Studio 2 ANSER SHEET: Oven Block P-arty! CHE 461

Fill in your answers here as you go through the studio. You will submit this document on Canvas to receive credit for the studio assignment. **NOTE: Not all answers to studio questions are submitted. However, you should complete the entire activity to engage with all of the skills and concepts.** In other words – DON'T JUST ANSWER THE QUESTIONS SHOWN HERE!

Part b. Modify your oven system to run experiments with a "closed-loop" P-only control scheme (i.e. "reconnect" the controller), as shown below:

Inspect the three plots and answer the following questions:

a. Does the oven temperature reach the desired setpoint? If not, what is the steady state error (or offset)? (You can use the "hand" tool to move plots around if data is off the scale. Could also go to MATLAB command window and type the command `Y_dev(end)` to retrieve the final value of oven temperature)

Steady state error = _____10-8=2_____ degrees

b. What is the steady state gain of the closed-loop servo transfer function (G_{CL})? You could derive this using block algebra, **OR** simply determine from your servo experiment data/plots (G_{CL} = *Y_dev/Ysp = T'/T'sp*)

Closed-loop servo gain = ___output/input= 8/10= 0.8______

c. Thinking like a process engineer, what steady state error and closed-loop servo gain would you desire in your control system?

Desired steady state error = ____0____ degrees

Desired closed-loop servo gain = ____1 (means output = input)____

d. When is "P-action" largest? Smallest? Why? (Since this is a P-only controller, the controller output "P_dev" is due only to P-action)

P-action is largest…___when t=2________________

P-action is smallest…___before t=2________(look at the pink graph)__

e. From your open-loop experiments in part (a), what value of P_dev (controller output, kW) is required to obtain a 10 degree steady state temperature change? What is the actual value of P_dev at steady state?

Required value of P_dev = ____2.5____ kW

Actual value of P_dev (controller output) = _(0.8) (2.5) =2___ kW

f. Can you ***eliminate*** steady state offset (steady state error) by making the gain K_c larger? Try it! (Use the plotting zoom tool to check!)

Can s.s. offset be **eliminated** with a P-only controller? **YES** or **NO**

g. Are there physical, or practical, device limitations that set an upper limit to how large Kc can be? **Hint:** Try running a simulation with Kc = 100 and look at the curve for controller output (P, kW)

List some physical/practical limitations for Kc:_

- Controller is powered by electricity and it has limitations on the amount of currents it can uptake which will determine the gain limitation as well.
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