PROBLEM 6.34

KNOWN: Steady-state operating data are provided for a Carnot power cycle.
FIND: Sketch the cycle on T-S coordinates. Also, evaluate Q/I and W/I for each process and the thermal efficiency of the overall cycle.

SCHEMATIC & GIVEN DATA:

ENERGY MODEL:
1. A control volume at steady state encloses each of the four components.
2. For the turbine and pump, \( Q_{ev} = 0 \).
3. Kinetic and potential energy effects are ignored.

\[ W_{ev} = h_1 - h_3, \quad h_2 = h_f + h_s(h_2 - h_f) \]
\[ = 196.26 + 0.867(964.1) = 1028.47 \text{ Btu/lb} \]
\[ W_{sw} = (199.3 - 1028.47) = -170.43 \text{ Btu/lb} \]

\( Q_{ev} = h_3 - h_2 = 339.31 - 1028.47 = -689.36 \text{ Btu/lb} \)

\( Q_{in} = T_c (S_4 - S_3) = 887.43^{°R}(0.544 - 1.546) \text{ Btu/lb} \)
\[ = -689.36 \text{ Btu/lb} \]

\[ \eta_1 = \frac{W_{cycle}}{Q_{in}} = \frac{170.43 - 162.27}{543.7} = 0.188 \]
\[ \eta = \frac{T_h - T_e}{T_h} = \frac{841.52 - 693.67}{791.58} = 0.183 \]