Control Valve Positioner Performance

How well are your control valve positioners performing? Could they be the cause of poor control loop performance? Are there any standards for control valve response?

A test of 31 control valves in a pulp and paper mill revealed that the positioners were causing most of the control valve problems. EnTech Controls http://www.entechcontrol.com , a Toronto company, recognized that control valve dynamics depend on many factors including positioner performance. Control valves stick and have difficulty responding to small input changes. Control valve gain is not always linear over the entire range of travel. EnTech has released a Control Valve Dynamic Specification that is available on their website. ISA recognized the significance of the spec and convened the SP75.25 Control Valve Dynamic Testing committee to write a standard that promotes uniform specifying, testing and reporting of control valve dynamic performance. The committee is being careful to define how testing is to be performed and reported without establishing performance criteria. Users will be able to see a consistent set of installed performance characteristics.

The ISA SP75.25 committee is currently working on two documents. ISA-dS75.25.01 is called **Test Procedure for Control Valve Response Measurement from Step Inputs**. The purpose of this standard is to define how to test, measure, and report control valve response characteristics. This information can be used for process control applications in order to determine how well and how fast the control valve responds to the control valve input signal. It does not define acceptable process control, or restrict the selection of control valves to any application, since process requirements and user objectives vary widely.

This standard defines methods and criteria for performing response tests and evaluating test results for three alternative environments--“bench testing”, “laboratory testing”, and “in-process testing”. “Bench testing” is testing without flow such as in a plant instrument shop, laboratory, or control valve manufacturing site. “Laboratory testing” is testing with flow in a laboratory. “In-process” testing is performed in a plant during normal plant operation with process flow.

The technical report ISA-TR75.25.01 describes the response characteristics of a control valve system, the factors that can affect its response; the impact of its response on process control and to provide guidance in specifying required response characteristics. This document identifies response characteristics from step inputs and reviews tests to determine these characteristics. A control valve system is the complete control valve body, with actuator, and any accessories required for normal operation assembled ready for use.

The EnTech Control Valve Dynamic Specification was revised in November 1998 to version 3.0. The specification has three parts 1) Nonlinear, 2) Dynamic Response, and 3) Valve Sizing. Parts 1) and 2) –nonlinear and dynamic response, deal with issues such as *dead band* and speed of response, and are intended for the control valve manufacturer. A given control valve can be expected to meet one of the categories called out in the first two parts of the 20 page specification. The third part – valve sizing, is intended for the process/instrumentation-engineering designer who is selecting and sizing a control valve for a particular process application. A given valve selection and process design can be expected to meet one of the categories called out in the third part of the specification.

The Specification considers the control valve as a dynamic system, from input signal through to the *flow coefficient* that determines the fluid flow in the pipe. The *control valve system* includes the actuator, drive train, positioner and valve, under normal process operating conditions. The key to determining performance is that there is a measured change in a *process variable* in response to small input step-changes.

Most control valves are used as final control elements in feedback control loops with PID control algorithms. The dynamic response of the *control valve system* is inherently nonlinear in a complex way and has the potential to create the following problems for the control loop:
1. For very small input signal changes, valve non-linearities and variable *dead time* cause ***limit cycle***s. **Once a *limit cycle* occurs, effective control is lost and unwanted process variability is create**d.
2. The ***speed of response* of the *control valve system*** must be sufficiently fast to allow the desired control loop *speed of response* to be achieved.
3. The *control valve system* response often introduces *dead time* into the loop, which can vary with the magnitude of the valve input signa**l. *Dead time* is extremely destabilizing** for a control loop. Variable *dead time* even more so.
4. For larger input changes valve non-linearities cause the valve **dynamic response** to be **inconsisten**t, making it difficult or impossible to tune the controller for consistent performance. **For effective control the *control valve system* must deliver a consistent dynamic response over a specified range of step sizes.**

At time of purchase the expected performance of a *control valve system* should be documented in a specification sheet, for *control valve systems* or “valve packages” assembled by a valve manufacturer or supplier. When a user assembles a *control valve system* from components (control valves, actuators, positioners), the user should attempt to document the performance based on in-process tests, after the valve system has been placed in service. The actual performance of a *control valve syste*m, as installed, should be documented in a specification sheet. The parameters called out in this specification should be reported.

Internet Resources:
Control Engineering Online
Select and Size Control Valves Properly to Save Money
http://www.manufacturing.net/magazine/ce/archives/1999/ctl1001.99/991001.htm

ISA's SP75.25 Control Valve Dynamic Testing Subcommittee Update
http://www.manufacturing.net/magazine/ce/archives/1999/ctl1001.99/991001w1.htm

Positioner Guidelines
http://www.manufacturing.net/magazine/ce/archives/1999/ctl1001.99/991001w2.htm

Control Valves: Sizing, Design, Characteristics
http://www.manufacturing.net/magazine/ce/archives/1997/ctl0301.97/03fbas.htm

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