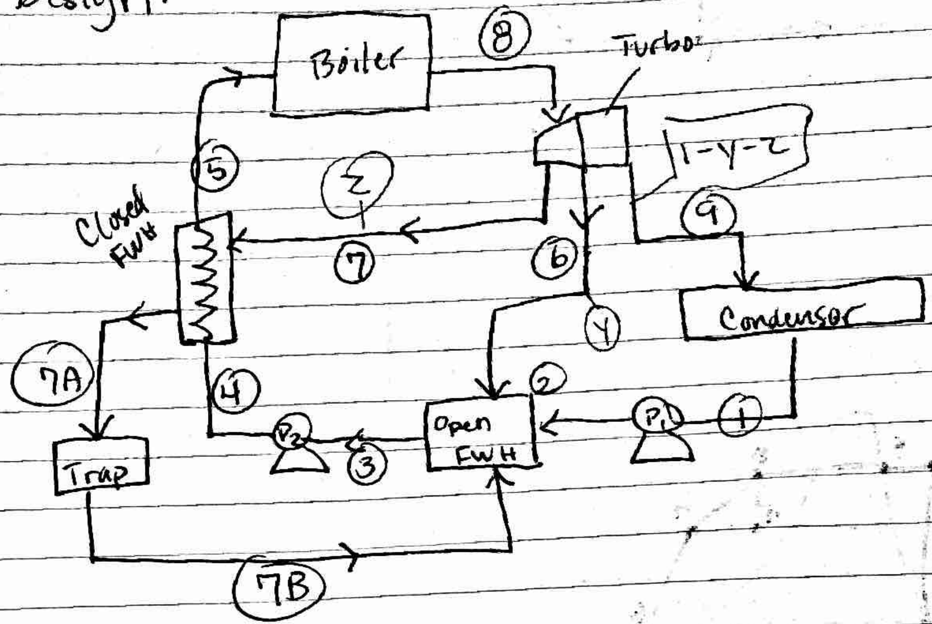
Test 2

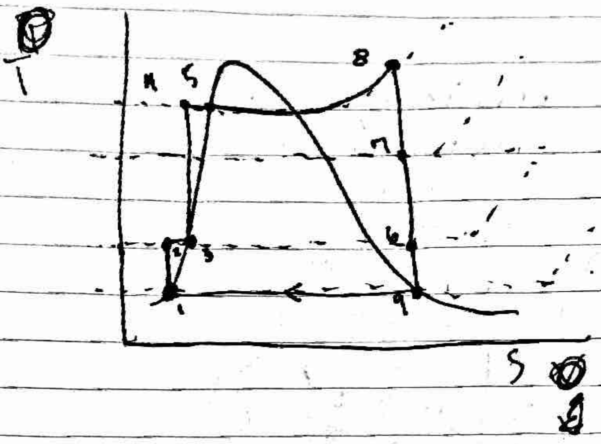
Purpose: Find thermal efficiency and the specific net work

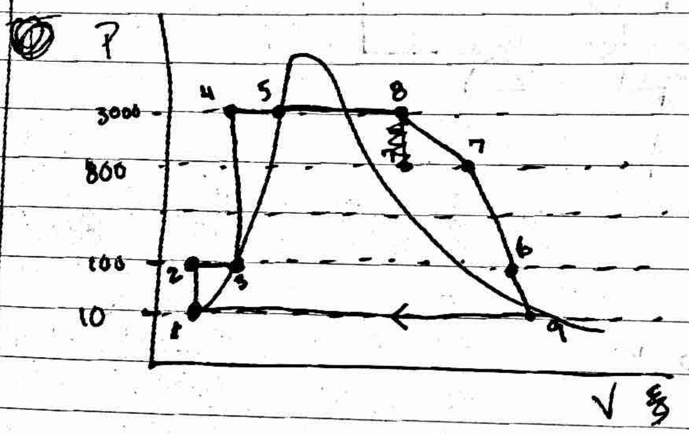
Design:



Source: Lecture, Book

Design Consideration: open FWH
closed FWH
Rankine Cycle





Quality = how much vapor
x is liquid

P_{const} $1-y-z$ → 1 $\xrightarrow{\text{Isent.}}$ 2 $\xrightarrow{\text{Pconst.}}$ 3 $\xrightarrow{\text{Isent.}}$ 4 $\xrightarrow{\text{Pconst}}$ 5 $\xrightarrow{\text{Pconst.}}$ 6   7 $\xrightarrow{\text{Pconst.}}$ 7a   7b   8 → 9

Isent. y   Isent. z   Isent.

