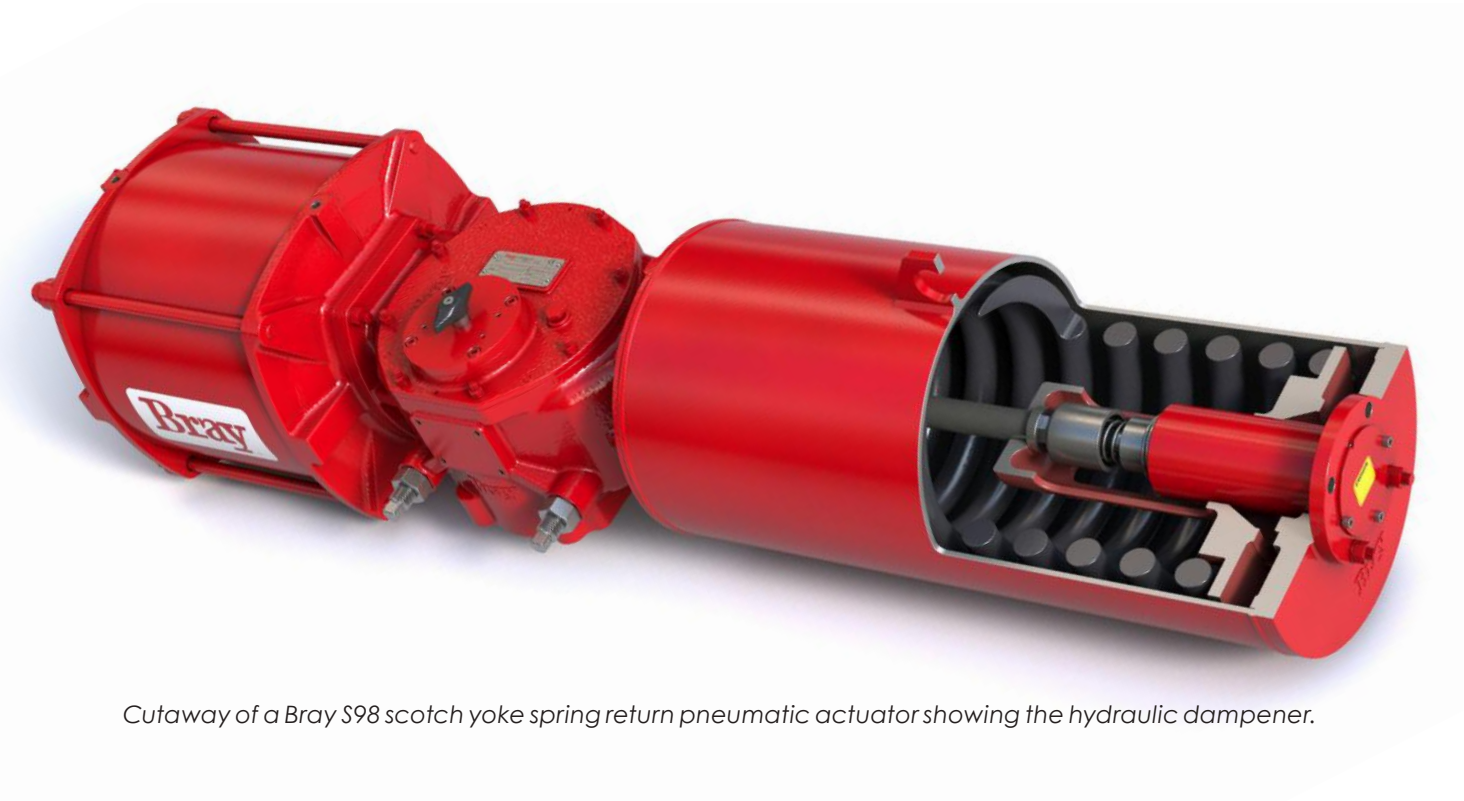
Cover Story

Hydraulic Dampeners – Enhancing Reliability for Fast-Acting Emergency Shutdown Valves



Cutaway of a Bray S98 scotch yoke spring return pneumatic actuator showing the hydraulic dampener.

A critical element of most hazardous processes, Emergency Shutdown Valves ensure safe operation by quickly stopping the flow of media in emergency situations. However, the speed with which these valves are required to operate may result in malfunction or failure of vital valve components. How are end users mitigating detrimental effects of fast operation and improving valve reliability?

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Emergency shutdown valves (ESDV) play a crucial role in protecting people, equipment, processes and the environment. Reliability is the single most important parameter in the design, selection and use of ESDVs and blowdown valves (BDVs).

