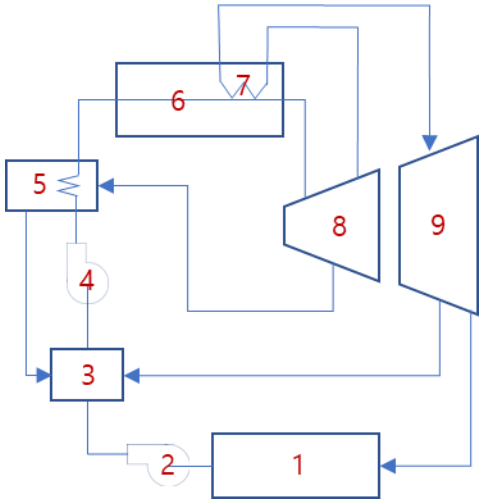
2021. 06. 18. Nuclear Systems Engineering Final Exam (09:00~12:00)

1. For the Rankine cycle below, (a) draw the T-s diagram. (b) Write the names of each component (1~9) and describe the functions of the components. (c) For the components 3, 5, 7, explain how these can increase the thermal efficiency of the system. [10 pts]



2. Explain the terminologies below. [10 pts]

   (a) Pinch point temperature difference

   (b) Throttling (explain with T-s diagram)

   (c) Moisture separation (explain with T-s diagram)

3. Consider a steam power plant that operates on an ideal Rankine cycle with one open feedwater heater, one closed feedwater heater, and one reheater. Steam enters the turbine at 15 MPa and 600°C and is condensed in the condenser at a pressure of 10 kPa. Some steam is extracted from the turbine at 4 MPa for the closed feedwater heater, and the remaining steam is reheated at the same pressure to 600°C. The extracted steam is completely condensed in the heater and is pumped to 15 MPa before it mixes with the feedwater at the same pressure. Steam for the open feedwater heater is extracted from the low-pressure turbine at a pressure of 0.5 MPa. In both open and closed feedwater heaters, feedwater is heated to the saturation temperature at the feedwater heater pressure. [40 pts]

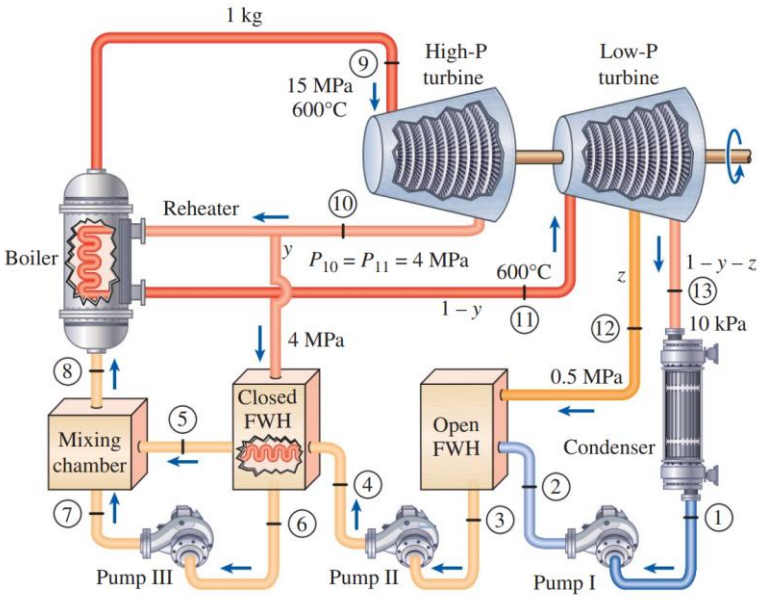
(d) Draw the T-s diagram of the cycle

(e) Calculate enthalpies at all positions except position 8.

(f) Calculate three pump works

(g) Determine the fractions of the steam extractions based on the mass and energy balances

(h) Determine the thermal efficiency of the cycle.



4. Air enters a gas turbine with two stages of compression and two stages of expansion at 100 kPa and 178°C. This system uses a regenerator as well as reheating and intercooling. The pressure ratio across each compressor is 4; 300 kJ/kg of heat are added to the air in each combustion chamber; and the regenerator operates perfectly while increasing the temperature of the cold air by 208°C. Assume isentropic operations for all compressor and the turbine stages and use constant specific heats at room temperature (cp= 1.005 kJ/kg). [40 pts]

   (a) Draw the T-s diagram of the cycle

   (b) Explain the benefit of adding the intercooler.

   (c) What is the regenerator effectiveness?

   (d) Determine this system's thermal efficiency.

   (e) What if one more stage of compression with intercooling and expansion is added to the cycle? Draw the modified T-s diagram and the thermal efficiency. Assume the pressure ratio of the added stage is the same with the others.