$P_{const.}$

$w_p = v_1(P_2 - P_1)$

$x = \frac{h - h_f}{h_{fg}} = x = \frac{s - s_f}{s_{fg}}$

7 = z

6 = y

9 = 1 - y - z

1	2	3	4	5	6	7	7a	7b	8	9
$P_1 = 10kPa$	$P_2 = 100kPa$	$P_2 = P_3$	$P_4 = 3MPa$ $3\times10^3 kPa$	$P_5 = P_4$	$P_6 = 100kPa$ $S_6 = S_8$	$P_7 = .8MPa$ $.8\times10^3 kPa$	$P_7 = P_{7a}$	$P_{7b} = 100$	$T_8 = 673.15$ $P_8 = 3MPa$ $3\times10^3 kPa$	$P_9 = 10k$

$x_1 = 0$

Table A5

A-5 State 1

$h_1 = 191.81$ kJ/kg

$v_1 = .001010$ m³/kg

$s_1 = 0.6492$ kJ/kg·K

State 2

$s_1 = s_2$

$h_2 = 191.9009$ kJ/kg

State 3

$h_3 = 417.51$ kJ/kg

$v_3 = .001043$ m³/kg

$s_3 = 1.3028$ kJ/kg·K

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

$h_2 = 191.9009$ kJ/kg

4

$h_4 = h_3 + w_{p_2}$

$v_4 =$

$s_4 = s_3$

$h_4 = h_3 + .001043(3000-100)$

$h_4 = 420.5347$ kJ/kg

$h_5 = 1008.3$ kJ/kg

$v_5 = .001217$ m³/kg

$s_5 = 2.6454$ kJ/kg·K

$h_8 = 3231.7$ kJ/kg

$s_6 = s_8 = 6.9235$ kJ/kg·K

$v_8 = .09938$ m³/kg

$x = \frac{s_6 - s_f}{s_{fg}} = \frac{s_6 - 1.3028 \text{ kJ/kg}}{6.0562}$

$x = .9280$

$x = \frac{h - h_f}{h_{fg}}$

$.9280(2257.6) + 417.51$

$h_6 = 2512.56$ kJ/kg

$s_7 = s_8$

$s_7 = 6.9235$

$h_7 = 2884.46$

$h_{7b} = 417.51$

$h_{7a} = 417.5$

$x = \frac{s_9 - s_f}{}$ $\frac{6.9235 - .6492}{7.4996}$

$x = .83661$

$.83661 = \frac{h_9 - h_f}{h_{fg}}$

$.83662 = \frac{h - 191.81}{2392.1}$

$h_9 = 2193.0647$

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

Closed $z(h_7 - h_{7a}) = h_5 - h_4$

Open $h_6 - h_2 =$

$y h_6 - (1-y-z)h_2 - z h_{7b} = h_3$

$z(2884.463 - 417.15) = 1008.3 - 420.5347$

$z\,2467.313 = 587.7653$

$z = .23822$

$y(2512.56) - (1 - y - .23822)191.9009 - .23822(417.51) =$

417.51 $\qquad y = .2452$

$$\eta_{th} = w_{net} / q_{in}$$

$$w_{net} = q_{in} - q_{out}$$

$$= h_8 - h_5$$

$$Q_{in} = 3231.7 - 1008.3 = 2223.4$$

$$Q_{out} = h_9 - h_1(1 - y - z)$$

$$2193.064 - 191.81(1 - .2452 - .2382)$$

$$(2001.254)(.5166)$$

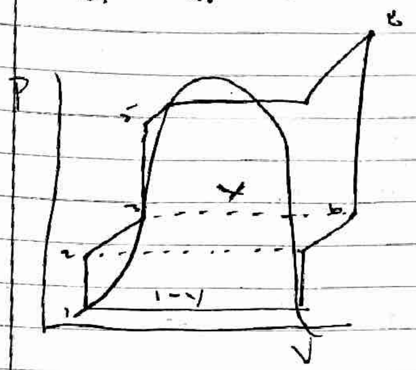
$$= 1033.84$$

$$2223.4 - 1033.84$$

$$\eta_{th} = \frac{1189.56}{2223.4} = .535$$

$$\boxed{53.5\%}$$

2 #1 ~~[illegible]~~ = ~~[illegible]~~ ~~[illegible]~~



$y = \frac{h_3 - h_2}{h_6 - h_2}$

$\frac{417.51 - 191.9009}{2517.56 - 191.9009}$

$y = .097$

$Q_{in} = h_6 - h_5$

$3231.7 - 1008.3$

$= 2223.4$

$Q_{out} = h_8 - h_1 (1-y)$

$(2193.064 - 191.81)(1 - .097)$

1807.132

$W_{net} = Q_i - Q_o$

$$\begin{array}{r} 2223.400 \\ -1807.132 \\ \hline 416.268 \end{array}$$

$\eta_{th} = \frac{416.268}{2223.4} = 18.7\%$

Procedure

#1 : Find all states
Find variables
Find PV and TS diagram
Then solve for w_{net}, q_{in}, q_{out}, η_{th}

#2 : Use states from #1 but change state
due to different design.
- Find y
- Find q_{in}, q_{out}, η_{th}, w_{net}

Analysis: Both are using turbine steam to function. Due to the valve being closed the eff. of the system will drop. The first design is 53.5%
eff.

Summary: The power plant work w/ an ideal steam regenerative cycle. It consist of two pumps, CFWH, OFWH, along w/ a trap. The plant is fully functional and seem to be efficient enough to continue operation for many years. After sometime, basic repair and maintenance is required.