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Professor Ayala

MET 350

02/18/2024

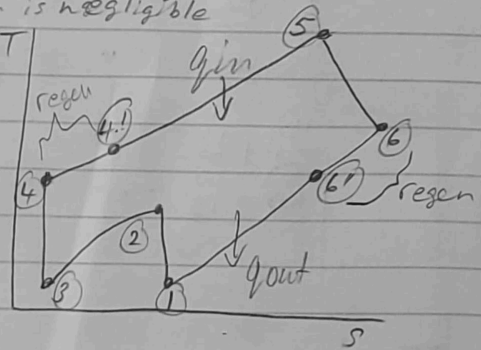
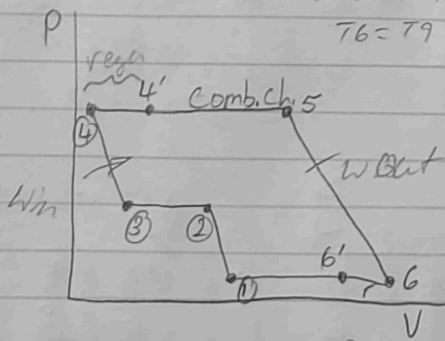
Test 1

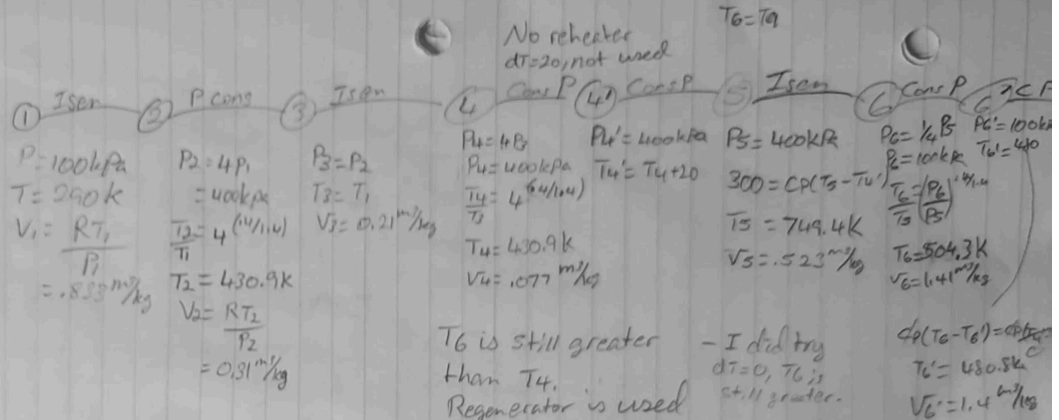
Test 1

- 1) - Air enters gas turbine w. 2 stages of comp. & 2 stages of expansion.
- $T = 17^\circ\text{C}$, $P = 100\text{ kPa}$ @ air inlet
- $r_p = 4$
- 300 kJ/kg at each combustion chamber
- no reheater!
- C_p & C_v constant $C_p = 1.005\text{ kJ/kg}\cdot\text{K}$, $C_v = 0.7186\text{ kJ/kg}\cdot\text{K}$
 $k = 1.4$

If T_6 is lower than T_4 , regen is negligible

$T_6 = T_9$ from original T





$$\dot{W}_{\text{net}} = \dot{W}_{5-6} - \dot{W}_{1-2} - \dot{W}_{3-4} = -33/300 = -11\%$$

$$\dot{W}_{5-6} = CP(T_5 - T_6) = 245.1 \text{ kJ/kg}$$

$$\dot{W}_{1-2} = CP(T_2 - T_1) = 141.6 \text{ kJ/kg}$$

$$\dot{W}_{3-4} = CP(T_4 - T_3) = 141.6 \text{ kJ/kg}$$

$$\dot{W}_{5-6} \times 2 = 490.2 \text{ kJ/kg} - 283.2$$

$$\eta = \frac{207}{300} = 69\%$$

2 x turbines

η_{th} is greater because, flow is constant through both turbines. No extra \dot{Q}_{in}

800 kW @ full load

$$800 = \dot{m} (226.8)$$

$$\dot{m} = 3.53 \text{ kg/s}$$

@ partial load

$$\dot{W}_{\text{net}} = 3.53 (207) = 730.7 \text{ kW}$$

1. reheater turned OFF

2)

