mech 262 – Assignment 8

heat exchangers

During last week's tutorial class a problem was posed that involved the development and analysis of tube-in-tube and tube-and-shell heat exchangers that were to produce a continuous stream of hot water for use by campers while taking their showers. We got through the analysis but the calculations were rather casual and we did not really explore all the design possibilities.

This assignment asks you to extend the tutorial analysis to explore and formally detail three different heat exchange types.

The heat exchange types are:

a. Simple counter flow (covered in the tutorial);
b. Simple parallel flow (not explored in the tutorial); and,
c. U-tube type with 1-shell-pass, 2-tube-pass, counter-flow (preliminary selection made in the tutorial).

Design Change Note: For the tube-in-tube heat exchangers (a & b above) use a ½" copper pipe as the central, cold water pipe and a 1 ½" schedule 40 pipe as the outer, hot water pipe. These have been chosen based on the initial work done in class to lower the cost of construction and in consideration of the fact that this installation will be outdoors and thus higher flow velocities can be tolerated.

Important: Clearly lay out your work!

Include the following as part of your report on this problem:

a. A summary of the problem that includes:
    - A statement of the need.
    - The important known parameters such as the shower demand flowrate, the required shower discharge temperature, the hot side inlet temperature, etc.
    - The important assumed parameters such as the heat exchanger's hot side temperature difference, the cold side's inlet temperature, the overall heat transfer coefficient, etc.
b. The heat transfer rate through the heat exchanger, Watts.
c. The heat exchanger's hot side flowrate, L/min & kg/s.
d. The LMTD of the three heat exchanger types being explored, °C.
e. The heat transfer areas required, for each HX type, to produce the desired heat transfer rate, m^2 & ft^2.
f. The length of the heat exchanger if you were to hand-make a simple counter-flow single tube tube-in-tube heat exchanger. Is it practical to build such a heat exchanger or would it be best to buy one?
g. The length of the heat exchanger if you were to hand-make a simple parallel-flow single tube tube-in-tube heat exchanger. Is it practical to build such a heat exchanger or would it be best to buy one?
h. For each heat exchanger type, calculate the NTU and find each one's effectiveness from the graphs provided in the HX handout. Based on the NTU values, comment on each heat exchanger's design.
i. Consider several ways to shorten the simple tube-and-tube heat exchanger developed in part "f" (counter-flow). Sketch out your thoughts.
j. Based on your heat exchanger calculations and utilizing the correction factor F (found in the graphs) for a 1-shell-pass, 2-tube-pass, counter-flow heat exchanger select the best heat exchanger from the TACO web-based catalogue (See the link on the Mech 262 web page). Comment on why you made the selection you did.
k. Is it better to build or buy?