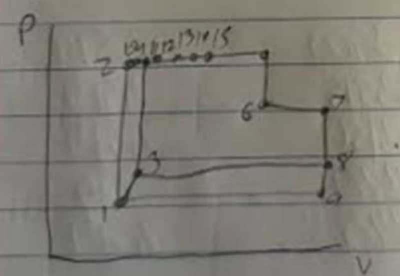
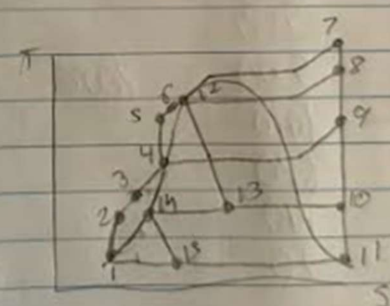
Purpose:

I Calculate the fraction of extracted mass for the open and close feedwater heater respectivly that gaurrees the proper operation of the cycle. Calculate the cooling water temperature rise in the condenser. Calculate the rate of heat rejected in the condenser.

Diagrams:







Sources:
Cengel, Boles, Kanoglu Thermodynamics and Engineering Approach 9th Edition

Design Considerations
1. water is pure
2. no heat loss in pipes

Data and Variables

state	P, kPa	T, °C	h, kJ/kg	s, kJ/kg·K
1	20			
2	620			
3	620			
4	620			
5	5000			
6	5000			
7	5000	700°C	3900	7.514
8	1910		3515	7.514
9	620		3154	7.514
10	140		2779	7.514
11	20		2428	7.514

P, kPa	T_{sat}, °C	v_f, m^3/kg	h_f, kJ/kg	s_g, kJ/kg·K
20	60.1	0.00102	251	7.907
140	109.3	0.00105	455	7.246
620	160.1	0.00110	676	6.748
1910	210.1	0.00117	898	6.356
5000	263.9	0.00129	1154	5.973

Procedure and Calculations:

I will first focus on part a of the problem, here we are looking for fraction of extracted mass, all the state calculations are shown in the art.

	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮
Enthalpy (kJ/kg)	251.42	252.03	458.37	676.09	[illegible]	858.04	[illegible]	[illegible]	3154	2799	2478	858.04	[illegible]	458.37	458.37

$h_2 = h_1 + v\Delta P = 251.42 + 0.00102 \cdot (620 - 20) = 252.03$ kJ/kg

$h_1 = h_f$ at 20 kPa $= 251.42$ kJ/kg

$h_{15} = h_3 = h_{14} = h_f$ at 140 kPa $= 458.37$ kJ/kg

$h_4 = h_f$ at 620 kPa $= 676.09$ kJ/kg

$h_6 = h_{12} = h_f$ at 1910 kPa $= 858.04$ kJ/kg

$h_9 y + (1-y) h_3 = h_4$

$3154 y + (1-y) 458.37 = 676.09$

$y = 0.081$

$$z = \frac{(h_4 - h_2)(1-y)}{h_{10} - h_{14}} = \frac{(676.09 - 252.03)(1 - 0.081)}{2799 - 458.37}$$

$z = 0.17$

a

$y = 0.081$

$z = 0.17$

$Q_{out} = m(h_{11} - h_{12}) = 100(2478 - 898.04)$
$Q_{out} = 157996$ kW

$Q_{out} = m_{cw} C_p \Delta T \rightarrow 157996 = 4200 \cdot 4.18 \cdot \Delta T$
$\Delta T = 9.00\ °C$ ✓ b

$W_T = 100 \cdot (3900 - 3515) = 38800$ kW
$W_{P1} = 100(252.03 - 251.42) = 61$
$W_{P2} = 100(676.09 - 458.37) = 21772$
$W_{net} = 38800 - 61 - 21772$
$W_{net} = 16668$ kW ✓ c

$Q = m_{cw} \cdot C_p \Delta T = 4200 \cdot 4.18 \cdot 9$
$Q_{out} = 158{,}004$ KW ✓ c

$Q_{in} = m(h_7 - h_6) = 100(3900 - 898.04)$
$Q_{in} = 300{,}196$ KW

✓ c

$\eta = 1 - \frac{Q_{out}}{Q_{in}} = 1 - \frac{158004}{300196} = 0.474 = 47.4\%$

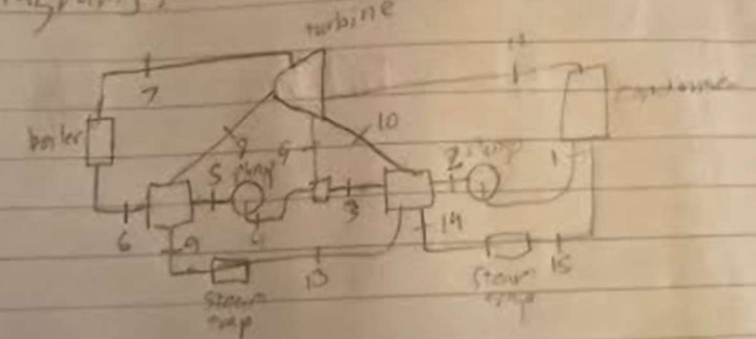
Summary:
The extracted mass y and x were 0.081 and 0.17 respectivly. The change in temperature for the cooling water was 9°C. The heat output was 158,004 kW, the net power was 16668 kW, and the thermal efficiency was 47.3%.

