

TIP sheet - Roadmap for improving process control performance

1. **Identify the key process control loops.**
 - ***Review the process.*** The key loops are those that have a significant impact on business performance (operating efficiency, raw material costs, and maintenance costs). At least 80% of your efforts should be spent improving the performance of the key loops.
2. **Measure the variability in the key loops. You can't reduce variability until you measure it.**
 - ***Establish the baseline variability.*** Use time series analysis techniques such as power spectrum and cross correlation to characterize the variability and identify the potential sources.
 - ***Establish variability targets for the key loops.*** Implement solutions to reduce variability. The solutions include eliminating the source of the variability, improving control performance and improving mixing performance
 - ***Develop an economic benefits formula*** for reduced variability in the key processes. The benefits justify an on-going program.
3. **Measure and Improve the Process dynamics**
 - ***Establish process dynamic targets for each type of loop.*** Good dynamics are the foundation of good control performance. Remember that deadtime is particularly destabilizing and needs to be minimized.
 - ***Establish targets for valve non-linearities.*** A good target for backlash is less than 0.5%. A good target for stiction is less than 0.25%. Repair or replace the control valve if necessary.
 - ***Establish filtering guidelines.*** A good general rule is to minimize sensor filtering. The PV filter should be equal to $\lambda/10$ or less and the filter time should not be greater than the controller integral time.
 - ***Conduct open loop bump tests at regular intervals.*** The *key loops should be bump tested* at 6 months to 1 year intervals to measure the process dynamics and identify loop health problems. The process dynamics may vary significantly and the bump tests should be conducted at 'normal' operating conditions. Upgrade dynamics if necessary.
 - ***Minimize / eliminate controller and actuator deadbands.*** Deadbands can/will result in limit cycles
4. **Optimize the PID controller tuning**
 - ***Standardize on the Lambda tuning method.*** A structured, scientific tuning method is required for optimization.
 - ***Develop a tuning strategy for the loops in the process system.*** The tuning strategy needs to be aligned with the process objectives. An important overall objective is to minimize variation in the *key process variables*.
 - ***Build robustness into the controller tuning.*** Ensure that the Lambda value is equal to or greater than 2 times the time constant or deadtime. This 'will minimize the occurrence of controller induced cycles.
 - ***Conduct setpoint steps*** to ensure that the tuning meets expectations.
5. **Measure and Improve process mixing**
 - ***Conduct mixing tests.*** Good mixing attenuates high frequency variability and reduces the workload of the controller.
6. **Install advanced regulatory control strategies to achieve further reductions in process variability.**
 - ***Cascade Control, Ratio Control, Feedforward Control*** will improve the ability of the controller to respond to one or more external disturbances. The feedback controller is only capable of attenuating relatively slow external disturbances.
 - ***Output characterization and Adaptive tuning*** provide more uniform control performance on highly non-linear processes. Poor valve selection is an important source of non-linearity on flow and pressure loops.
7. **Install Multivariable Model Based control (MPC) on complex/interactive process systems**
 - ***MPC uses models*** to calculate the best way to move the manipulated variables. Process limits/constraints can be built into the model. An economic optimization layer drives the process towards the low cost operating point.
8. **Adopt an analytical approach to troubleshooting**
 - ***Document the problem*** to establish a baseline.
 - ***Conduct an Auto / Manual comparison*** test to determine if a process cycle is induced by the control action
 - ***Conduct Open Loop Bump tests*** to dig deeper into the source of controller *induced cycles*.
 - ***Conduct Setpoint Step Tests*** to evaluate controller tuning
 - ***Conduct Coupling Step tests*** to discover the impact of one process variable on another process variable.