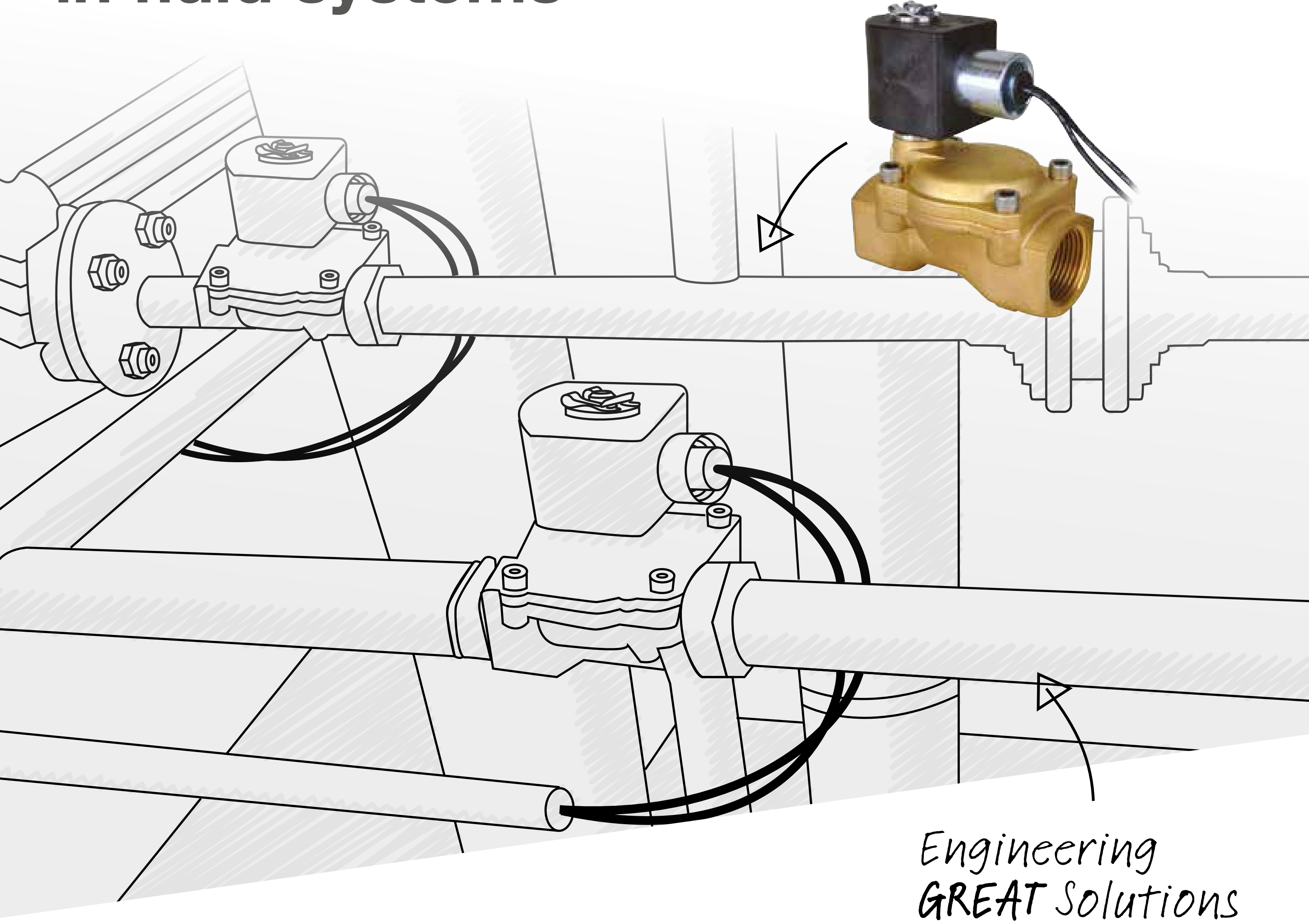
IMI NORGREN

WHITE PAPER

Water Hammer

Reducing pressure spikes in fluid systems



Engineering GREAT Solutions

IMI Precision Engineering

Executive Summary

Water hammer is a pressure wave or surge caused when a fluid in motion is forced to stop suddenly, as when a valve closes rapidly. This surge creates a pressure spike in a pipe system that can damage seals, gauges, pipes, hoses, and fittings – virtually anything upstream of the shut-off point. Traditional solutions to this problem include pressure regulators, shock absorbers, accumulators or check valves upstream to dampen the effect, but adding components increases complexity.

IMI Precision Engineering addresses the problem of water hammer at its cause – the valve. IMI Norgren® 82410 and 82740 solenoid valves are proven to reduce pressure spikes by more than 80% compared to leading competitors' valves.

What is “water hammer” and why does it matter?