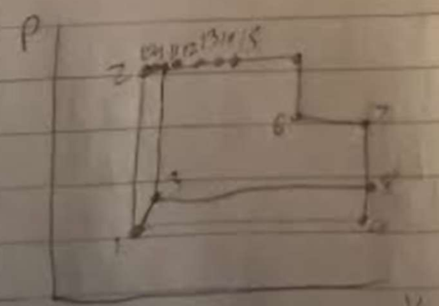
Analysis:
In this problem a lot of the answers rely on enthalpy even a slight change in the enthalpy will case a massive shift in answers.

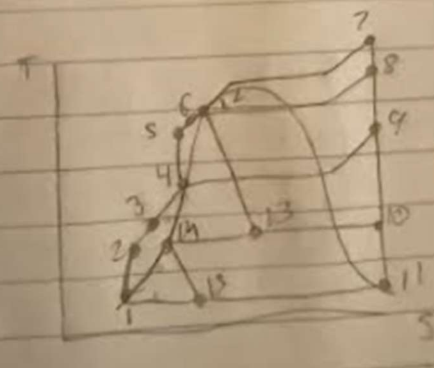
Purpose:

2 Calculate the fraction of extracted mass for open feedwater heater respectively, that guarantees the proper operation of the cycle. Calculate the cooling water temperature rise in the condenser. Calculate the rate of heat rejected in the condenser.

Diagrams:







Sources:
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Design Considerations
1. water is pure
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Data and Variables

state	P, kpa	T, °C	h, kJ/kg	s, kJ/kg·K
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4	620			
5	5000			
6	5000			
7	5000	700°C	3900	7.514
8	1910		3515	7.514
9	620		3154	7.514
10	140		2794	7.514
11	20		2478	7.514

P, kPa	T_{sat}, °C	v_f, m³/kg	h_f, kJ/kg	s_g, kJ/kg·K
20	60.1	0.00102	251	7.907
140	109.3	0.00105	455	7.246
620	160.1	0.00110	676	6.748
1910	210.1	0.00117	898	6.356
5000	263.9	0.00129	1154	5.973

Procedure and Calculations:
I will first focus on part a of the problem. here we are looking for fraction of extracted mass. All the state calculations are shown in the work.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
enthalpy (kJ/kg)	251.42	252.03	458.37	676.09	[illegible]	898.04	3350	3515	3164	2764	2078	898.04	458.37	458.37	458.37

$h_2 = h_1 + v\Delta P = 251.42 + 0.00102 \cdot (620-20) = 252.03$ kJ/kg

$h_1 = h_f$ at 20 kPa = 251.42 kJ/kg

$h_{15} = h_3 = h_{14} = h_f$ at 140 kPa = 458.37 kJ/kg

$h_4 = h_f$ at 620 kPa = 676.09 kJ/kg

$h_6 = h_{12} = h_f$ at 1910 kPa = 898.04 kJ/kg

$m_9 = y \cdot 100$

$m_{10} = (1-y) \cdot 100$

$m_1 = 100$ kg/s

$m_9 h_9 + m_{10} h_{10} = m_1 h_1$

$3154(y \cdot 100) + 2799((1-y) \cdot 100) = 100(458.37)$

$315400y + 279900 - 279900y = 45837$

$35500y = -234063$

$y = 0.659$ ← A

$Q_{out} = 100(2478 - 899.04)$

$= 157996$

$Q_{out} = m_{cw} C_p \Delta T$

$157996 = 2400 \cdot 4.18 \Delta T$

$\Delta T = 9.00°C$ ← B

$Q = m_a C_p \Delta T = 4200 \cdot 4.18 \cdot 9$

$Q_{in} = 158004$ kW ← C

$Q_{in} = m(h_7 - h_6) = 100(3900 - 898.04)$

$Q_{in} = 300196$

$\eta_{th} = 1 - \frac{Q_{out}}{Q_{in}} = 1 - \frac{158004}{300196} = 47.4\%$ ← C

$W_T = 100(3900 - 3515) = 38500$ kW

$W_{p1} = 100(252.03 - 251.42) = 61$ kW

$W_{p2} = 100(676.05 - 458.37) = 21772$ kW

$W_{net} = 38500 - 61 - 21772$

$W_{net} = 16668$ kW

Summary:
The extracted mass was 0.659. The change in temperature for the cooling water was 9°C. The heat output was 158004kW, the net power was 16668kW, and the thermal efficiency was 47.39%.

Analysis:
The only real change was the extracted mass. This could just mean the machine is still working just going through one spot.