Corso di Dinamica e Controllo dei Processi Chimici – A.A. 2019-20

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Homework #2

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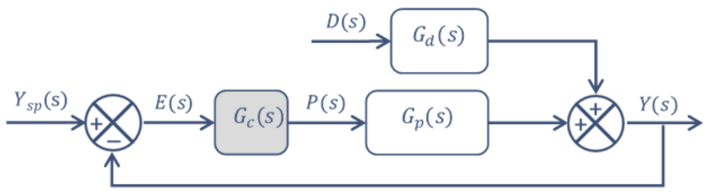

A feedback-controlled system is shown in the figure. The process transfer function is the following:

$$G_p = \frac{K_p e^{-\theta_p s}}{(\tau_1 s + 1)(\tau_2 s + 1)}$$

with $K_p = 1.25 \frac{\%TO}{\%CO}$; $\tau_1 = 1\, min$; $\tau_2 = 0.6\, min$; $\theta_p = 0.2\, min$

The transfer function includes the sensor and valve dynamics.

1. Using analytical techniques, approximate the process transfer function to that of a first-order-plus-dead-time (FOPDT) system:

   $$\tilde{G} = \frac{\tilde{K} e^{-\theta_{app} s}}{(\tau_{dom} s + 1)}$$

   Indicate the values of the transfer function parameters.
2. Use Simulink to check that the approximation fits with the original SOPDT function
3. Using the results found at point 2, tune a PI controller according to the IMC tuning rules in the following cases: $\tau_{c,1} = \theta_{app}$; $\tau_{c,2} = \tau_{dom}$;
   Indicate explicitly the values and units of the controller tuning parameters.
4. Comment what happens if you choose a value of $\tau_{c,3} = 0.5\theta_{app}$; $\tau_{c,4} = 3.0\theta_{app}$;
   Did you expect this behavior?
5. Tune a PI controller according to the continuous cycling method. Consider both Ziegler-Nichols and Tyreus-Luyben tuning relations. Indicate explicitly the values and units of the controller tuning parameters, as well as those of the ultimate gain and ultimate period. (Hint: to measure the distance between peaks use the ruler icon within the “scope” screen)
6. Assume that the system nominal conditions correspond to $u = 50\%CO$ and $y = y_{sp} = 50\%TO$. For the controllers of cases 4 and 5, plot the profiles of the manipulated input and controlled output for step increase of the set-point to 30%, 50% and 60%. Comment the results.
   Hint (you can add a block called “Saturation” in Simulink in order to set a range of variation for signals)