PROBLEM SET 12 CHEG 355 DUE 12/8/11

1. Consider the bathroom piping network depicted below. You are asked to determine the change in the outlet temperature of the shower head when the water closet is activated (a very practical problem considering the bathrooms in undergraduate dorms). The system is governed by the following parameters: The cold water stream is at 50°F and the hot at 160°F. Both feed into the piping network with a pressure of 60 psig. The resistance of the pipe prior to the cold water T is equivalent to 200 ft of pipe. Take the length of all other sections (e.g., T to WC, etc.) to be 5 ft each. The WC has a resistance equivalent to a gate valve either 1/4 open (K=20) or fully closed. Under normal operating conditions, the shower hot water valve is a gate valve 1/2 open (K=4.4) and the cold 1/2 open. The shower head has a resistance equivalent to a gate valve 1/4 open. All piping is smooth 1 in ID tubing. The contribution of both the cold an hot streams to the shower temperature is proportional to the flow rate of each stream. Make any simplifications or assumptions you feel are necessary to obtain a solution to this problem with a reasonable amount of effort (but state these assumptions clearly).

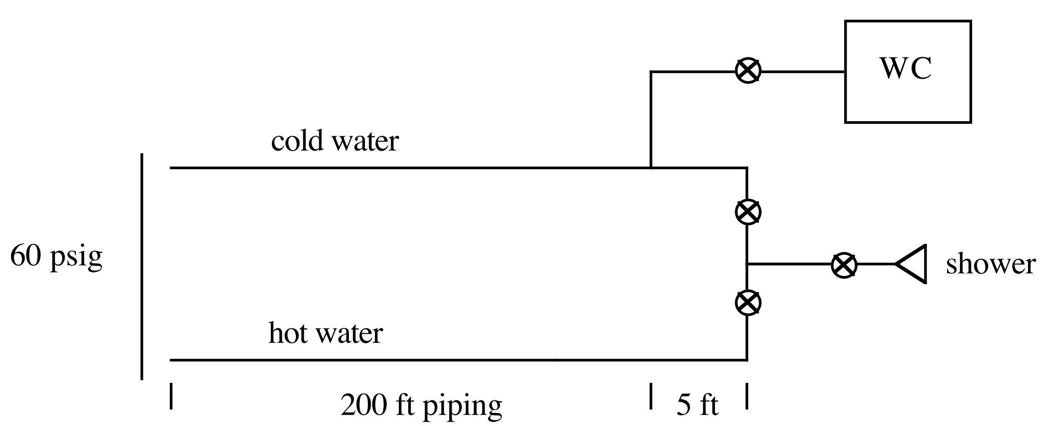
a. Develop the equations governing the flow rates in each of the streams

b. Adapt the solution from problem 20 of last semester (OK, a depressingly large number of years ago...) to calculate the total flow rate and water temperature of the shower with the WC off. Calculate the same with the WC activated. The link is:

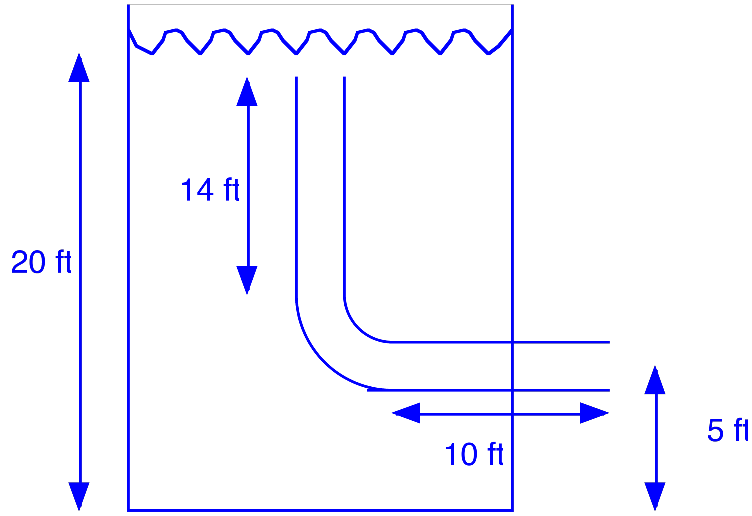
http://www.nd.edu/~dtl/cheg258/notes/l22/notes.html

(Hint: You will have to work out expressions for the resistances in each segment of the flow, which will be weak functions of the flow rates through the dependence of the friction factor on Re. You may find it simpler to write your own code from scratch, however it would probably be a good idea to look at the old solution.)

c. As an engineer, how would you improve the plumbing to reduce this temperature difference (and so avoid potential scalding)?



2. You are designing an overflow drain for a tank as depicted below. It is required that the pipe must handle a flow rate of 50 gal/minute. What is the minimum diameter of the drain pipe?



3. A recycle pump is installed on a CSTR as depicted below. Where should the pump be placed on the recycle stream? If we want to throttle the flow from the pump, where should the metering valve be placed? Briefly justify your answer.