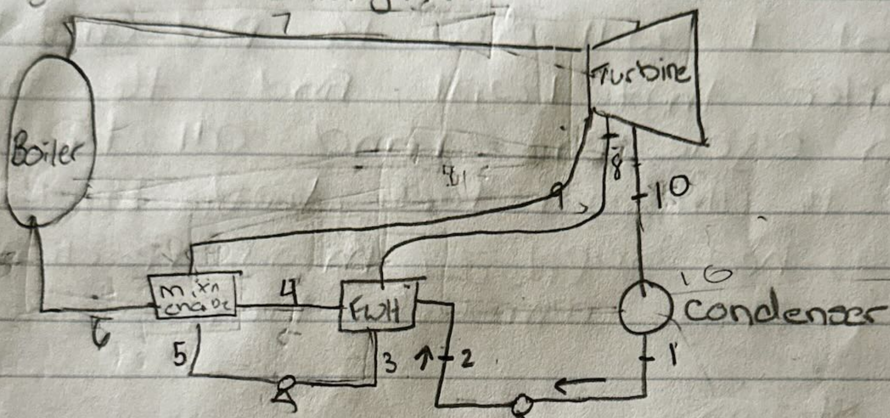
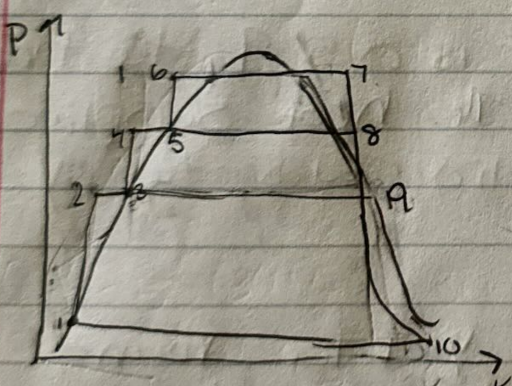
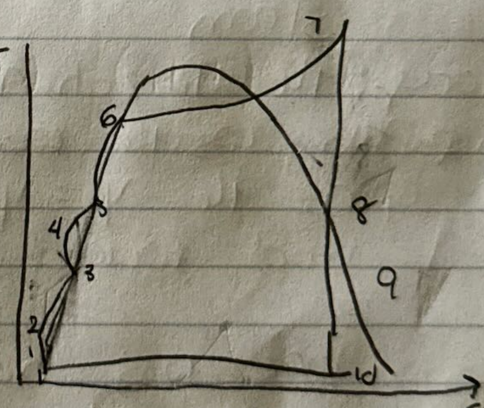
Aaliyah Ashley 3/18/24

Purpose: Determine the Utizalation factor, P-v and T-s diagrams, the turbine work per kg, for a 50,000 kW load the mass steam enterinsg the turbine, the heat supplied to the working areas for the conditions in di all the states of the cycles, mass fractions y_2 and y_1, and the rate of heat removed in the consendser.

Drawings and diagrams:







Sources: Cengel Yunus and Bogel Micheal, thermodynami and Engineering Approach, 9th edition

Design considerations:
1) Steam used at power plant to generate electricity
2) Steam is getting heated

Data and variables:
$P_1 = 15$ kpa P_2 and $P_3 = 150$ kpa $P_7 = 5.5$ mpa $P_6 = 600$ kpa
$T = 500°C$
$y_2 = y_1$

Procedure: First I will draw the P-V and T-s diagrams. After that I will find the states of each cycle. Once I find all the states I will find the utilization factor, turbine work per kg, mass flow, heat supplied, mass fractions and rate of heat removed from condensor.

materials: steam

Summary: The utilization factor is 0.559, the turbine work per kg is the work out, the heat supplied is the q_{in}. the $y_1 = y_2$ ratio was the y that I had found.

Analysis: There was not a y value found when doing the states. So I found the y to solve for the q_{out} and $W_{turbine}$.

? cont

1 isen 2 P-const 3 isen 4 P con 5 isen 6 isent 7 isen 8 isen 9 isen 10

State 1:
$P_1 = 15\ kPa$
$h_1 = 225.94\ kJ/kg$
$v_1 = 0.001014\ m^3/kg$

$W_P = v_1(P_2 - P_1)$
$= 0.001014(150-15)$
$= 0.13689$
$h_2 = W_P + h_1 = 0.13689 + 225.94$
$h_2 = 226.08$

State 2:
$P_2 = 150$
$h_2 = 226.08$

State 3:
$P_3 = 150\ kPa$
$h_3 = 467.13$
$v_3 = 0.001053$

$W_P = v_3(P_4 - P_3)$
$= 0.001053(600-150)$
$= 0.47385$
$h_4 = 0.4785 + 467.13$
$= 467.604$

State 4:
$P_4 = 600\ kPa$
$h_4 = 467.604$

State 5:
$P_5 = 600$
$h_5 = 670.38$
$v_5 = 0.001101$

$W_P = v_5(P_6 - P_5)$
$W_P = 0.001101(5500-600)$
$= 5.3949$
$h_6 = 5.3949 + 670.38$

State 6:
$P_6 = 5500$
$h_6 = 675.77$

State 7:
$P_7 = 5.5$
$h_7 = 3429$
$s_7 = 6.93$

State 8:
$P_8 = 600\ kPa$
$h_8 = 2846$
$s_8 = 6.93$

State 9:
$P_9 = 150\ kPa$
$s_8 = s_9$
$x_9 = \frac{6.93 - 1.4337}{5.7894}$
$= 0.9493$
$h_9 = 467.13 + 0.9493 \times 2226.0$
$= 2624.79$

State 10:
$P_{10} = 15\ kPa$
$s_{10} = s_9$
$x_{10} = \frac{6.93 - 0.7549}{7.2522}$
$x_{10} = 0.8514$
$h_{10} = 225.94 + 0.8514 \times 2373$
$= 2245.71$

(a) $Q_{in} = h_7 - h_6 = 3429 - 675 = 2754$

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

$Q_{out} = (1-0.536)(2846 - 225.94) = 1215.708$

$y = \frac{h_3 - h_2}{h_{10} - h_2} = \frac{467.13 - 226.08}{675.77 - 226.08} = 0.536$

$\varepsilon_{th} = 1 - \frac{1215.708}{2754} = \boxed{0.559}$

(c) $W_{out} = (h_7 - h_8) + (1-y)(h_8 - h_9) + (1-y)(h_9 - h_{10}) = 861.53\ kJ/kg$

$\boxed{\text{turbine work per kg: } 861.53\ kJ/kg}$

(d) $\dot{m} = \frac{50{,}000\ kW}{861.53} = \boxed{58.036\ kg/s}$

(e) heat supplied is $\boxed{2754\ kJ/kg}$

(g) $y = \dot{m}_s / \dot{m}_a$

$0.536 = \dot{m}/58.036$

$\dot{m} = 31.107$

$y = \frac{31.107}{58.036}$

$\boxed{y_1 = y_2 = 0.536}$

(h) $\dot{m}_h = \frac{\dot{m}(h_{10} - h_1)}{58.036}$

$\dot{m}_h = \frac{31.107(2245.71 - 225.94)}{58.0336} = 1082.63$