

MECE E3311: Heat Transfer | Spring 2018

Quiz II (Take Home)

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Project Description:

You are designing a condenser to be used in a 900 MW (electrical) coal-fired thermal power plant in the US. The inlet of the condenser must have steam quality fraction of 0.9 and condensation of the steam must occur at 8 kPa. River water at 20°C will be used for condensation and the exit temperature of the cooling water will be 33°C. Assume a typical value of efficiency for coal-fired power plants in US. Use Python and CoolProp for any simulations.

Requirements:

1. What type of heat exchanger will you use for the condenser (plate heat exchanger, cross-flow, shell-tube, etc.)? Briefly justify your decision.
2. Determine the rate of heat transfer in the condenser.
3. Determine the rate of condensation of steam.
4. Determine the mass flow rate of cooling water.
5. Determine the heat transfer coefficient outside the tube (condensate side) as well as inside the tube (forced convection).
6. Determine the UA of the heat exchanger for condensing the steam at the rate you have determined above, taking conduction through the pipe into consideration.
7. Determine the number of passes and length of tube per pass. Optimize so that you have a heat exchanger with the smallest foot print (measured as product of diameter and length of shell side).
8. Determine the pressure drop in the shell as well as tube side.
9. Determine the number of tubes in your heat exchanger.
10. Determine the diameter of the pipes - you should pick the closest standard size. What is the pitch of tubes? What is the material of the tubes?
11. Make a list of all the design parameters: Shell diameter, tube diameter, tube pitch, number of passes, length per pass, and any other parameters you may think of as relevant.
12. Make a list of all thermal parameters: tube side heat transfer coefficient, shell side heat transfer coefficient, overall heat transfer coefficient, tube material and thermal conductivity, pressure drops in shell and tube sides.
13. Identify heat exchangers from any manufacturer(s) (Holtec, GE, Maarky, etc) that will be closest to your calculations. Search literature to find the type (make, manufacturer, etc) of condenser used in power plants of similar size (each unit generating approximately 900 MW - 1 GW).
14. At the end of your report, write the line: "I affirm that I did not plagiarize, use unauthorized materials, or give or receive illegitimate help on this assignment."

Report Formatting

Write a 2-4 page typed report. List and justify all assumptions clearly. Be sure to include citations for any information obtained from sources beyond textbooks.

Use of Outside Resources:

You may only consult with the instructor, Arvind Narayanaswamy, or the teaching assistant, Braden Czapla. The chapter on heat exchangers in your textbooks (Lienhard or Incropera and Dewitt) is a good starting point. The following articles are reasonably useful too: http://www.chemstations.com/content/documents/Technical_Articles/shell.pdf or <http://nptel.ac.in/courses/103103027/pdf/mod1.pdf>.