DIGITAL VALVE POSITIONER ENHANCES THE PERFORMANCE OF PRESSURE/FLOW CONTROL

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Specifying a control valve for Pressure/Flow Control service should be a relatively straightforward process. The range of compressed air flow and pressures must be known along with the target delivered air pressure. With this information, the performance specifications published by the various suppliers can be referenced for selecting a valve package. Often, however, the valve selected is too large in size to ensure it will have sufficient capacity to satisfy current and future flow requirements. Valve manufacturers use different design criteria in rating their units and in how their product is presented. There are no standards. For example, some list nominal flows suggesting the valve is about 50% open at the rating point. Others show a range of flows, which can be misleading since most valves cannot be tuned to perform equally well at both the low flow and the high flow conditions. Stated pressures are also an arbitrary number that may require adjusting the rated flow at the site specific facility. **Table 1** is an example of the approximate flow capacities for one such 6" valve.

TABLE 1

SIZE	NOMINAL FLOW @ 100 PSIG	NOMINAL FLOW @ 125 PSIG	NOMINAL FLOW @ 150 PSIG	OVER RANGE MAX FLOW
6" Valve	7,500 SCFM	9,550 SCFM	10,430 SCFM	14,539 SCFM

Where:

- Nominal Flows assumes the valve is about 50% open.
- Over range Flow is the highest practical flow with the valve about 80% open @ 100 psig.

Rated flows assume a 10 psid pressure differential across the valve.

Any of these flows could be listed as a rating point when properly qualified. Besides selecting a valve to meet the highest system flow requirement, the performance capabilities of the valve over the full anticipated system range of flows and pressure profile must be looked at. Manufacturer "A", for example, rates their 6" valve package at 6,500 scfm while Manufacturer "B" shows a range of flows from their 6" package of 800-10,700 scfm. Selecting the "A" valve based upon its rated flow of 6,500 scfm provides for a wide margin of safety. Selecting the "B" valve at its 10,700 scfm rated flow to be safe could create problems if it is also expected to control at significantly lower flows. A valve tuned properly within a PID Control loop for the high flow performance may tend to oscillate or hunt at the low flow condition.

Another common error is to size a valve based upon the piping header diameter. The thinking is if the valve is the same size as the connected pipe, it will certainly be big enough to pass the pipe flow. While this is technically correct, it usually results in an oversized valve that may have problems operating at the low flow conditions of the air system. If this situation exists, one solution is to retrofit the control valve with a Digital Valve Positioner (DVP). Let's look at the issue and see how a DVP could correct it.

The most prevalent throttling valve used for Pressure/Flow Control service is the butterfly valve. It is mechanically simple, requires a minimum of space, and provides high flow capacity with low pressure loss through the valve. They are relatively inexpensive in terms of flow capacity per investment dollar and match up with standard pipe flanges for ease of installation. **Figure 1** depicts a commonly used butterfly valve configured for Pressure/Flow Control service.

Flow is controlled by rotating a disk in the compressed air stream. The disk stem connects to a quarter turn actuator that is driven by a pneumatic control signal from an electronic positioner. An analog signal to the positioner from a PID Controller is generated in accordance with the outlet pressure sensed.

When to disk rotates, the torque applied to the shaft causes wear on the stem, seal, bearing surfaces, and seat. Improperly sized or misapplied valves that continuously oscillate and hunt put excess wear on these components. If the disk is allowed to get too far out into the

