Manual Tuning of PID Loops

This procedure has proven to be useful for processes where autotuning and adaptive tuning may have failed or is not available.
To avoid upsetting the process when changing PID values, place the control in manual. While in manual, the PID values may be changed without upsetting the output. After changing PID values, place the loop back into auto. If a small upset of the output is not important, PID constants may be tuned while in auto.
Time is a factor in temperature processes. Allow time between adjustments; for most thermal process wait 20 minutes before making new ones.

Proportional (P) Control

When using single mode PB for control, set the TI and TD to Off. Using only P mode for control requires a smaller PB than using PI and PID. A range of 3-10% of the SP is a useful range for this form of control.

Proportional and Integral (PI) Control

The two-mode PI is the most common control mode in the industry. The PB must be tuned first before the TI. Preset values may be used to accomplish a faster tuning. TI below 30 seconds will most likely cause cycling and is not recommended for most thermal applications.

Proportional, Integral and Derivative (PID) Control

The three-mode PID control is used primarily when overshoot of the PV cannot be tolerated as in the Quarter Wave Decay response of two-mode PI controls. PI must be tuned before attempting to tune the Derivative mode. D mode is only used on slow process and is not recommended for fast processes.

Input/Output Digital Filter

Adjusting the PID without the filter (set at 0) provides the fastest output response to a step change. Input filter should be turned off for very fast processes. The filter may be turned On at any time by using 1-255. If the PV is cycling with the PB at 30% of SP, or if the output is changing more than 2-3% with good PID values, the digital filter should be turned On. Settings are in scan rates of the unit, the same as the Input Filter. Use 3, 5, 10 seconds for the filter. Example for the CLS208 with 3 scans per second would use 9 for a 3-second response. Increase filter setting in steps of the scan rate until the output or PV has stabilized. Remember to allow at least 20 minutes between adjustments.

Rules for PID Manual Tuning Procedure

Set the Input filter to a value equivalent to 3 second response time. This will be determined by the scan rate of the controller. As an example: for the CLS204 which has a scan rate of 6 scans per second, set the input filter to 18. For thermal processes Set PB to 20% of the controller SP, for other use 40% of SP. Note when tuning the P Mode, the PV will line out below the SP.

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To tune P Mode

Step	Description
1	Set P to 30% of SP; I and D Modes to 0. Place in Auto. Wait until PV is close to SP and as stable as it can get.
2	Set Control Mode to Manual
3	Set P to ½ of current setting
4	Set Control Mode to Auto
5	Check to see that the output is stable (look at output % not PV)
6	If output is stable at less than a 2% delta change, go to step 2
7	When output is **NOT** stable with more than 2% delta change
8	Set Control Mode to Manual
9	Increase P by 25%
10	Set Control Mode to Auto
11	Check to see that the output is stable (look at output % not PV)
12	If output is **NOT** stable go to step 8
13	When output is stable leave Control Mode in Auto and tune the I Mode

To tune I Mode

Step	Description
1	Set I to 60
2	Set Control Mode to Auto
3	Check to see that the output is stable (look at output % not PV)
4	If output is stable with less than a 2% delta change
5	Set I to 50% of current setting
6	Check to see that the output is stable (look at output % not PV)
7	If output is stable go to step 5
8	When output is **NOT** stable with a greater than a 2% delta change
9	Increase I by 50% of current setting
10	If output is still not stable increase I by 50% of current setting until stable
11	When output is stable leave Control Mode in Auto and tune the D Mode

To set the D term: Divide I setting by 6 = D setting

Summary

After PID values are selected for proper response of the PV, they remain the same in most processes without a need to re-tune. The PB changes when operating at a very low temperature and then at a much higher temperature. For instance, controlling at 250°F and 2250°F with the same controller requires different PB values. TI and TD usually remain the same without a need of further tuning.
Two cases may require a new value for the TI:
1. When changing process material loads from a very large load to a much lighter load.
2. When changing the process load due to exothermic based processes.
When changing TI while the Derivative is in use, the TD should also be changed. In most cases, PID values do not need to be changed after they have been set correctly. Changing PID values to correct for process problems can cause more problems.

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