Problem Set 4: Simulation of the Controlled Shower

For this problem set, I will accept submissions with one or two names.

(1) The notes present a linear model for the shower, operating under proportional control. The hot flow F_h is manipulated to control the total flow F, and the cold flow F_c to control T. This model is then examined for the limiting case of no interaction – i.e., when the RGA elements for the paired variables are equal to 1.

In a similar manner, derive the opposite limiting case, in which the RGA elements for the paired variables are equal to 0. Present the equations you derive, and discuss their implication for disturbance response, set point response, interaction between control loops, and the effect of controller gain settings.

The purpose of both these derivations is to learn how conclusions you would draw from the RGA (a screening tool used early in design) are borne out in simulation of the process (a more detailed activity appropriate in later design stages).

- (please use the nomenclature of the Lecture Notes)

(2) For each variable in the shower process, state your reference value and scaling (max-min) limits. Be sure to include units. Then calculate process responses under proportional control:

- Plot $T^{*'}$ and $F^{*'}$ vs. K_{CT}^{*} for $T_h^{*'} = -0.25$, under conditions of small $K_{CF}^{*'}$ (a low gain on the flow controller) and T_c and set points remaining at their reference values. On the same plot, illustrate what would happen if there were no control.
- Make similar plots for medium and for high K_{CF}^{*}.
- Discuss, from the shower user's point of view, whether control has helped.
- What is the effect of the two controller gain settings? What settings do you recommend for your shower?
- (You must decide what constitute low, medium, and high values for K_{CF}^{*}, as well as a suitable plotting domain for K_{CT}^{*}. If you were doing this assignment for money, you would try to achieve the best illustration of the system behavior, so that useful conclusions could be drawn. Here, you are working for points, but the same principle applies.)

