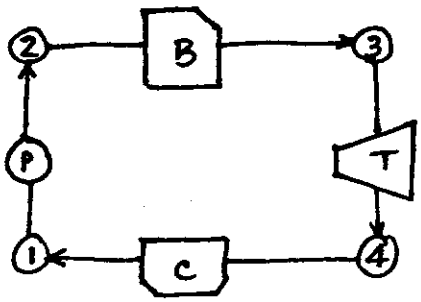
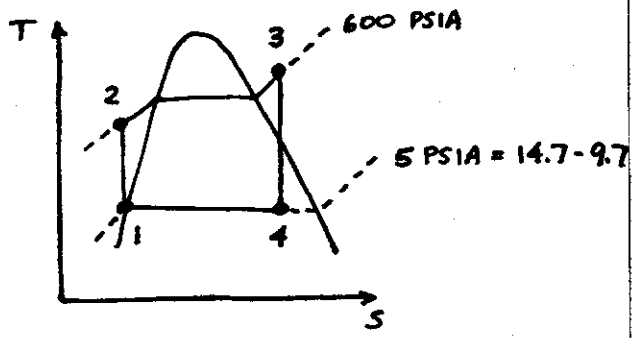
IDEAL RANKINE CYCLE

A STEAM PLANT PRODUCES STEAM AT 600 PSIA, 650°F. SATURATED LIQUID EXITS THE CONDENSER AT 9.7 PSI VACUUM.

FIND: a) w_P, b) w_T, c) q_S, d) η_{TH}





FIND ALL ENTHALPIES FIRST

$h_1 = h_f$ @ 5 PSIA $= \underline{\underline{130.20}} \frac{Btu}{lbm}$ (TABLE 2), $v_1 = .016407 \frac{ft^3}{lbm}$

$$h_2 = h_1 + w_P = h_1 + v_1(p_2 - p_1)$$

$$= 130.20 \frac{Btu}{lbm} + .016407 \frac{ft^3}{lbm}(600-5)\frac{lbf}{in^2}\left(\frac{144 in^2}{ft^2}\right)\left(\frac{1 Btu}{778 ft\,lbf}\right)$$

$$h_2 = 130.20 \frac{Btu}{lbm} + 1.81 \frac{Btu}{lbm} = \underline{\underline{132.01}} \frac{Btu}{lbm}$$

$h_3 = h$ (SUPERHEATED, 600 PSIA, 650°F) $= \underline{\underline{1322.0}} \frac{Btu}{lbm}$ (TABLE 3)

h_4: STEP 1 $\quad s_4 = s_3 = 1.5621 \frac{Btu}{lbm\,°R}$

@ 5 PSIA (TABLE 2): $s_f = .2349 \frac{Btu}{lbm\,°R}$ $\quad s_{fg} = 1.6094 \frac{Btu}{lbm\,°R}$

$$s_4 = s_f + x_4(s_{fg})$$

"STEAM QUALITY"

$$1.5621 = .2349 + x_4(1.6094) \rightarrow x_4 = .8247$$

STEP 2 $\quad h_4 = h_f + x_4(h_{fg})$

@ 5 PSIA (TABLE 2): $h_f = 130.2 \frac{Btu}{lbm}$ $\quad h_{fg} = 1000.9 \frac{Btu}{lbm}$

$$h_4 = 130.2 + (.8427)(1000.9) = \underline{973.7} \frac{Btu}{lbm}$$

a) $w_P = h_2 - h_1 = 132.01 - 130.20$

$$\boxed{w_P = 1.81 \frac{Btu}{lbm}}$$

b) $w_T = h_3 - h_4 = 1322.0 - 973.7$

$$\boxed{w_T = 348.3 \frac{Btu}{lbm}}$$

c) $q_S = h_3 - h_2 = 1322.0 - 132.01$

$$\boxed{q_S = 1190.0 \frac{Btu}{lbm}}$$

d) $\eta_{TH} = \frac{w_{NET}}{q_S} = \frac{w_T - w_P}{q_S}$

$$\boxed{\eta_{TH} = 29.1\%}$$