# Increased Plant Availability through Proper Anti-Surge Valve Selection

*By Riyaz Ali*

## Introduction

Surge is characterized by fast flow reversals through a compressor and is caused by a large-scale breakdown of flow patterns within the compressor. Surge happens at low flow rates, often when the downstream demand decreases. When flow decreases below a certain minimum point, flow patterns in the compressor become unstable and fluid can move back through the compressor from the high-pressure side to the low-pressure side.

Because surge is a fast, high energy phenomenon, it can introduce excessive dynamic loads on internal components, such as thrust bearings, seals, and blades as well as introduce unwanted pipeline vibrations.

The cost of replacing compressor seals alone is on the order of $20K to $50K. Over time, surge can introduce fatigue failures that can damage the entire compressor.

Antisurge control valves have been used on compressors for decades. Most antisurge valves recycle flow from the outlet of the compressor back to the inlet to keep a minimum amount of flow going through the compressor.

## Basic Requirements for Anti-Surge Control

The goal of any compressor controller is to operate turbomachinery within a safe operating envelope. Aside from surge limits, compressor controllers must handle a number of physical limitations including choke limits, power limits, process limits and rotational speed limits. The task of operating a compressor within this region becomes particularly complex on multistage compressors or when multiple compressors are operated in parallel. While many compressors today are controlled by sophisticated and integrated control systems, the majority of antisurge valves are still specified only by stroking speed.

Valves that are designed only for stroking speed rarely control well in throttling applications. Because of this, the performance of the antisurge system suffers. Not only does the performance of the antisurge system suffer, plant availability and throughput hinges on the performance of these valves. Following are requirements for antisurge valves.

Partial stroke testing requirements:

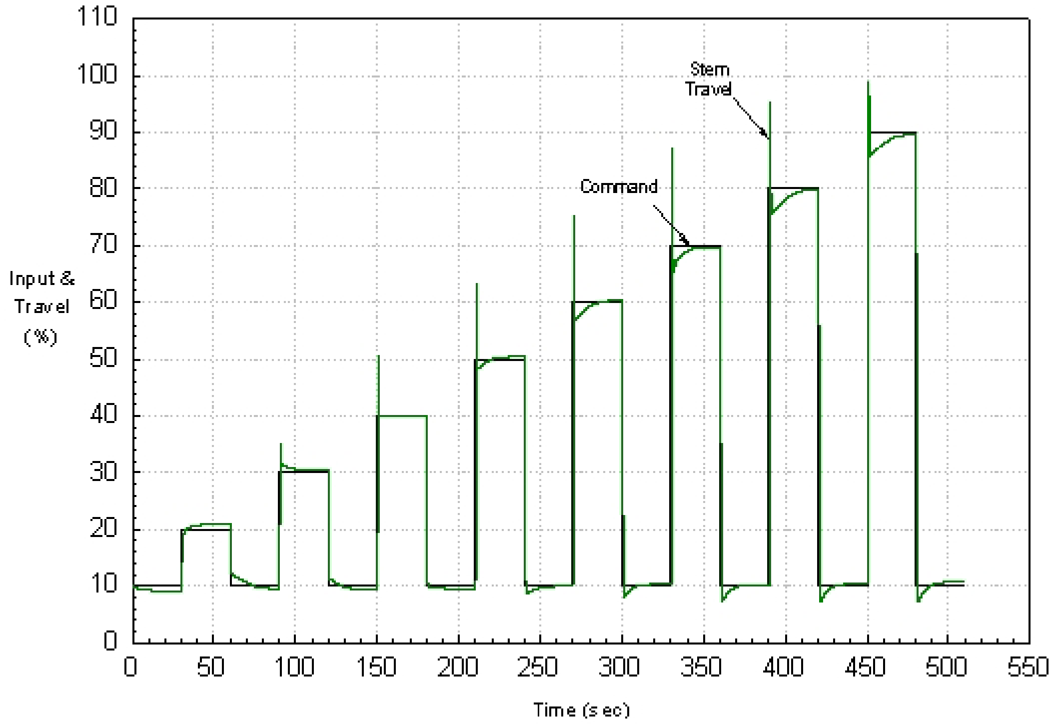


*Figure 1: Performance of Antisurge Valve Designed Only for Stroking Speed.*

Systems that have been designed only for stroking speed end up with a lack of robustness in the control servo loop. This means that the system likely will be unstable when operated outside of open-loop requirements. This can cause excessive overshoot and instability when the valve responds to a set point change. Figure 1 shows the performance of an 18” antisurge valve designed for only fast stroking speed when subjected to a series of step tests. As the step size becomes larger, the valve ‘hunts’ for position, a tell-tale sign of a poor performing antisurge valve.

Because stable valve performance is critical in this application, an unstable servo loop requires that the valve be run in manual control making startup and shutdown difficult. This also equates to reduced compressor throughput and efficiency since the system must be de-tuned because of the valve’s poor performance.

