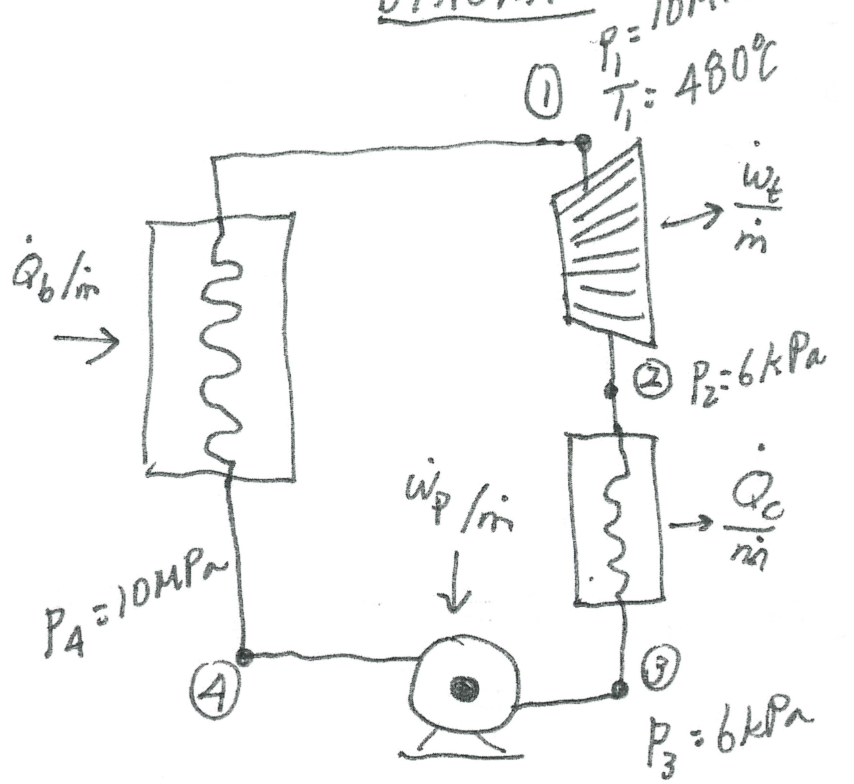
M.S. 8.2

GIVEN: Ideal Rankine cycle
P_1, T_1, P_2, P_3, P_4

FIND: (a) $\dot{Q}_b/\dot{m}$
(b) η
(c) $\dot{Q}_c/\dot{m}$

DIAGRAM



ASSUME: Usual assumptions for an ideal Rankine Cycle:
- $\Delta P = 0$ in boiler/condenser.
- Adiabatic pump/turbine.
- KE & PE effects are negligible
- Reversible processes; $\dot{\sigma} = 0$

These assumptions imply isentropic turbines/compressors.

Also: $\frac{\dot{Q}}{\dot{m}} = \Delta h$ for boiler/condenser.

$\frac{\dot{W}}{\dot{m}} = \Delta h$ for turbine/pump.

ANALYSIS: To get (a)-(c), we need $h_1 \rightarrow h_4$. Let's get ~~there~~.

① superheated table gives $\boxed{h_1 = 3321.4 \text{ kJ/kg}}$. I know I'll need entropy for state ②, so $s_1 = 6.5282 \text{ kJ/kg·K}$

State ② $P_2 = 6kPa$ $s_2 = s_1 = 6.5282 \text{ kJ/kg·K}$

This is a saturated state: $s_2 = 6.5282 = (1-x)s_f + x s_g$

This gives $x_2 = 0.7692$ which gives

$$\boxed{h_2 = 2009.8 \text{ kJ/kg}}$$

state ③ At this point we need to make one more assumption since all we have at states ③ & ④ are pessure. The typical assumption at this point is to assume state ③ is saturated liquid.

From saturated table: $h_3 = h_f(.06\ \text{bar}) = 151.53\ \frac{kJ}{kg}$

$s_3 = 0.5210\ kJ/kg \cdot K$

state ④ $s_4 = s_3 = 0.5210\ kJ/kg \cdot K$

$P_4 = 10\ MPa$

Interpolating for h in the subcooled tables gives:

$h_4 = 161.96\ kJ/kg$

Now solve for (a), (b), (c)

(a) $\dot{Q}_b/\dot{m} = h_1 - h_4 = 3159.4\ kJ/kg$

(b) $\eta = \frac{\frac{\dot{W}_t}{\dot{m}} - \frac{\dot{W}_p}{\dot{m}}}{\dot{Q}_b/\dot{m}} = \frac{(h_1-h_2)-(h_4-h_3)}{h_1-h_4} = 0.412$

(c) $\dot{Q}_c/\dot{m} = h_2 - h_3 = 1858.3\ kJ/kg$