1.Kısa Sınav-Çözümler

P_1 T_1 P_2

1 bar 25°C   5 bar

$T_1 = \cancel{298}\,K$ (25°C) $\rightarrow h_1 = 298.18$ kJ/kg

$P_{r1} = 1.3543$

$\dot{m} = 0.8$ kg/s.

State 2 For isentropic compression,

$P_{r2s} = (P_2/P_1) P_{r1} = 5 \times 1.3543 = 6.7715 \rightarrow h_{2s} \cong 472.24 \frac{kJ}{kg}$

$$\eta_c = \frac{h_{2s} - h_1}{h_2 - h_1}$$

$$h_2 = h_1 + \frac{h_{2s} - h_1}{\eta_c} = 298.18 + \frac{472.24 - 298.18}{0.8}$$

$= 515.75$ kJ/kg $\longrightarrow \boxed{T_2 \cong 510\,K}$ State 2

State 4: $\boxed{T_4 = 1300\,K} \longrightarrow h_4 = 1395.97$ kJ/kg

State 5: Work consumed by compressor is equal to high ~~temp~~ pressure turbine work production.

Thus $h_2 - h_1 = h_4 - h_5 \rightarrow h_5 = h_4 + h_1 - h_2$

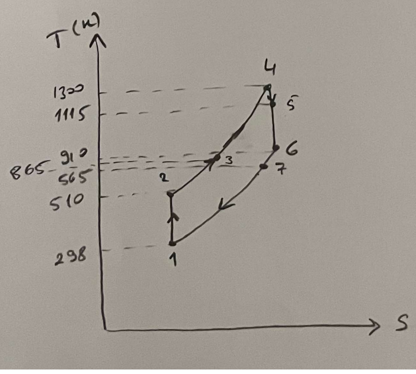
$= 1395.97 + 298.18 - 515.75$

$= 1178.4$ kJ/kg

273

25

$T_1 = 298$
$T_2 = 510$
$T_3 = 865$
$T_4 = 1300$
$T_5 = 1115$
$T_6 = 910$ K
$T_7 = 565$ K



Turbine efficiency: 0.9 (both turbines)

$h_4 - h_5 = \eta_t (h_4 - h_{5s}) \longrightarrow h_{5s} \cong 1154.23 \frac{kJ}{kg}$

Thus, $P_{r5s} \cong 165$

$\frac{P_5}{P_4} = \frac{P_{r5s}}{P_{r4}} \longrightarrow P_5 \cong \left(\frac{\overset{165}{P_{r5s}}}{\underset{330.9}{P_{r4}}}\right) \overset{5\,bar}{P_4} \cong 2.5\ bar$

h_5 was found to be $1178.4\ kJ/kg \rightarrow P_{r5} \cong 175$

$\rightarrow \boxed{T_5 = 1115\ K}$

State 6: For isentropic expansion through the low pressure turbine

$P_{r6s} = \left(\frac{P_6}{P_5}\right) P_{r5} = \left(\frac{1}{2.5}\right) 175 = 70 \rightarrow h_{6s} \cong 915 \frac{kJ}{kg}$

Using the turbine efficiency

$h_6 = h_5 - \eta_t (h_5 - h_{6s}) =$
$1178.4 - 0.9 (1178.4 - 915) \cong 941.34\ kJ/kg$

$\rightarrow \boxed{T_6 \cong 910\ K}$

State 3: Now, using the regenerator effectiveness ($\eta = 0.9$)

$\eta_{reg} = \frac{h_3 - h_2}{h_6 - h_2} \Rightarrow h_3 = \eta_{reg} (h_6 - h_2) + h_2$
$= 0.9 (941.34 - 515.75) + 515.75$
$= 898.71\ kJ/kg \rightarrow$

$\boxed{T_3 \cong 865\ K}$

State 7: Applying energy balance to a CV enclosing regenerator

$0 = (h_3 - h_2) + (h_6 - h_7)$

$h_7 = (h_2 - h_3) + h_6 = (515.75 - 898.71) + 941.34$
$= 558,38\ kJ/kg \rightarrow \boxed{T_7 \cong 565\ K}$

a) Net power output is the power produced by the low pressure turbine

$\dot{W}_{net} = \dot{m} (h_5 - h_6) = 0.8\ kg/s\ (1178.4 - 941.34)$
$= 189.65\ kW$

b) Thermal efficiency

$\eta = \frac{\dot{W}_{net}}{\dot{Q}_{in}} = \frac{\dot{W}_{net}}{\dot{m}(h_4 - h_3)}$

$= \frac{189.65\ kW}{0.8 \frac{kg}{s} (1395.97 - 898.71)}$

$\cong 0.48$

$\eta_{II} = \frac{\eta_{\text{ısıl}}}{\eta_{\text{ısıl,tr}}}$ (ısı makinaları)

$\psi = (h - h_0) - T_0(s - s_0) + \frac{V^2}{2} + gz$

$\psi_6 = (h_6 - h_0) - T_0 (s_6 - s_0)$