

MET 355

Test 2

Mizell Smalls

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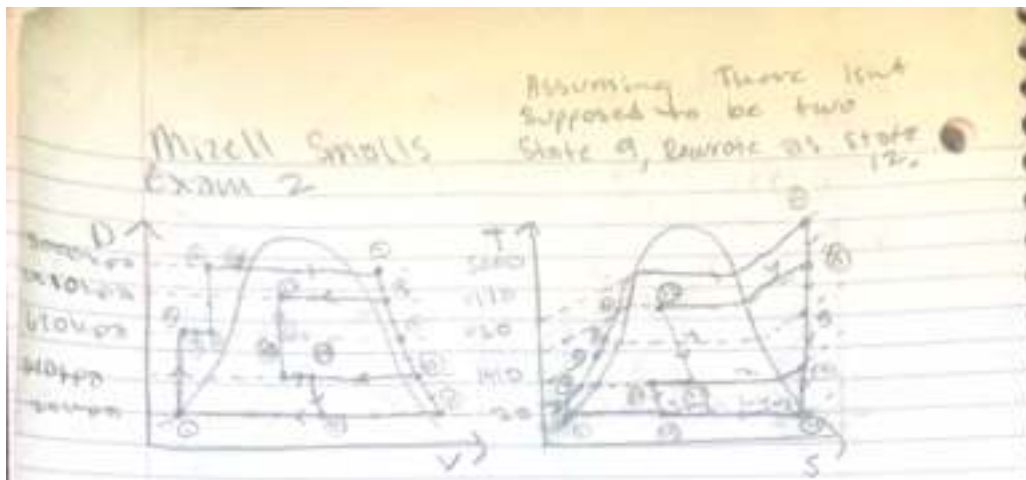
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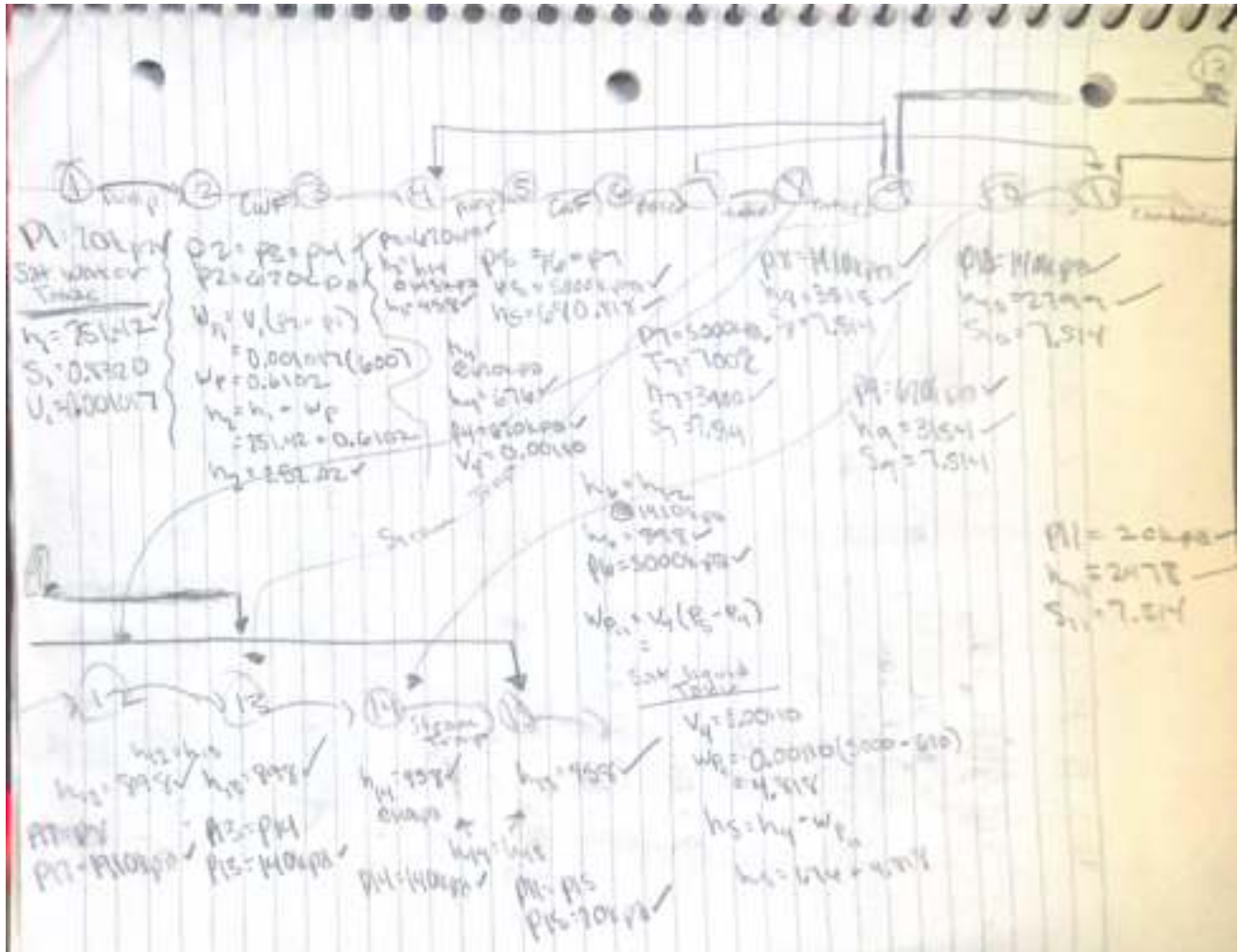
1.