- Pure jet engine

- Vaircraft: 240 m/s

- $P_1 = 45 \text{ kPa}$, $T_1 = 2160.15 \text{ K}$

- Engine inlet = 1.6 m

- $\text{PR} = 13$

- Inlet turbine = $557^\circ\text{C} = 830.15 \text{ K}$

- $\eta_c = .80$ $\eta_T = .85$

Variable: c_p, c_v

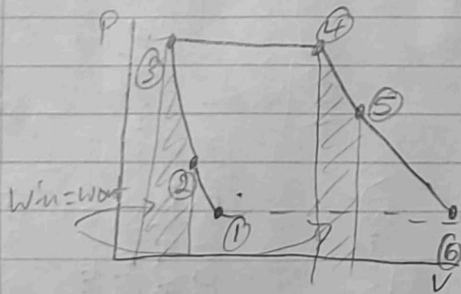
@ 260.15 K $c_p = 1.003$

$c_v = .716$

$k = 1.401$

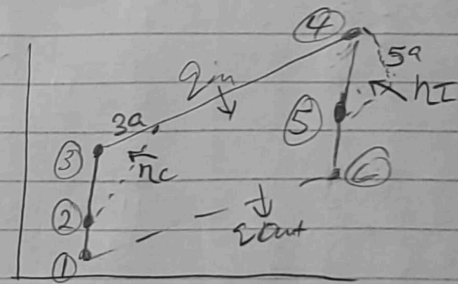
$$\eta_p = \frac{\dot{W}_p}{\dot{Q}_{in}}$$

η_{prop} ? compare to original on 9-142



$$\eta_c = \frac{h_3 - h_2}{h_{3a} - h_2}$$

$$\eta_T = \frac{h_4 - h_{5a}}{h_4 - h_5}$$



All "h"
interpolated
by online
Calc.

$$\eta_p = \frac{\dot{W}_p}{\dot{Q}_{in}}$$

① Isent

$$P_1 = 45 \text{ kPa}$$

$$T_1 = 260.15 \text{ K}$$

$$V_1 = \frac{RT_1}{P_1} = 1.659 \text{ m/s}$$

$$V_1 = 240 \text{ m/s}$$

$$h_1 = 260.09$$

$$P_{r1} = 0.8405$$

$$\dot{m} = 290.8 \text{ kg/s}$$

New

$$F = \frac{V_1}{\sqrt{1}} \frac{\pi}{4} D^2 (V_6 - V_1)$$

$$= 147,178.8 \text{ N}$$

$$\dot{W}_p = 35824.9$$

$$\dot{Q} = 51209.9$$

$$\eta_p = 68.9\%$$

② Isent

$$V_2 = 0 \text{ m/s}$$

$$V_2^2 + h_1 = 0 + h_2$$

$$\frac{V_2^2}{2} + h_1 = h_2$$

$$\frac{0}{2} + 260.09 = h_2$$

$$h_2 = 288.9 \text{ kJ/kg}$$

$$T_2 = 288.7 \text{ K}$$

$$P_{r2} = 1.21$$

$$\frac{P_2}{P_1} = \frac{P_{r2}}{P_{r1}}$$

$$P_2 = 64.8 \text{ kPa}$$

$$V_2 = 1.27$$

③ P const

$$V_3 = 0 \text{ m/s}$$

$$P_3 = 13 \text{ Pa}$$

$$P_3 = 842.4$$

$$T_3 = 584.3 \text{ K}$$

$$V_3 = 0.202 \text{ m/s}$$

$$h_3 = 601.03 \text{ kJ/kg}$$

$$\eta_c = \frac{h_3 - h_2}{h_{3a} - h_2}$$

$$0.80 = \frac{h_3 - h_2}{h_{3a} - h_2}$$

$$h_{3a} = 679.1 \text{ kJ/kg}$$

$$P_{r3} = 13(P_{r2})$$

$$= 15.73$$

$$P_{r4} = h_4 - h_{3a} = 176.1$$

η_p changes. That is
because of lower
exit velocity and \dot{Q}_{in}
is much less than
original.

Variable SH

④ Isent

$$P_4 = P_3$$

$$T_4 = 830.15 \text{ K}$$

$$V_4 = 0.283 \text{ m/s}$$

$$h_4 = 855.2$$

$$V = 0 \text{ m/s}$$

$$P_{r4} = 54.9$$

$$\frac{P_5}{P_4} = \frac{P_{r5}}{P_{r4}}$$

$$P_5 = 168.9 \text{ kPa}$$

$$0.85 = \frac{h_4 - h_{5a}}{h_4 - h_5}$$

$$h_{5a} = 589.91$$

Original

$$F = 94964.6$$

$$\dot{W}_p = 22647.5$$

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

$$= 75200.9$$

$$\eta_p = 30\%$$

$W_c = W_T$

⑤ Isent

$$V_5 = 0 \text{ m/s}$$

$$h_4 + h_5 = h_3 + h_2$$

$$h_5 = 543.1 \text{ kJ/kg}$$

$$T_5 = 538.8 \text{ K}$$

$$P_{r5} = 11.012$$

$$P_{r6} = \frac{1}{13} P_{r5}$$

$$V_6 = \frac{V_5^2}{2} + h_5 = \frac{V_6^2}{2} + h_6$$

$$V_6 = \sqrt{2(h_5 - h_6)}$$

$$= 74.6 \text{ m/s}$$

$$h_3 = 607.9$$

$$h_4 = 866.5$$