Process Control Briefings

Weekly News Digest

#10/July 24/2024

Neglected topics in Process Control : Exploring the Limitless Potential of PID Controllers – Part 1

Sigifredo Nino, P. Eng.

Better than PID?

“The Limitless Potential of the PID Controller” highlights that Advanced Regulatory Control (ARC) is the framework that should be used for comparison with MPC, which uses a different control law and operates on a matrixial array of process models and constraints. I will address this topic in a future briefing. For now, as per my experience, Model Predictive and PID control have a clear place in the chemical process industries, they complement each other.

With this in mind, I'd like to discuss some claims about PID controllers' ability to address some process arrangements and dynamics.

Astrom and Hagglund dedicated a section of their 2006 book "Advanced PID Control" to situations requiring more sophisticated control. They explored three cases, two of which will be analyzed in this and the next briefing.

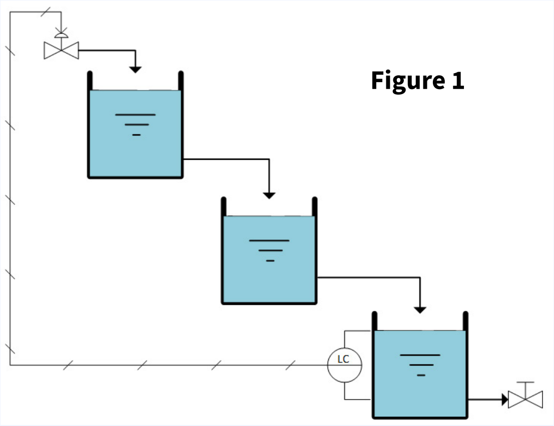

Figure 1

A theoretical model of three gravity-drained tanks, such as those shown in **Figure 1**, was used to compare the performance of the PID controller and RST controller, where each letter represents a cubic polynomial to make up for the following control law:

$$R \cdot CO(t) = -S \cdot PV(t) + T \cdot SP(t)$$

Where CO is controller output, PV is process variable and SP is setpoint.

Instead of the PID algorithm:

$$CO(t) = \frac{100}{P}\left([SP(t) - PV(T)] + \frac{1}{I}\int [SP(t) - PV(T)] \cdot dt - D\frac{dPV_f(t)}{dt}\right)$$

Where P, I, and D represent the Proportional band, Integral time, and Derivative time respectively. Typically, PVf is the PV smoothed using a first-order filter.

Figure 4 shows the structure of the PID and RST controllers.

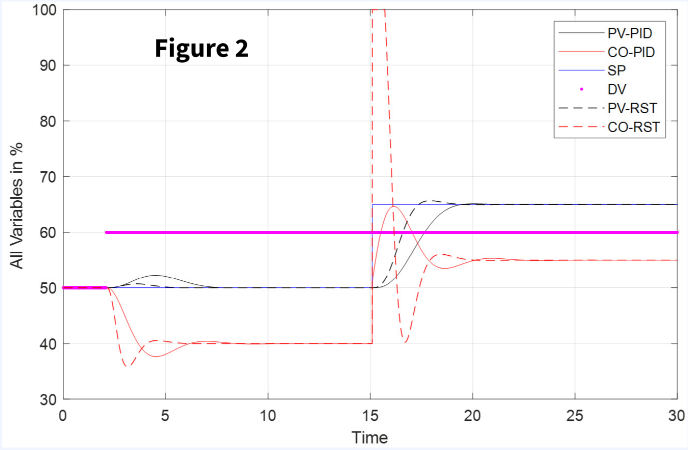

Figure 2

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Observations...

Figure 2 compares the responses of both controllers to changes in step setpoint (SP) and load disturbance (DV), from there it is evident that the RST controller displays a smaller maximum deviation of the process variable from the setpoint and shorter settling time compared to the PID controller. The Integrated Absolute Error (IAE) of the PID is only 10% higher; however, the RST controller exhibits more aggressive output moves than the PID controller.

The RST controller is tailor made...

Perhaps this example isn't the best. As Hagglund mentioned in our recent email conversation, PID is the preferred solution unless it is not expected that the end user will need to adjust the RST controller manually, among other conditions that may make using this control law suitable for a plant floor application.

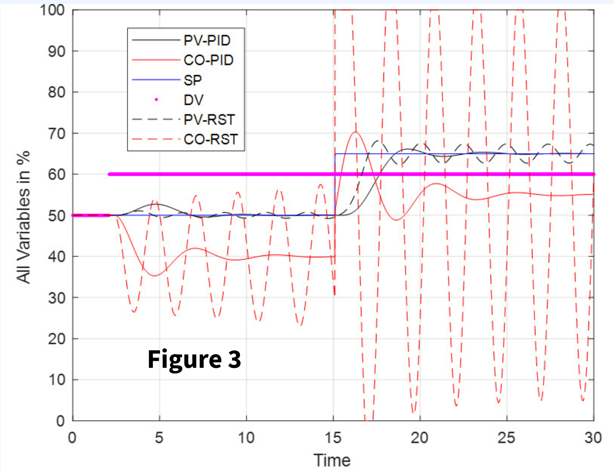

Figure 3

Fragility...

On the other hand, this RST controller is quite fragile! A short time delay (deadtime) of only 0.25 seconds pushes the system to its stability limit, as seen in **Figure 3**. This isn't ideal for real-life applications in the process industries where deadtime is ubiquitous.

In conclusion

An effective control law that can outperform a PID should be straightforward to adjust and must be as robust. Furthermore, higher-order systems pose increased modeling difficulties, which may be unnecessary given that feedback control adequately addresses dominant dynamics.

Controllers' structure

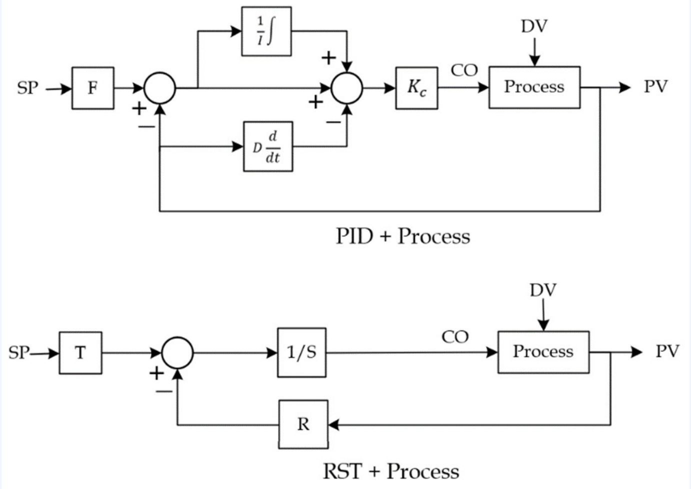

Figure 4