**T2 SOLUTIONS (WATTS)**

My data were obtained 9/16/03 16:50 hrs.

Ambient air temp = 75°F = 297 K

Atmospheric pressure (assumed) = 1 atm = 101.3 kPa

Compressor delivery pressure = 200 psig = 214.77 psia

\[ \text{Pressure ratio} = \frac{214.77}{14.77} = 14.54 \]

\[ p_1 = 101.3 \text{ kPa}, \quad T_1 = 297 \text{ K} \]

\[ p_2 = 14.54 \times 101.3 = 1473 \text{ kPa} \]

\[ \frac{p_2}{p_1} \rightarrow \frac{T_2}{T_1} = 2.147 \quad T_2 = 638 \text{ K} \]

3. Constant pressure heating

\[ P_3 = 1473 \text{ kPa}, \quad T_3 = 1400 \text{ K} \quad \text{(given)} \]

4. 5 = adiabatic expansion by \( \frac{P_3}{P_4} = 14.54 \)

\[ P_4 = 101.3 \text{ kPa} \]

\[ \left( \frac{P_4}{P_3} \right)^{5/4} = \frac{T_4}{T_3} = 0.46 \quad T_4 = 652 \text{ K} \]

b) Thermal efficiency

\[ \eta = 1 - \frac{T_1}{T_2} = 1 - \frac{297}{638} = 0.534 \]

\[ W = C_p \left( T_3 - T_2 + T_1 - T_4 \right) = 1003.5 \left( 1460 - 638 + 297 - 652 \right) = 408 \text{ kJ/kg} \]
c) \( T_2 \) fixed.

\begin{align*}
\text{Cold Day} & \quad T_1 = 273 K \\
\text{Hot Day} & \quad T_1 = 303 K
\end{align*}

\( \eta_{\text{cold}} = 1 - \frac{273}{638} = 0.57 \)

\( \eta_{\text{hot}} = 1 - \frac{303}{638} = 0.525 \)

\[ \eta = \frac{20}{69.63} = \frac{\text{Work}}{\text{Qin}} = 0.287 \]

A variety of non-ideal processes cause the efficiency to be significantly less than the value obtained for the ideal cycle.

d) Total gas energy flow = \( 66 \times 10^3 \) BTU/s = 69.63 MJ/s

\( \text{Active Load} = 20 \text{ MW} \)

\[ \eta = \frac{20}{69.63} = \frac{\text{Work}}{\text{Qin}} = 0.287 \]

For pressure ratio of 14.54, calculated \( \frac{T_2}{T_1} \approx 21.49 \)

So \( T_2 \approx 638 \text{ K} \) (Ideal)

Measured \( T_2 \) (Compressor discharge temp) = 730 \text{°F} \)

\( T_2 \) measured = 661 K

But note there is also some cooling between the ambient \( (T_{2,\text{amb}} = 75 \text{°F}) \) and the compressor inlet \( (\text{Comp Inlet Temp} = 62 \text{°F}) \) which was not accounted for. If you account for this our g-S, adiabatic model is even worse (i.e. shows a smaller \( \Delta T \) than in real device)