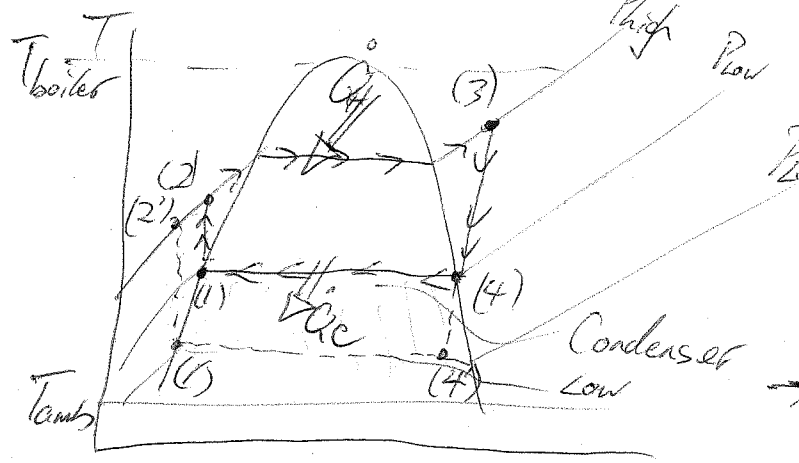
Rankine Cycle Modifications & Optimization

→ Last time we introduced the Carnot Cycle & showed that by operating this cycle in the vapor dome we can come close to approximating ~~the~~ Carnot.

→ There are several modifications to the Rankine cycle that can increase the efficiency of the cycle.

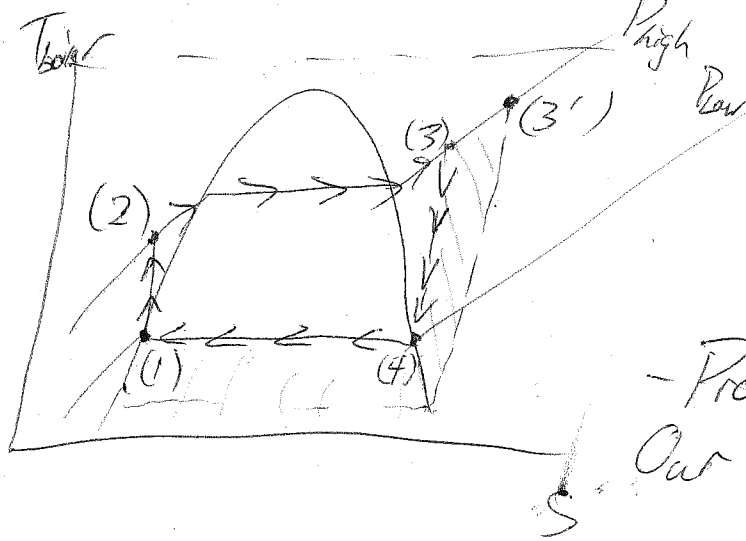
1) Lowering the Condenser pressure



- By lowering the condenser pressure we decrease the temperature at which heat is rejected from the cycle & decrease entropy generated.

→ Problems? Increased amount of liquid in turbine. ~~Cant~~ ought to go below T_{amb}

2) Superheating the steam to higher temperatures



- By increasing the temperature of the steam leaving the boiler. This also makes it easier to decrease the Condenser pressure.

- Problems? Added problems in boiler. Our best metals limit $T_{boiler} \approx$ ~~620~~ 620°C (1150°F)

