Guided Exercise for PID controller Tuning

Tip: The values of set point (SP), process variable (PV) and manipulated variable (MV) are drawn through the red, blue, and green lines in the graph panel in the right-lower part of screen. The Bode diagram are shown in left-upper part are shown for process, controller, and open-loop transfer function (G_{OL}). The parameters for process and controller can be changed through the tabs in left-lower part, and the response characteristics are shown in the right-upper part of the graph panel.

Lesson: Effect of PID tuning parameters on the close-loop response and the Bode diagram.

1. Initially, the process is set as FOPDT model with K_p=1, τ=1.0min, θ=0.2min and the controller is set as PI controller with K_c=1.5 and τ_I=1.0. The resulting closed-loop response looks overdamped and reasonable. Observe the Bode diagram and gain margin (GM) and phase margin (PM). Some of the response characteristics are tabulated in the Table shown in right-upper part of the panel.
2. Change the process parameters one-by-one and observe its effect on closed-loop response and Bode diagram for G_p. Then, change the controller parameter one-by-one including τ_D, and observe the effect on closed-loop response, Bode diagram for G_c, and the changes in critical frequency (ω_c), GM, and PM.

Lesson: Effect of MV limitation on the close-loop response and the Bode diagram.

3. Check the 'Constrained MV' checkbox in the controller tab and observe the changes in the close-loop response and Bode diagram. Can the Bode diagram reflect this change? Would the constrained MV affect the stability of the system?
4. For tuning rules using ultimate information (K_{cu} and P_u), find the K_{cu} and P_u, then compare the values shown in the value in 'Process' tab. Is this information affected by the constrained MV situation? Will the relay feedback method obtain correct ultimate information?

Lesson: Comparison of the various tuning rules.

5. Return to original process parameters. (K_p=1, τ=1.0min, θ=0.2min) Then, click the 'Tuning' tab in the left-lower part. There are different tuning rules you can choose. The JavaScript module will calculate the controller tuning parameters automatically depending on the method you choose. Default is PID controller and PI controller can be chosen by checking 'PI controller' checkbox.
6. At this point the calculated tuning parameters are not applied to the controller. You can do that by clicking the 'Apply' button. If you check the 'Disturbance at 5min' checkbox in the 'Process' tab, you will see the SP and DV changes all together. In this case, the performance characteristics in the right-upper table are

only for SP change except ITAE value. It would help to show longer time span by setting the t_{max} to 10 min.

7. The IMC rule has an addition parameter, τ_c. Observe the effect of τ_c on the closed-loop response, GM, and PM.
8. Can you observe trade-off between SP tracking and DV rejection?
9. Try different tuning rules for different process parameters and compare the results. Some tuning rules can result unstable tuning parameters for different situations, which implies you cannot trust these rules blindly.