**PURPOSE:**

- (a) Determine the fraction of extracted mass “y” and “z” for the open and closed feedwater heater respectively that guarantees the proper operation of the cycle.
- (b) Determine the cooling water temperature rise in the condenser, in °C, when the cooling water flow rate is 4200 kg/s. Assume  $C_p = 4.18 \text{ kJ/kg}\cdot\text{K}$  for cooling water.
- (c) Determine the rate of heat rejected in the condenser, the produced net power, and the thermal efficiency of the plant.

**DIAGRAM & VARIABLES:**





## SOURCES:

I used my Notes from class, Previous Homework, & Appendix (SI units)

## DESIGN CONSIDERATIONS

After reading the question, I assumed that it was an Ideal Rankine Cycle, Closed Feedwater heater @1910kpa Malfunctions, Cooling water flow rate is 4200kg/s, &  $C_p = 4.18 \text{ kJ/kg} \cdot \text{K}$

**PROCEDURE & CALCULATIONS:**

$$\dot{m} = 100 \text{ kg/s} \quad C_p = 4.18 \text{ kJ/kg}\cdot\text{K}$$

$$1A) y h_g + (1-y) h_3 = h_4 \quad \text{@ open Feed water Heater}$$

$$y(h_g - h_3) = h_4 - h_3$$

$$y = \frac{h_4 - h_3}{h_g - h_3} = \frac{676 - 458}{2694 - 458} = \frac{218}{2236}$$

$$y = 0.097$$

$$1h_2 + 2h_{10} + y h_{13} = h_3 + (y+z) h_{11} \quad \text{@ closed Feed water Heater @ 1910 kPa}$$

$$z = \frac{(h_3 - h_2) + y(h_{11} - h_{13})}{h_{10} - h_{11}}$$

$$z = \frac{(458 - 252.02) + (0.097)(458 - 298)}{2799 - 458}$$

$$= \frac{(105.98) + (-35.64)}{2341} = z = 0.072$$

$$1b) Q = \dot{m} c_p \Delta T \quad (c_p = 4.18 \quad \dot{m}_w = 4200)$$

$$W_T = \dot{m} (h_1 - h_{11})$$

$$= 100 (2100 - 2479)$$

$$= 142,200$$

$$Q_{in} = \dot{m} (h_2 - h_6)$$

$$= 100 (2101 - 898)$$

$$= 300,200$$

$$Q = Q_{in} - W_T$$

$$Q = 300,200 - 142,200$$

$$Q = 158,000$$

$$\Delta T = \frac{Q}{\dot{m} c_p} \rightarrow \frac{158,000}{4200 (4.18)} = \frac{158,000}{17556} = 8.99$$

$$\Delta T = 8.99$$

$$1c) Q_{out} = \dot{m} (h_{11} - h_1)$$

$$= 100 (2479 - 2101.42)$$

$$Q_{out} = 222,658$$

$$W_{net} = W_T - W_{P1} - W_{P2}$$

$$W_{P1} = \dot{m} (h_2 - h_1) \rightarrow 100 (2152.02 - 2101.42)$$

$$W_{P2} = \dot{m} (h_5 - h_4) \rightarrow 100 (420.918 - 616)$$

$$W_{net} = 142,200 - 60 - 481.1$$

$$W_{net} = 141,458.2 \quad W_{P1} = 60 \quad W_{P2} = 481.1$$

$$\eta_{th} = \frac{W_{net}}{Q_{in}} \rightarrow \frac{141,458.2}{300,200} \quad \eta_{th} = 0.471 \quad 47.1\%$$