We’ve all heard it – that bang in the pipes when we turn off the shower or faucet suddenly. Sometimes multiple bangs shudder through the pipe as the water bounces back and forth. The same phenomenon can happen in large commercial or industrial fluid systems.

Water hammer, also called fluid hammer or hydraulic shock, is a wave or surge caused when a fluid in motion is forced to stop suddenly. In process applications this happens when a fast-acting valve closes a pipe while the water upstream is still moving. The water hits the closed valve and bounces back, creating a pressure spike in the system upstream.

How bad is it?

Pressure spikes have been measured as high as 15 times higher than the normal water pressure in the pipeline. This exceeds typical UL rating safety factors and can damage equipment not designed to withstand pressures that high.

Water hammer is a problem for applications using water from public utilities that usually comes in with a pressure rating between 70 and100 psi. Applications range anywhere from small dental offices to large manufacturing facilities. Water hammer is also a problem in mobile equipment that carries water, like concrete mixers or street sweepers. Industrial processes that use pressurized water can also be seriously impacted by water hammer.

Repeated over-pressurization and vibration can cause damage ranging from premature wear to catastrophic failure of pipes, tubing, fittings, regulators, pumps, floats, gauges and anything else upstream from the closure point, as well as the unpleasant noise it creates.

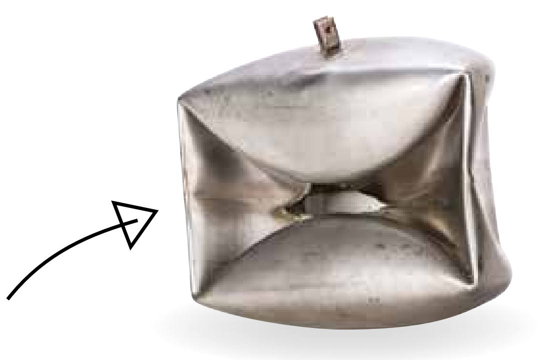
Typical solutions and their shortcomings

Engineers, designers and maintenance professionals have come up with various ways to reduce the problems caused by water hammer. One obvious solution is to use a regulator upstream of the valve to lower the pressure rating and reduce the maximum pressure of the surge. However, the addition of a regulator will drop the flow rate, possibly reducing performance and productivity in the system.

There are several mechanical methods to reduce the impact of water hammer. One is to install check valves upstream to control the distance the pressure spike travels. Another is to use accumulators; pressurized vessels that divert the excess fluid until the pressure spike abates. Large systems sometimes incorporate water towers to accommodate the surge. Alternatively, a shock absorber, also called a water hammer arrestor, can be installed upstream to absorb the shock of the pressure spike.

Adding components like these increases cost and complexity as well as introducing additional potential failure points into a system.

Another tactic is to modify the whole system design. Inserting elbows and loops into piping may slow the velocity of the water hammer surge. Unfortunately, this also increases the space required for the piping and, again, increases complexity and the chance for error.



Effect of a pressure surge on a float gauge

Instead, a better valve

The simplest approach is to attack this problem at its source – the valve. After all, it is the rapid closing of the valve that sends the fluid surging back upstream.

But rapid closing is required for safe and effective operation in systems that typically use these 2-way valves. The question is, how can operators get the speed they need without creating a large water hammer effect? The answer is the IMI Norgren® 82410 and the 82740 2-way normally closed valves.

The beauty of this solution lies in the way these valves close. These IMI Norgren® valves have a proprietary internal design that lets them close smoothly and gently, reducing pressure spikes while still maintaining closing speed. The result is valves that close in a quarter-second but with just a fraction (one-fifth) of the pressure surge typical of other similar valves.