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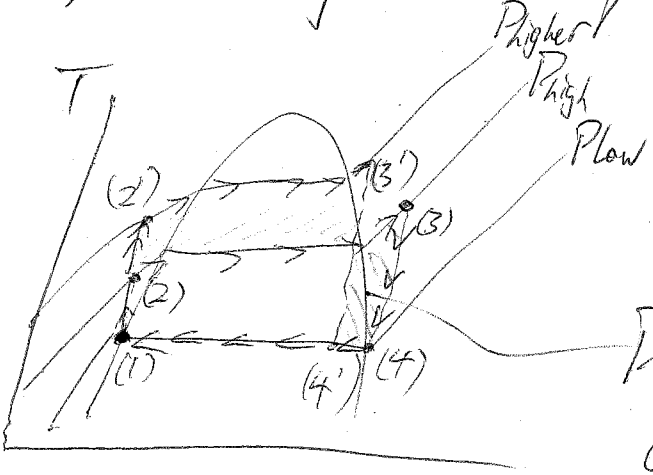
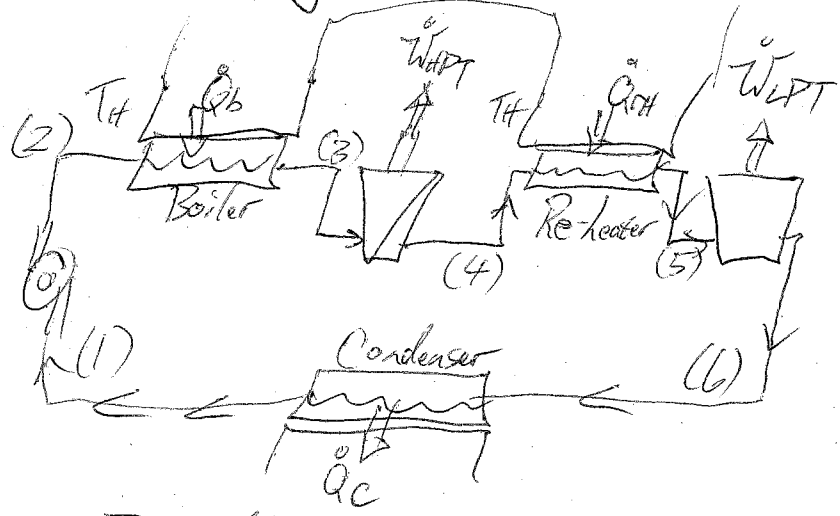
3) Increasing the boiler pressure

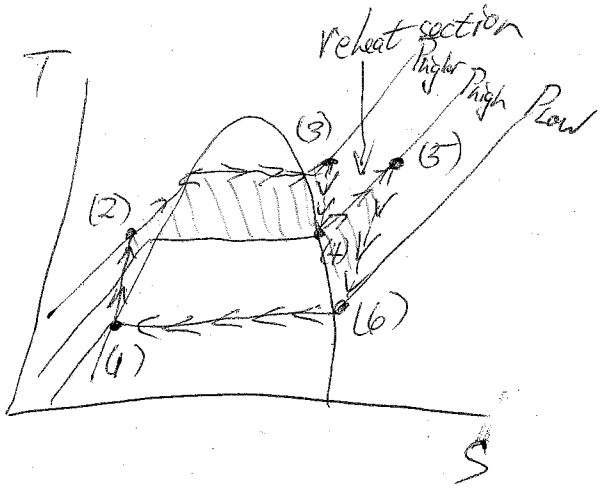


→ Increasing the boiler pressure increases the average temperature that heat is added to the steam, increasing efficiency.

Problems? ~~The~~ Slight increase in stress on boiler... but we lose work from part of the diagram. How can we recapture this lost work?

4) Reheating the steam





By adding a second hot HEX & a second turbine to our system, we can use Reheat in our Rankine cycle to increase efficiency further.

- Example: $T_H = 825k$, $T_C = 310k$, $P_5 = 6.11 MPa$, $\eta_T = 0.9$, $\eta_P = 0.5$, $\Delta T_{HX} = 20k$, $\Delta T_{cond} = 5k$, $\Delta T_5 = 25k$. Find: Optimal pressure for reheat loop.

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How do we start?

Make a diagram, table & figure out what we know.

		T	P	x	h	s
Pump	1	30+5		0.0		
	2		6.11MPa		η_P	
Boiler	3	825-25	$=P_2$			
HPT	4		1MPa		η_T	
Rheat	5	825-20	$=P_4$			
LPT	6		$=P_1$		η_T	
Condenser						

→ assume fluid entering pump is saturated liquid.

→ Assume no pressure drop across heat exchangers

→ Assume a reheat pressure initially, we're trying to optimize this.

→ Now go to EES