MAE 110A Winter 2017 Design Problem

Due: Monday March 20 (time/location TBA)

Background

Solar Thermal power plants are an attractive alternative to *Photovoltaic (PV)* systems for generating electicity from solar energy. Depending on the solar collector type, the source temperature varies from low to moderate values. *Organic Rankine Cycles* (ORC) have been employed for energy conversion systems involving low to moderate temperature sources such as solar thermal, geothermal, and waste heat. The ORC has the same operating principles as a conventional Rankine cycle but uses an organic compound instead of water as the working fluid.

Design Problem Description

Develop the preliminary design of an ORC for a solar thermal power plant. The system must produce 200 kW of electricity using R134a as the working fluid. The following is a list of requirements and constraints:

- maximum allowable cycle temperature is 150°C and the maximum allowable pressure is 20 bar
- turbine exit has quality greater than 90% or is superheated vapor
- turbine operates with isentropic efficiency of 90%
- pump operates with isentropic efficiency of 80%
- heat rejection at condenser using water from nearby lake

Report Requirements

Include the following in your problem write-up/report:

a. Objective: statement of design objective

b. Background: 1 page max justifying the chosen system (solar thermal ORC). Consider the energy source (solar thermal) and list advantages and disadvantages over PV and fossil fuel for electrical power generation. Consider also the motivation of ORC over a conventional Rankine cycle using water. Cite any references used.

c. Engineering model: indicate all key assumptions and system specifications

d. Description of system: schematic of cycle layout indicating all components and states; operating temperatures and pressures at key points within the system (show states and processes on $T-s$ diagram)

e. Analysis and calculations: complete analysis of system operating conditions, energy transfer rates (kJ/kg, kW), and performance.

f. Results: include required energy (heat) input rate from source (kW), mass flow rate (kg/s), thermal efficiency

g. Conclusion: comment on results.