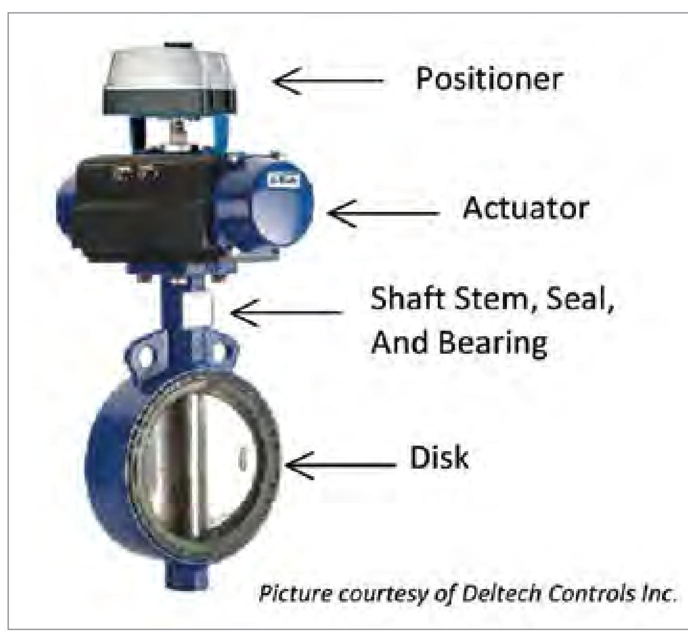

Figure 1. Butterfly Control Valve Assembly

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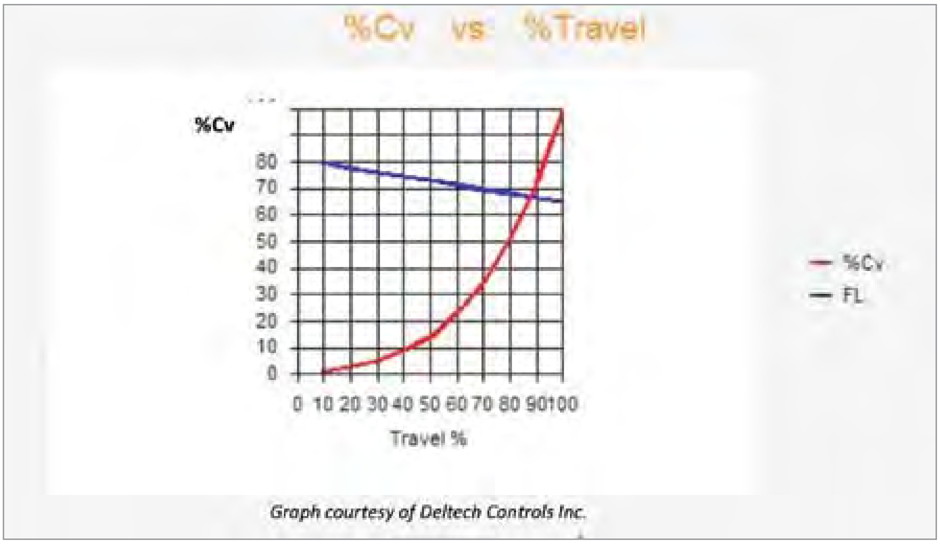

Figure 2. Typical Butterfly Valve Performance Curve

air stream, the torque to bring it back can sometimes snap the shaft. For a dynamic plant air system, alternate valve configurations should be explored in advance and the best one chosen to deal with the site specific performance requirements. For existing installations, the valve can be retrofitted to eliminate hunting by replacing the analog positioner with a DVP.

Butterfly valves have equal percentage flow characteristics meaning the flow capacity increases exponentially with valve trim travel. An **equal percentage** flow characteristic is a non-linear curve of which the slope increases as the valve disk opens. **Figure 2** illustrates a typical butterfly valve performance curve.

Note how a large incremental change in travel produces a small change in flow at the low end of the flow curve while a similar incremental change in travel produces a large change in flow at high end of the curve. Flow in the mid-range from about 25% to 70% is fairly linear. A butterfly valve chosen to operate within this limited mid-travel range can be tuned to perform satisfactorily. A valve chosen to operate at a wider range may have a tendency hunt at the low flow conditions.

"Equipping a Flow Control with a DVP can be a valuable step in improving the overall plant performance and deliver a good return on investment."

— Bob Wilson, PEMCO Services

The FL curve shows the liquid pressure recovery factor for the valve. As the valve travel changes, the directional flow path of the air across the disk also changes. The number is really only important in critical applications. Generally, the higher the number the better the valve will perform. The valve manufacturer will have these numbers if needed for selecting a valve for a critical application.

The recent trend of adding higher efficiency VSD and Variable Displacement compressors to the multiple compressor network changes some of the reasons why Pressure/Flow Control is applied. The increased part load performance capabilities of these types of compressors allow operating the network in a base/trim profile within a narrow pressure band set for the lowest optimal pressure needed to sustain production. Reducing the delivered air pressure by creating a large volume of primary storage in a receiver for release by the Pressure/Flow Control becomes less of a benefit. The new variable flow compressor designs provide reserve energy the system can draw upon from the compressor motor if it is operating at less than full load. The purpose of Pressure/Flow Control now is to supplement to the energy input of the compressors to maintain the optimal energy balance as the demand profile changes. Also, modern day system master network controllers offer new configurations based upon energy algorithms. These allow pressure bands to be set in the +/- 2-3 psi range. The Pressure/Flow Control valve must be capable of operating at lower pressure differential for the system to take maximum advantage of the higher efficiency of the newer compressor networks. **Figure 3** depicts a modern day compressor network operating in a base/trim profile with the Pressure/Flow Control supplementing energy input of the compressors to maintain the system energy balance.

