Some Comments on the Turndown of Control Valves

The purpose of a control valve is to maintain flow at a specific set-point, subject to limitations in turndown, accuracy, and speed of response.

Turndown is the ratio of max to min flow. For a pinch valve, 10:1 is typical, so if you have a maximum flow of 5,000 SCFM, you can expect to maintain stable control down to 500 SCFM. Of course, the valve can close drop tight (zero flow) but it’s difficult to maintain stable control between zero and your minimum controllable flow.

Measuring “turndown” is like trying to nail Jell-O to the wall, because it’s tricky trying to establish the minimum stable flow rate. It’s near impossible trying to predict in advance unless you have some very good modeling of your process dynamics. It is usually calculated by taking your competitor’s claim and multiplying by 4.

Turndown says nothing about speed of response, undershoot, overshoot or duty cycle.

There are several ways to increase turndown:

1. **Change from an electric actuator to a pneumatic actuator.**

   The specs for a typical electric actuator and a typical pneumatic positioner are both published as ±1. However, I have observed that in actual shop testing a pneumatic positioner and actuator assembly typically can position the valve stem with an order of magnitude better performance than we typically observe with an electric actuator.

   The other limitation of electric actuators is speed of response. An electric actuator has one speed. This is usually slow; otherwise the valve overshoots and become unstable.

   In contrast, pneumatic valves are inherently variable speed. As a result, they respond faster with less overshoot than an electric actuated valve. The pneumatic valve starts out fast and decelerates as it approaches set point.

2. **Tune the PID controller to respond slower.**

   If you reduce the gain and increase the Integral function, turndown increases at the expense of response time. Now you have a valve with increased turndown, but it’s slow. For example, suppose your valve is holding flow at 2,000 gpm and you change the set-point to 100 gpm. The valve closes down to
500 gpm in a couple of minutes, but then it spends the next 20 minutes to jogging down in tiny increments to get to your 100 gpm target.

3. **Use adaptive tuning in your controller.** Here you input multiple sets of P-I-D parameters into your controller with a cross over point. At high flows, your controller picks high gain numbers for fast response, and at low flows it uses the lower numbers for better stability.

4. **Use two valves in parallel,** a big one and a small one, with a split range. For example you might have a 3-inch and a 1-inch valve side by side. At high flow rates, the 1-inch valve is full open and the 3-inch valve is modulating. At low flow rates, the 3-inch valve is closed and the 1-inch valve is modulating.

System performance is a function of the system dynamics: how fast does the load change, what are the inherent frequency response and damping characteristics of the system, what is the lag time in the pressure sensor, and what is the relationship between flow and pressure in the system?

David Gardellin  
Onyx Valve Co  
P: 856-829-2888  
F: 856-829-3080  
E: david@onyxvalve.com