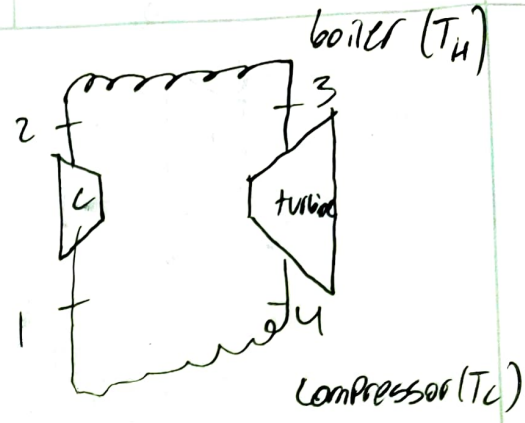
5. 2.4 kg/s of air



$R = 287$ $k = 1.4$

$T_H = 2200\,K$ $T_C = 450\,K$

a) $\eta_{TH} = 1 - \frac{T_C}{T_H} = 1 - \frac{450}{2200} = .8$

b) $Q_{23} = \dot{m}(R)(T_2)\ln\left(\frac{P_2}{P_3}\right) = 774.06$ kW

c) $\eta_{TH} = \frac{\text{Power out}}{Q_{in}} = \frac{\dot{W}_{net}}{Q_{23}} = .8$

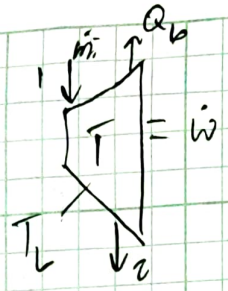
$\Rightarrow \dot{W}_{net} = 619.26$ kJ

d) $\Sigma Q = \dot{W}_{net}$

$Q_{23} - Q_C = \dot{W}_{net}$

$\Rightarrow \boxed{Q_C = 154.82\ \text{kW}}$

6.



$\dot{W} = 6.5$

$\dot{m} = 10\ kg/s$

$T_1 = 500^\circ C = 773.1\ K$

$P_1 = 2\ MPa$

$P_2 = 20\ kPa$

$T_b = 150^\circ C = 423.15\ K$

a) $\rho_1 = \frac{1}{V_1} = 5.69\ kg/m^3$

$h_1 = 3467.7$

$S = 7.4316$

$P_2 = .131\ kg/m^3$

$h_2 = 2608.9$

$S_2 = 7.907$

$\dot{m} = \rho_1 A_1 V_1 = \rho_2 A_2 V_2$

$\Rightarrow \boxed{V_2 = 289.5}$

$h_1 + KE_1 + PE + \dot{Q} = h_2 + KE_2 + PE_2 + \dot{W}$

$\Rightarrow \boxed{\dot{Q} = -1670.75\ kW}$

1. $COP_{cool} = \frac{\dot{Q}_L}{P_{in}} = \frac{\dot{Q}_H - P_{in}}{P_{in}}$

$5 = \frac{4.8}{P_{in}} - 1$

$COP_L = \frac{\dot{Q}_L}{P_{in}} - 1$

$\Rightarrow \boxed{P_{in} = .8}$ $\Rightarrow COP_{cool} = \frac{T_L}{T_H - T_L} \Rightarrow \boxed{T_L = 246.79\ K}$

2. $c_p = \frac{1.4(287)}{1.4-1} = 1004.5\ J/kg \cdot K$

$h_1 + \frac{V_1^2}{2} + P\cancel{z_1}^{0} + 0 = h_2 + \frac{V_2^2}{2} + Pz_2 + \cancel{W}^{0}$

$c_p T_1 + \frac{20^2}{2} = c_p T_2 + \frac{100^2}{2}$

$T_2 = 288.37\ K$

$\rho = \rho_1 R T_1 \Rightarrow \rho_1 = 1.19\ kg/m^3$

$\Rightarrow P_2 = \boxed{98.49\ kPa}$ $\Rightarrow \rho_1 A_1 V_1 = \rho_2 A_2 V_2$

$\Rightarrow \frac{A_2}{A_1} = \frac{V_1}{V_2} = \boxed{.2}$

3. $T_{max} = 26^\circ C \quad V_1 = 3\ m^3, \quad P_1 = 20\ bar$

$= 299.15 \quad V_2 = 95\ m^3, \quad T_2 = 26^\circ C$

$P_2 = 101325\ Pa$

$\Rightarrow P_2 = \frac{P_1 V_1}{V_2} = .632$

$P_{max} = 20\ bar$

b) $\Delta S = C_p \cdot \ln \frac{V_2}{V_1} + C_v \ln \frac{P_2}{P_1}$

$= 1.005 \ln \frac{95}{3} + .716 \ln \frac{.632}{20}$

$\Delta S = 3.473 + (-2.48) = \boxed{.993}\ kJ/K$

4. $\dot{m}_{tot} = \dot{m}_1 + \dot{m}_2 = 1.15\ kg/s$

$\dot{m}_1 h_1 + \dot{m}_2 h_2 - \dot{m}_{tot} h_3 = 0$

$h_3 = 1627.2$

$\Rightarrow 1627.2 = 720.87 + x(2047.5)$

$s_3 = 2.0457 + .443(4.6160) = 4.09\ kJ/kg\cdot K$

$T_{sat} = 170.41^\circ C$

$\Rightarrow 6 = 1.15(4.09) - .25(10.12) + .9(2.0957)$

$= \boxed{332.37\ W/K}$