## **SUMMARY:**

The extracted mass “Y” for the open feedwater heater is **0.081**, and the extracted mass for “z” for the closed feedwater heater is **0.072**

The cooling water temperature rise is **8.99°C**

The rate of heat rejected in the condenser is **222,658kj/kg**, the produced net power is **141,458.2kw**, and the thermal efficiency is **47.1%**

## **MATERIALS:**

Closed Feedwater Heater

Open Feedwater Heater

Condenser

2 pumps

Boiler

Turbine

2 Steam Trap

## **ANALYSIS:**

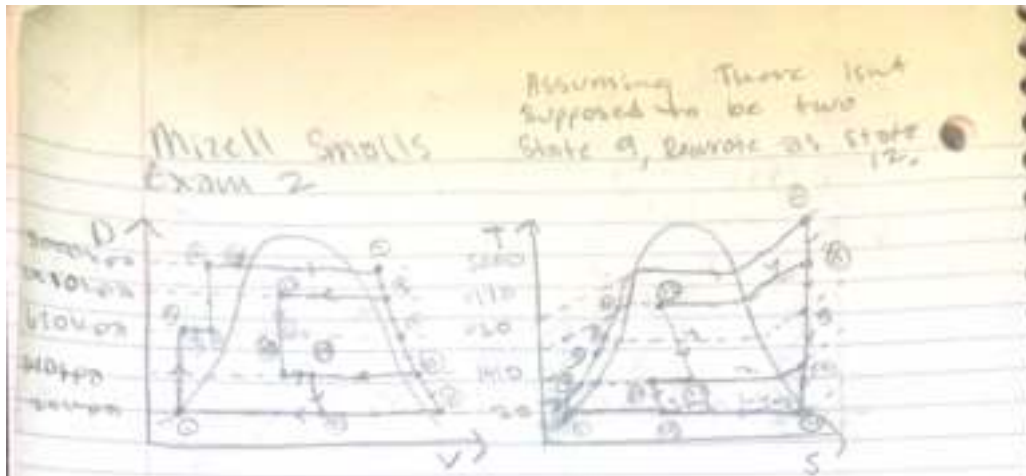
My answers seem to line up with what we've done in class and on homework based on regenerative Rankine cycles, so they feel reasonable. The calculations follow the same patterns we've practiced in class and on previous assignments, so I assume they make sense.

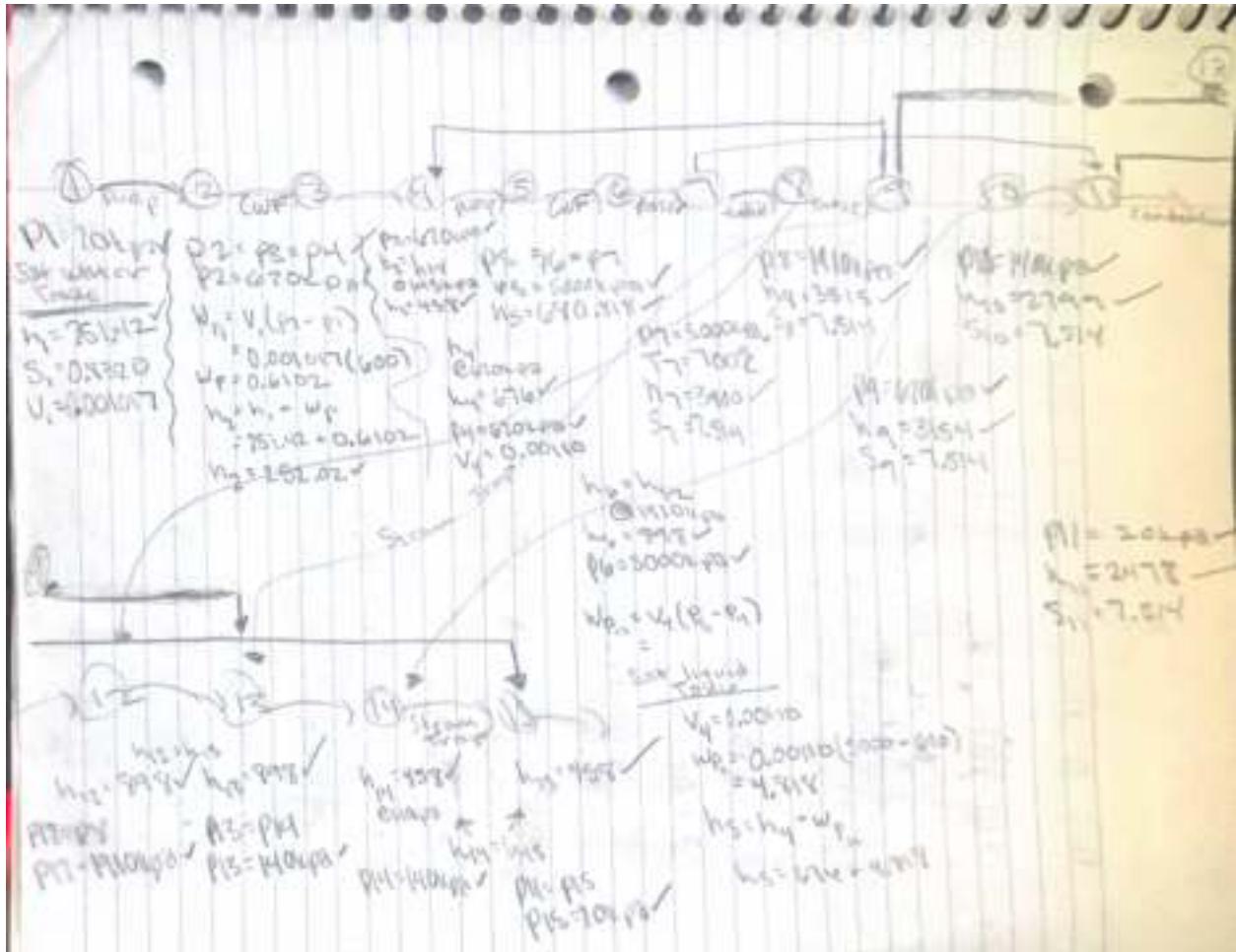
2.