## Optimized Digital Valve Controller to the Rescue

The optimized antisurge valve with a digital valve controller is designed with both open- and closed-loop performance in mind. The open-loop response is tied directly to stroking speed while the closed-loop response is directly related to the actual control function of the antisurge controller. Better control yields improved system gains, which equates to faster action and tighter control. This tighter compressor control allows the compressor to operate more efficiently while increasing compressor throughput. For new units, this means that a smaller compressor could be used with an optimized antisurge valve compared to one that uses a valve selected by traditional means.

Introducing digital valve controllers on antisurge valves can help meet the challenging requirements of antisurge applications where speed and accuracy are important, where:

- speed requirements are typically less than 2 seconds
- overshoot criteria are in the 5% or less range
- online tuning/diagnostics are required
- valves must respond to small step changes without overshoot or undershoot

## Solution to the Problem

By designing with both open- and closed-loop performance in mind, adequate protection of the compressor in case of surge is ensured along with accurate throttling control to maximize compressor output and efficiency. By designing the system for fast acting, accurate closed-loop control, the compressor antisurge system can perform at its peak potential by allowing for higher system gains.

Figure 2 shows the performance of the same 18” antisurge valve designed with the enhancements of the optimized antisurge valve.

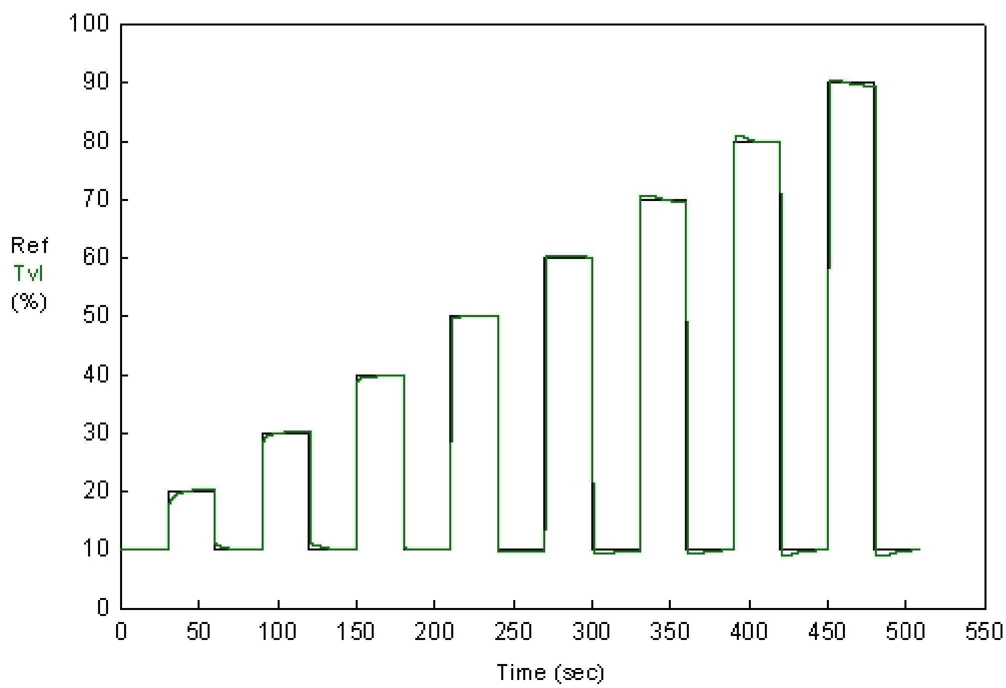


*Figure 2: Performance of the Optimized Antisurge Valve*

Stable performance throughout the entire valve travel ensures that the valve will respond quickly and accurately to any changes initiated by the antisurge controller. The symmetric performance in the opening and closing directions can improve tuning and controllability.

In addition to other benefits, digital valve controllers can provide online tuning and live feedback so that adjustments can be done remotely at faster speed, all components can be tuned together remotely and non-intrusive diagnostics including performance diagnostics, triggered diagnostic, and an on-seat diagnostic that can be performed online. This allows the user to identify any potential issues without any shutdown and actively pre-plan for any necessary improvements or upgrades during the next shutdown. It also allows for partial stroke testing to ensure movement of the valve at desired stroking speed during demand, as these valves operate infrequently.

Most processes don't utilize redundant compressors, making the compressor system the critical point of operation. The performance of the valve is important, but also ensuring the entire valve package is designed with this in mind is necessary.

Antisurge valves can be found in nearly any production or process facility, but are most suited for challenging and daunting performance needs of the olefin and LNG industries. Olefins and LNG facilities commonly integrate capacity and antisurge control into the antisurge controller since these two systems can fight one another if left independent. This integration requires excellent performance from the antisurge valve in order to operate efficiently.

## Conclusion

With the advent of digital technology, the controllers are now expected to provide more than just antisurge control. They must be designed to handle physical limitations of the compressor as well as to maximize the throughput and efficiency of the compressor. In many cases, this has been accomplished by combining the throughput and capacity control requirements into the antisurge controllers.

This was possible due to specific control and tuning algorithms in digital valve controller, which allows a user to tune the valve from the control room and adjust the gains and damping functions immediately to see the results in control room.

When antisurge valve applications use a digital valve controller with antisurge-specific control algorithms built in, and when coupled with the proper valve, actuator and accessories, increased compressor throughput, reliability and efficiency can be achieved, increasing plant uptime.

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