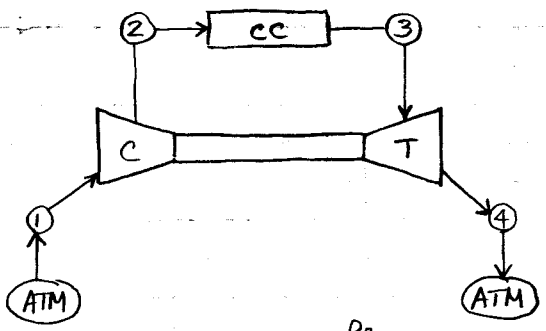
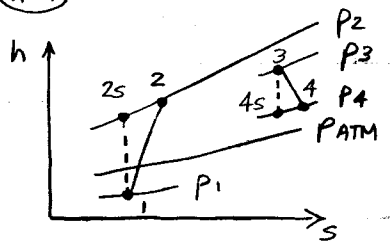


$r_p = 10$ $\quad p_{ATM} = 14.7$ PSIA
$T_1 = 65°F$

HEAT SUPPLIED: $q_s = 330 \frac{Btu}{lbm}$

EFFICIENCIES: $\eta_c = 94\%$
$\eta_{cc} = 98\%$
$\eta_T = 92\%$

PRESS. DROPS: INLET 0.3 PSIA
CC 2.0 PSIA
EXH 0.5 PSIA



* NOTE: THE LETTERS IN EACH PROPERTY BOX BELOW SHOW THE CORRESPONDING CALCULATION STEP

	1	2s	2	3	4s	4
p [PSIA]	14.4 A	144 B	144 B	142 C	15.2 D	15.2 D
T [°R]	525 E	1006 H	1036 J	2270 L	1287 N	1369 P
h [$\frac{Btu}{lbm}$]	125.5 F	242.5 H	250.0 I	580.0 K	313.6 N	334.9 O
Pr	1.256 F	12.56 G	13.991 J	291.150 L	31.165 M	39.368 P

CALCULATIONS: $\boxed{\text{DO PRESSURES FIRST}}$ (USE h-s DIAGRAM TO VISUALIZE)

(A) $p_1 = p_{ATM} - \Delta p_{IN} = 14.7 - .3 = \underline{\underline{14.4 \text{ PSIA} = p_1}}$

(B) $p_{2s} = p_1(r_p) = 14.4(10) = \underline{\underline{144 \text{ PSIA} = p_{2s} = p_2}}$

(C) $p_3 = p_2 - \Delta p_{cc} = 144 - 2.0 = \underline{\underline{142 \text{ PSIA} = p_3}}$

(D) $p_{4s} = p_{ATM} + \Delta p_{EXH} = 14.7 + .5 = \underline{\underline{15.2 \text{ PSIA} = p_{4s} = p_4}}$

$\boxed{\text{ENTER GIVEN INFO NEXT}}$

(E) $T_1 = 65°F = \underline{\underline{525°R = T_1}}$ (ATMOSPHERIC OR AMBIENT TEMP)

$\boxed{\text{LOOKUP AIR TABLES}}$

(F) FOR $T_1 = 525°R \Rightarrow \underline{\underline{h_1 = 125.5 \frac{Btu}{lbm}}}$ $\quad \underline{\underline{Pr_1 = 1.256}}$

$\boxed{1 \rightarrow 2s}$

(G) KNOWING $p_{2s} = p_2$: $\frac{p_2}{p_1} = \frac{Pr_{2s}}{Pr_1} = r_p$

$\frac{Pr_{2s}}{1.256} = 10 \Rightarrow \underline{\underline{Pr_{2s} = 12.56}}$

$\boxed{\text{LOOKUP AIR TABLES}}$

(H) FOR $P_{r2s} = 12.56 \Rightarrow \underline{\underline{T_{2s} = 1006°R}}$ $\underline{\underline{h_{2s} = 242.5 \frac{Btu}{lbm}}}$

$\boxed{2s \rightarrow 2}$

(I) $\eta_c = \frac{h_{2s} - h_1}{h_2 - h_1} = .94 = \frac{242.5 - 125.5}{h_2 - 125.5} \Rightarrow \underline{\underline{h_2 = 250.0 \frac{Btu}{lbm}}}$

$\boxed{\text{LOOKUP AIR TABLES}}$

(J) FOR $h_2 = 250.0 \frac{Btu}{lbm} \Rightarrow \underline{\underline{T_2 = 1036°R}}$ $\underline{\underline{P_{r2} = 13.991}}$

$\boxed{2 \rightarrow 3}$ (NOTE: $T_{MAX} = T_3$ IS NOT GIVEN, BUT q_s IS GIVEN)

(K) $q_s = h_3 - h_2 \Rightarrow 330 = h_3 - 250 \Rightarrow \underline{\underline{h_3 = 580.0 \frac{Btu}{lbm}}}$

$\boxed{\text{LOOKUP AIR TABLES}}$

(L) FOR $h_3 = 580.0 \frac{Btu}{lbm} \Rightarrow \underline{\underline{T_3 = 2270°R}}$ $\underline{\underline{P_{r3} = 291.150}}$

$\boxed{3 \rightarrow 4s}$

(M) KNOWING $p_{4s} = p_4$: $\frac{p_3}{p_4} = \frac{P_{r3}}{P_{r4s}}$ $(\neq r_p) \Leftarrow$ NOTE THIS !!! (DUE TO PRESSURE DROPS)

$\frac{142}{15.2} = \frac{291.150}{P_{r4s}} \Rightarrow \underline{\underline{P_{r4s} = 31.165}}$

$\boxed{\text{LOOKUP AIR TABLES}}$

(N) FOR $P_{r4s} = 31.165 \Rightarrow \underline{\underline{T_{4s} = 1287°R}}$ $\underline{\underline{h_{4s} = 313.6 \frac{Btu}{lbm}}}$

$\boxed{4s \rightarrow 4}$

(O) $\eta_T = \frac{h_3 - h_4}{h_3 - h_{4s}} = .92 = \frac{580.0 - h_4}{580.0 - 313.6} \Rightarrow \underline{\underline{h_4 = 334.9 \frac{Btu}{lbm}}}$

$\boxed{\text{LOOKUP AIR TABLES}}$

(P) FOR $h_4 = 334.9 \frac{Btu}{lbm} \Rightarrow \underline{\underline{T_4 = 1369°R}}$ $\underline{\underline{P_{r4} = 39.368}}$

WHAT ABOUT η_{cc} – IT WASN'T USED?

$$\eta_{cc} = \frac{\dot{m}_{AIR}(q_s)}{\dot{m}_{FUEL}(LHV)}, \quad q_s = h_3 - h_2$$

– IT WASN'T NEEDED THIS TIME, BUT CERTAINLY COULD BE USED BECAUSE h_3 AND h_2 ARE PART OF COMBUSTION CHAMBER EFFICIENCY.