**PURPOSE:**

- (A) Determine the fraction of mass “y” extracted for the open feedwater heater that guarantees the proper operation of the cycle.
- (B) Determine the cooling water temperature rise in the condenser, in °C, when the cooling water flow rate is 4200 kg/s. Assume  $C_p = 4.18 \text{ kJ/kg}\cdot\text{K}$  for cooling water.
- (C) Determine the rate of heat rejected in the condenser, the produced net power, and the thermal efficiency of the plant.

**DIAGRAMS AND VARIABLES:**





**SOURCES:**

I used my Notes from class, Previous Homework, & Appendix (SI units)

**DESIGN CONSIDERATIONS:**

After reading the question, I assumed that it was an Ideal Rankine Cycle, both steam traps malfunction, & the cooling water flow rate is 4200kg/s, &  $C_p = 4.18 \text{ kJ/kg}\cdot\text{K}$

PROCEDURE & CALCULATIONS:

$$2A) \dot{m} h_7 = (y \dot{m} h_7 + (1-y) \dot{m} h_1)$$

$$h_7 = y h_7 + (1-y) h_1$$

$$h_7 - h_1 = y(h_7 - h_1)$$

$$y = \frac{h_7 - h_1}{h_7 - h_1} \rightarrow \frac{3900 - 251.42}{3900 - 251.42}$$

$$\boxed{y = 1}$$

$$2b) \dot{q}_{in} = \dot{m}(h_{11} - h_1) \\ = 100(2178 - 251.42) \\ \dot{q}_{in} = 222,658$$

$$\Delta T = \frac{222,658}{4200(4.18)} \rightarrow \frac{222,658}{17556}$$

$$\boxed{\Delta T = 12.68}$$

$$2c) \dot{Q}_{out} = \dot{m}(h_4 - h_1) \\ = 100(2178 - 251.42)$$

$$\boxed{\dot{Q}_{out} = 222,658}$$

$$W_{net} = W_T - W_{P_1} - W_{P_2} \quad W_{P_1} = 60 \\ = 147,200 - 60 - 481.8 \quad W_{P_2} = 481.8 \\ \boxed{W_{net} = 141,458.2} \quad W_T = 147,200$$

$$\eta_{in} = \frac{W_{net}}{\dot{q}_{in}} \rightarrow \frac{141,458}{222,658} \rightarrow \boxed{\eta_{in} = 0.635}$$

64%

## **SUMMARY:**

The extracted mass “Y” for the open feedwater heater is 1

The cooling water temperature rise is 12.68°C

The rate of heat rejected in the condenser is 222,658kj/kg, the produced net power is 141,458.2kw, and the thermal efficiency is 63.5%

## **MATERIALS:**

Closed Feedwater Heater

Open Feedwater Heater

Condenser

2 pumps

Boiler

Turbine

2 Steam Trap

## **ANALYSIS:**

My answers match what we've covered in class and on homework about regenerative Rankine cycles, so they seem reasonable. Since both steam traps malfunctioned, this led the fraction of mass “Y” extracted for the open feedwater heater to be equal to 1.