Practitioners of every age know that tuning very slow processes presents a challenge when faced with rigid time constraints. Specifically the time needed to perform the requisite bump tests isn’t always practical. In order to tune such loops quickly some practitioners have successfully applied a hybrid approach. While this approach won’t be found in university textbooks, it has been proven to do the trick in a range of situations. Skeptical? Read on.
Never tune control loops on a Friday. That’s a straightforward maxim – a little piece of wisdom or general rule of behavior that can help practitioners to make good choices. In the world of process manufacturing there are scores of choices to be made on a daily basis for which maxims can help. Indeed, most practitioners of experience can appreciate the wisdom of not tuning at the end of the work week. At one point or another in their career those same practitioners were surely called in on a Saturday to adjust the new tuning parameters they’d implemented just the previous day. By following that maxim and tuning PID control loops earlier in the week, those practitioners were on hand at the plant when things went wrong. What’s more, they assured that future weekends weren’t interrupted for something as seemingly trivial as tuning loops on a Friday.
As another maxim goes: **It's better to be safe than sorry.** That's equally true whether you’re tuning loops manually or with the help of software. Industry best-practices for modeling a process’ dynamic behavior and calculating tuning coefficients can reduce the risk of things going wrong. Generally speaking best-practices safely guide practitioners through a series of repeatable steps and to a positive outcome. They also provide insight into the type and size of test that’s required. Best of all the use of proven methods often minimizes the iterations involved in tuning PIDs. Face it – tuning a loop on the first pass always beats the need for multiple attempts.

While it’s often said: **You can’t teach an old dog new tricks**, that maxim doesn’t always hold true. Practitioners of every age know that tuning very slow processes presents a challenge when faced with rigid time constraints. Specifically the time needed to perform the requisite bump tests isn't always practical. Consider the typical dynamics of furnace temperature and distillation concentration loops. These and similar self-regulating processes can have a Time Constant value on the order of 30 minutes. Driving the Process Variable of such a process sufficiently outside of the loop’s noise band until it reaches a new steady-state can take hours. In such instances even old dogs will try something new.

Never forget this one: **Time is money.** Experienced practitioners understand that common approaches don’t necessarily apply to uncommon situations. Here we’re focused on very slow processes. In order to tune such loops quickly some practitioners have successfully applied a hybrid approach. They’ve broken away from the tried-and-true methods uniformly prescribed for self-regulating processes. To get the job done quicker they’ve modeled the process by using both an integrating model and an estimate of the corresponding closed loop response time. While the approach won’t be found in university textbooks, it has been proven to do the trick in a range of situations. If you’re skeptical just remember: **Nothing ventured, nothing gained!**
Never Too Old To Learn

For some processes such as batch or furnace temperature, concentration, or others with a large Time Constant, the time required to complete a typical “step” response can be extensive. Loops such as these can be tuned much faster and with comparable performance by using the approach widely prescribed for integrating processes. The procedure requires a shorter segment of step test data. What’s more, the process is not required to reach a new steady state as part of the testing procedure.

Let’s begin this exercise by establishing a base case for the time often required when tuning very slow PID loops. On the right is a trend that shows a step test performed on a non-integrating along with its associated response. With the help of software a model of the process is calculated with the three (3) parameters clearly displayed across the top. Note in particular the value for the Process Time Constant (τP): 1,986 seconds. That equates to more than 33 minutes.

Using the process model the software calculates a Controller Gain of 1.151, Reset Time of 1986 seconds, and Derivative of 0. The software uses this information to estimate the process’ Settling Time. As shown immediately on the left the Settling Time is pegged at 5,840 seconds or over 1 ½ hours. That’s the time needed by this very slow process to complete its transition from one steady-state to another steady-state – a standard requirement when tuning manually and stepping the process. For practitioners who are pressed for time spending a couple hours tuning may not be an option.
In some instances the use of an integrating model on a non-integrating process can significantly reduce the time involved with tuning. On the right is another trend showing the same process as it is allowed to respond to a similar step change. After the step test is initiated, however, only ~16 minutes is needed to capture data that adequately captures the process' dynamics. Although the process is automatically recognized as non-integrating the software permits a manual override and selection of an integrating model. Coefficients for both Integrator Gain (KP*) and Dead-Time (θP) are computed.