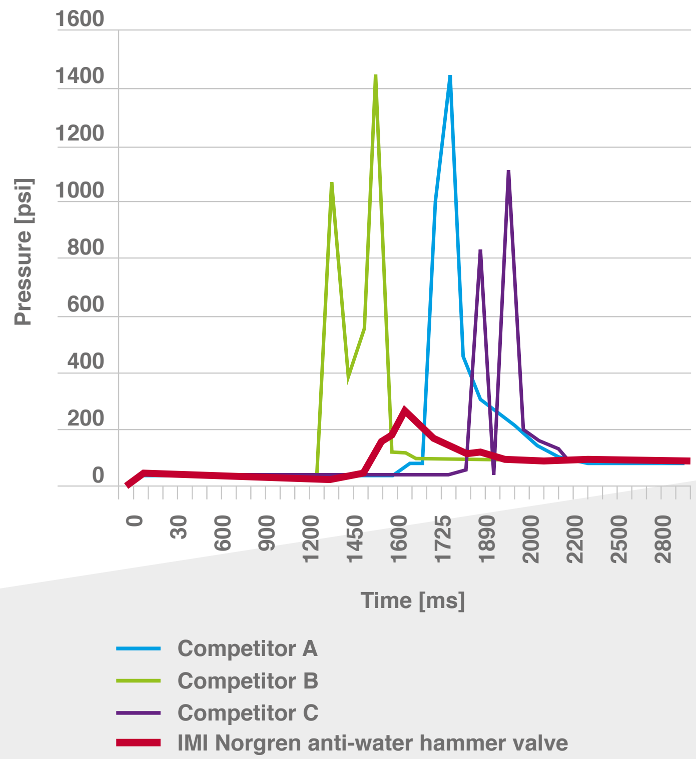
The proof

System designers have been selecting these solenoid valves for years for their performance and robust design. They didn't always realize they were also getting the benefit of protection from the water hammer effect. But as this advantage became more apparent over time, IMI Precision Engineering decided to quantify the difference through comparative testing.

The tests compared the IMI Norgren® solenoid valve to three other best-selling valves. All were 2-way, normally closed, pilot operated valves with ½" NPT threads and ½" orifices and each closed in 250 ms or less. In other words, the valves were directly comparable. Each was tested on a pipe with inlet water pressure of 4 bar (87 psi), within the range of 70-100 psi typical of public waterline pressure. The power was shut off so the valves would move to the closed position and then the pressure upstream was measured every 100 milliseconds.

Two competitors' valves hit peaks of 1440 psi, roughly 100 bar, and one hit 1101 psi or about 75 bar. Two of the three valves created not just one but two pressure spikes before the pressure returned to 87 psi. In contrast, the IMI Norgren® 82410 reached a single peak of only 265 psi or 18 bar, less than 20% of the two valves with the highest spikes. The graph below tells the story quite clearly.

Valve-by-valve comparison of water hammer pressure spikes



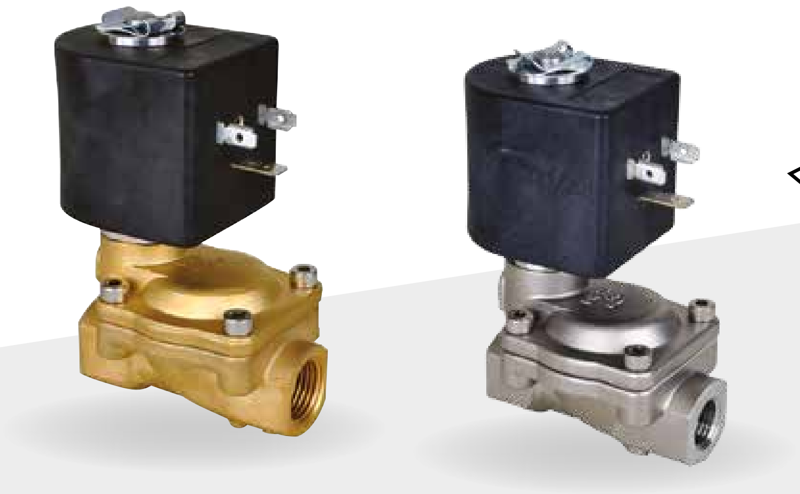
Third-party tests under different conditions – using a rubber hose instead of a hard-piped system – yielded similar results.

In the field

It's easy to use these solenoid valves in any design or installation. Each is a standard industry workhorse, a 2-way normally closed, pilot operated valve familiar to anyone designing or using fluidics for commercial or industrial applications. The IMI Norgren® 82410 is supplied in brass and the IMI Norgren® 82740 in 316 stainless steel for more aggressive operating environments. In addition, their compact size gives engineers design flexibility and more control over their equipment footprint.

But the benefits of reduced water hammer effect are not limited to new equipment. These valves can also be used as a maintenance upgrade. While it is common practice to replace worn valves with new ones from the same manufacturer, the case for reducing water hammer is often strong enough to make plant operators and maintenance professionals consider a direct replacement with the IMI Norgren® 82410 or 82740 instead. IMI Precision Engineering can help evaluate port-to-port sizing to make sure it will fit in your hard-piped system.

Whether designing new systems or improving existing ones, reducing pressure spikes is a simple way to prolong service life, maintain system safety and reduce noise. Choosing the right valve is the simplest, most cost-effective way to reduce pressure spikes due to water hammer.



IMI Norgren® 82410 and 82740 solenoid valves prevent water hammer damage by closing smoothly and gently

IMI Precision Engineering operates four global centres of technical excellence and a sales and service network in 75 countries, as well as manufacturing capability in the USA, Germany, China, UK, Switzerland, Czech Republic, Mexico and Brazil.

For information on all IMI Precision Engineering companies visit **www.imi-precision.com**

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