

ME 18b, HW 3

Due Tuesday April 21, 2008 (accepted until 4 pm)

TAs for HW #3:

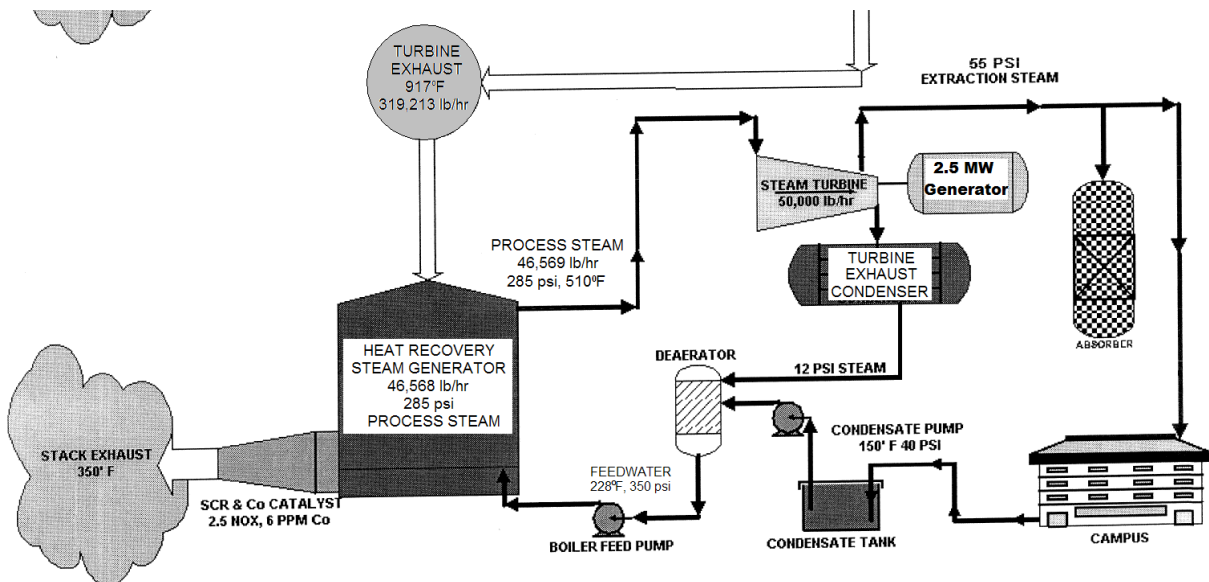
Dan Alvarez, Monday 8-10 pm, SFL 229;

Mary Dorman, Monday 7-9 pm SFL 331

1. Cal Tech Power Plant Rankine Cycle analysis: The Cal Tech Power Plant uses two thermodynamic cycles to produce electric power and provide steam for campus use. Examine the following schematic of the power plant's Rankine cycle. (A better copy of this is posted as a handout on the class website). Using the information given on the diagram you should do a complete thermodynamic analysis of the cycle which includes finding:

[Note: Please convert all given values to SI units]

- The heat input of the steam generator (compare the heat lost by the gas turbine exhaust to the heat gained by the water)
- The work produced by the steam turbine, (compare this to the generated electric power of 2.5 MW – how efficient is the turbine/generator system)
- The work of the pump
- The overall Rankine cycle efficiency
- Suggest some ways the plant could become even more efficient



2. Refrigeration Cycle: A refrigeration cycle using R-134a has an evaporator exit temperature that is superheated by 8°C at a pressure of 600 kPa. The compressor has a pressure ratio of 2 and the refrigerant leaving the condenser is a saturated liquid. Compare the coefficient of performance, the compressor work per unit mass, the refrigerant temperature at the

compressor exit for this cycle with those of an ideal cycle having no evaporator superheat. Draw the process for both cycles on a T-s diagram.

3. **Cascade Refrigeration Cycle:** A cascade system is composed of two ideal refrigeration cycles as shown below. The high-temperature cycle uses R-140a. Saturated liquid leaves the condenser at 40°C , and saturated vapor leaves the heat exchanger at -20°C . The low-temperature cycle uses R-23. Saturated vapor leaves the evaporator at -80°C with $h = 330 \text{ kJ/kg}$, and saturated liquid leaves the heat exchanger at -10°C with $h = 185 \text{ kJ/kg}$. R-23 out of the compressor has $h = 405 \text{ kJ/kg}$. Calculate the ratio of the mass flow rates through the two cycles and the COP of the total system. Draw the cycle processes on a T-s diagram.