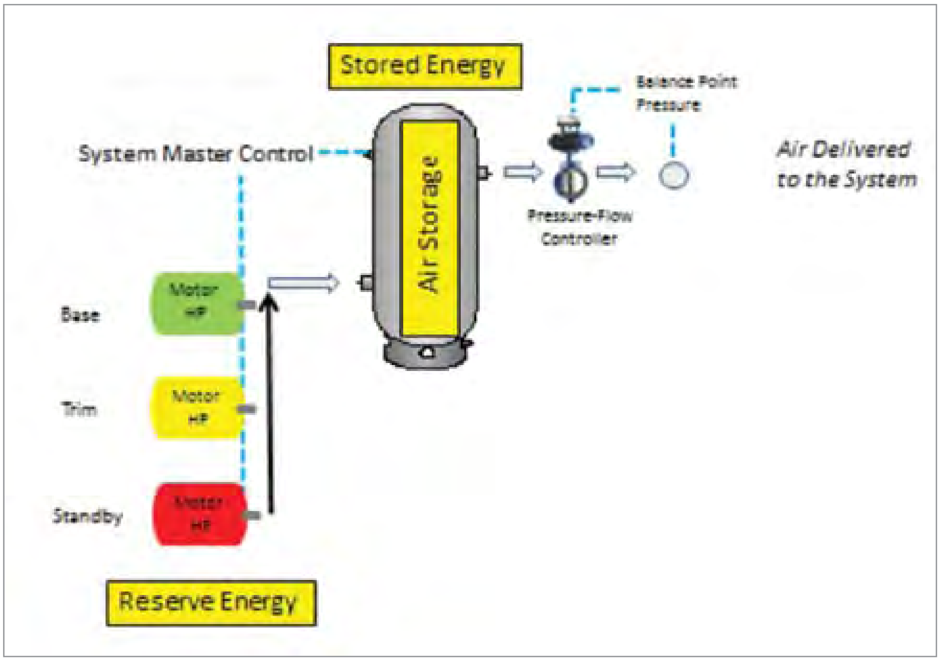

Figure 3. Modern Compressor Room Configuration

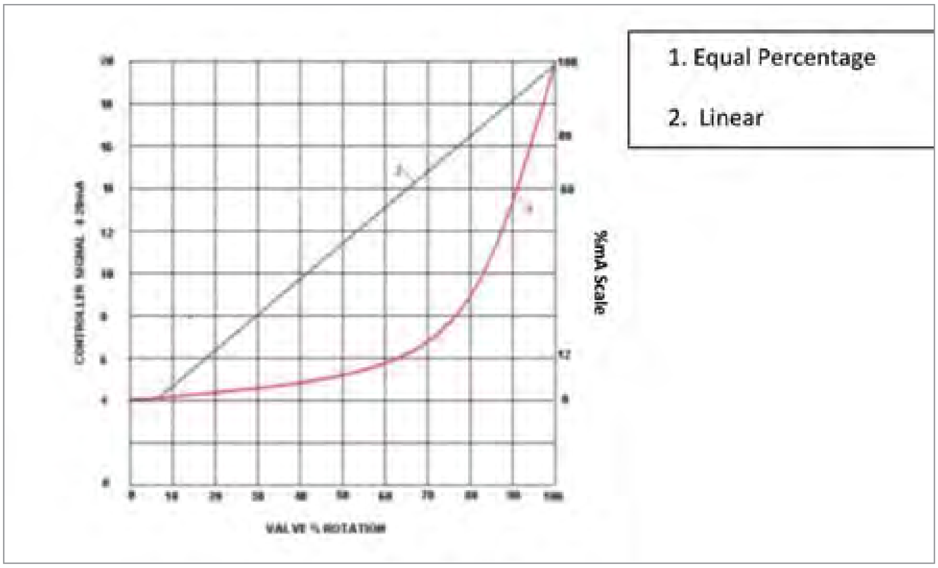

Figure 4. Linear Performance Curve for Valve Equipped with a Digital Positioner

Many engineers recognize the performance benefits of the new compressor technology but remain uncertain of how best to implement it in their plants. If an existing Pressure/Flow Control has problems after the addition of VSD or Variable Displacement compressors and/or a System Master Network Control, one solution

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is to retrofit the analog positioner on the valve with a new advanced technology digital positioner. **Figure 4** depicts a performance curve of a valve equipped with a DVP.

DVPs can be programmed to provide linear performance over the entire valve flow curve. This eliminates the excessive hunting and oscillation of a valve at the lower end of the flow curve. Because of their immediate response to change and accuracy without oscillation DVPs are ideally suited for use in applications like Pressure/Flow Control service where the process variables change rapidly. The performance curve depicted shows that this particular DVP is also programmed to initially rotate the disk about 8% to move it out of its seat so flow begins before the valve starts to control in a linear manner. **Figure 5** is a picture of a butterfly control valve with the DVP mounted on the actuator.

Figure 5. Butterfly Valve with DVP

Most DVP manufacturers offer product training programs to teach about how to mount and set up the unit and how to commission and troubleshoot it. There are many different styles and makes of digital positioners available. They range in costs from about $1000 - $2,000. Criteria must be carefully considered in choosing the right positioner for a site specific application and environment.

Some digital positioners will support an open protocol for digital communications such as HART, FOUNDATION Fieldbus, or PROFIBUS. These provide a means to monitor the health and performance of the Control valve. They can also be equipped with additional inputs and outputs such as dry contacts, and built-in diagnostic software that can provide advance warning of maintenance issues or a pending failure.

Even with the better pressure stability of the new model variable flow compressors, Pressure/Flow Control can still offer cost saving opportunities. The air pressure required by the air treatment equipment limits the extent of the decrease in supply pressure. The Pressure/Flow Control can provide a further reduction in the delivered air pressure. This is an excellent method to reduce and control air leakage. Also, the controlled storage in the receiver buffers the compressor response from the system demands so they have time to react and smoothly add their reserve energy to the system. The application of a DVP will enhance the performance of a Pressure/Flow Control allowing the system to take maximum advantage of higher compressor efficiency. Equipping a Flow Control with a DVP can be a valuable step in improving the overall plant performance and deliver a good return on investment. BP

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