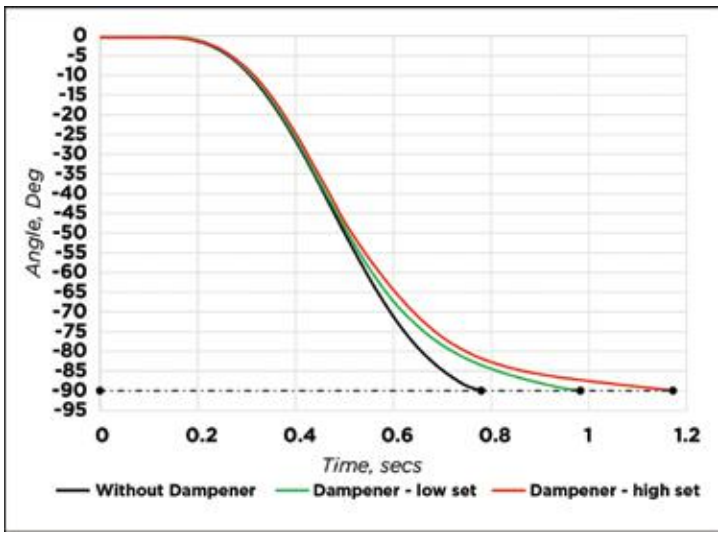
Equipped with a spring return pneumatic actuator set to fail in the closed position (spring-close), ESDVs isolate flow and pressure during an abnormal occurrence in a process or piping system. Similarly equipped but set to fail in the open position (spring-open), BDVs are used to vent a gas from a piping system to atmosphere or a gas flare during an emergency shutdown of a pipeline, plant or process. Both ESDVs and BDVs require the actuator to operate quickly to minimize the consequences of the emergency. Fast operation requires quick acceleration and quick deceleration.

In an emergency shutdown situation, the pressure inside the actuator is exhausted allowing the internal spring mechanism to rapidly move the valve to the fail position. The stress created by fast operation of valves is a major concern potentially affecting the entire valve assembly, including springs and travel stops of the actuator, valve-actuator couplings, adapter hardware, valve stems, guides, seats and seals. Further compounding the problem is the potential impact this stress can have on connected piping, hydraulic shock to the piping system, and even reliability of actuator controls and limit switches. While actuators and valves are typically designed to withstand stresses from static loads, often there is little investigation into the dynamics of collision kinetic energy and absorbed energy of various components in a valve-actuator assembly. A linear static analysis may be applied but the loads remain constant (time-invariant), and no inertial or damping forces are considered. A linear dynamic analysis, where applied loads are time-dependent, considers inertial and damping forces due to high velocities and acceleration, but is rarely applied. Unfortunately, consideration of the effects of fast valve operation often happens only after a failure occurs. For emergency shutdown valves, failure in service may have catastrophic consequences. To minimize these consequences, manufacturers and end users have found that equipping the actuator with a hydraulic dampener significantly improves reliability of ESDVs and BDVs.

The hydraulic dampener acts as a shock absorber to manage high kinetic energy of the fast moving parts. Kinetic energy of an object is directly proportional to the square of its speed. Requiring no external power source, hydraulic dampeners operate without significantly affecting the travel speed until the end of the stroke (either full open to full close for ESDVs or full close to full open for BDVs). This allows the valve to travel as fast as possible for the first 70 to 90 percent of the actuator stroke and then significantly slower for the remainder of the travel or rotation. “Fast” is defined differently for various valve types and applications, but for many quarter-turn valve applications, fast is operating a full 90-degree rotation in 0.1 to 0.3 seconds per nominal pipe size (NPS). For example, 1 second is considered fast for a 10 NPS valve.

Close-up of the hydraulic dampener on a Bray Series 98 Spring-Return Pneumatic Actuator.

The hydraulic dampener functions by using a controlled rate of oil displacement in a closed loop. As the piston rod of the dampener is pressed down into the dampener's hydraulic cylinder, oil is displaced by the piston and forced through varying orifices that are progressively closed off as the piston strokes. This results in constant linear deceleration of the piston rod over its stroke, which differentiates it from older, conventional



Operating Time vs. Angle of Disc Rotation, Without and With Dampener (Example: Tri Lok Triple Offset Valve with Series 98 Spring-Return Pneumatic Actuator).

A Bray Tri Lok triple offset valve with Series 98 pneumatic spring return actuator and hydraulic dampener for blowdown service.

methods using springs or dashpots. The oil displaced from the cylinder is directed into an accumulator chamber and then refills the cylinder as the piston retracts outward by either a spring return or by the compression reaction of the nitrogen gas filled accumulator.

In the modular design of the Series 98 actuator from Bray, the hydraulic dampener is located within the spring module of the actuator without reducing the actuator end torque, or even impacting ingress protection rating and overall dimensions. In this design, no external tanks are used. Locating the dampener within the actuator enables the linear position adjustment of dampener so that the start point of the dampening occurs just in the last 10% to 15% of the actuator's end of stroke. Hydraulic dampeners may include a built-in rate adjustment to fine-tune the dampening action to match the seat type – soft or metal.

A properly designed and functioning hydraulic dampener will protect critical components, extend valve life and improve reliability of emergency shutdown systems.

To see this technology in action visit

http://www.bray.com/s98-hydraulic-dampener

Valve Components Susceptible to Damage or Malfunction Due to Fast Operation:

Seat
Seal
Bearings
Stem
Springs
Guides
Stem Packing

Actuator Components Susceptible to Damage or Malfunction Due to Fast Operation:

Travel Stops
Springs
Drive Nuts
Position Switches
Actuator Mounted Controls

Valve-Actuator Connection Components Susceptible to Damage or Malfunction Due to Fast Operation:

Actuator Mounting Bracket
Stem Coupler
Adapter Fasteners