Since first order integrating processes do not involve a Time Constant, it is necessary to estimate one. Such an estimate can be calculated by determining the amount of time that it takes for the Process Variable (PV) to change by 1% when the Controller Output (CO) is similarly changed by 1%. Using these inputs and an estimate of the Process Gain, the time needed for the process to complete 63% of its change can be calculated easily. In terms of this exercise, the Closed Loop Time Constant is calculated at 1615. When that value is keyed in the software displays both recommended tuning coefficients and a simulated Set Point Response trend. Recall that these coefficients correspond with an integrating process. It is again necessary to override the software and revert back to the non-integrating model option to view coefficients that are suitable for your controller.

Proof Point: When Breaking the Rules Pays

The image below showcases the difference between this hybrid tuning method and the traditional approach. Along the top the software shows the same Recommended Tuning Parameters that were displayed at the beginning of this exercise – Controller Gain of 1.151, Reset Time of 1986, and Derivative of 0. By selecting the Compare To Your Existing Tunings option, the coefficients that were generated using the hybrid method can be keyed in and compared side-by-side. Indeed, the hybrid coefficients are shown to provide comparable performance as illustrated in the Set Point Response trend. The light green response
corresponds with use of the traditional, non-integrating model. The dark green response is the result of using the hybrid, integrating model.

While best-practices for PID controller tuning exist to assure safe, consistent and effective results there are occasions when alternative methods are needed. Very slow processes are one example where the use of a hybrid tuning procedure can prove valuable. Indeed, traditional methods don’t always work for practitioners who are tasked with improving loop performance while also being pressed for time. This rule reinterpretation reminds us: **Necessity is the mother of invention.**

Loop-Pro: A Standards-Based Approach to PID Controller Tuning

Loop-Pro™ Tuner is a standards-based technology ideally suited for tuning noisy, oscillatory, and long Dead-Time PID controllers. The software is widely recognized for both its ease-of-use and its unique ability to optimize highly complex loops. In six (6) simple steps Loop-Pro guides you through a repeatable procedure that delivers both consistent and superior results. Based on proven best-practices for modeling process dynamics and tuning PID controllers, Loop-Pro fulfills your requirements for optimized control.

**Repeatable Procedure**

- Six step procedure: Connect, Test, Model, Tune, Implement, Report
- Focus modeling on bump test data - avoid disturbance-driven data
- Use built-in heuristics to assess process data resolution and ‘quality’
Process Knowledge

- Compare the performance of existing vs. proposed tuning parameters
- Simulate performance of all controller forms (i.e. P-Only, PI, and PID)
- Simplify alignment of loop performance with its control objective

Validation & Documentation

- Facilitate capture of observations and performance of validation testing
- Capture details associated with loop testing, modeling, and optimizing
- Automatically store tuning reports and log tuning parameter changes
The NSS Modeling Innovation

Control Station’s Loop-Pro Product Suite is comprised of award-winning, industrial grade process modeling and PID controller tuning software tools. Control Station is proud to have its products private-labeled or referenced by industry-leading OEMs such as Rockwell Automation, Yokogawa Corporation of America, and NovaTech Process Solutions. Each of its products is powered by the NSS Modeling Innovation and equips practitioners to tackle the complexities of highly dynamic industrial control loops —what you know as the ‘real world’.

If you experience difficulty modeling and tuning oscillatory, noisy and long Dead-Time PID control loops, contact Control Station and learn how Loop-Pro and the NSS Modeling Innovation can help you tackle your industrial strength challenges.