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From lab to production,
providing a window into the process

Coping with Transducer-Crippling Pressure Spikes

Many transducers in fluid power systems fall victim to short-duration pressure overloads–commonly called pressure spikes. If these spikes are severe enough, a permanent, positive zero shift in the transducer's output can occur.

After investigating these spikes, we developed a laboratory method for determining the magnitude of the actual pressure spike that caused a specific field failure. The method shows that pressure spikes many times that of nominal system pressure can occur in a system.

Using this procedure, we determined, for example, that two transducers returned by one of our users for failure analysis had been subjected to pressure spikes of 19,500 and 21,500 psi. The user found our conclusions difficult to accept, and a small wonder. The system contained appropriate relief valves, a cushioned hydraulic ram, and had a working pressure of only 1350 psi. When we told the user that pressure spikes 14.4 and 15.9 times system pressure had occurred, logic ruled against our findings.

To resolve this problem, we took a digital storage oscilloscope and disk recorder to the user's plant to test the hydraulic systems of the die casting machines experiencing the transducer failures. The recorder had automatic triggering function that allowed measuring with a resolution of 0.5usec/point. Test results revealed pressure spikes of 5500 to more than 20,000 psi. During the test period working pressure was maintained between 1250 and 1350 psi.

We ran similar tests on injection molding machines at the University of Lowell, Lowell, Massachusetts. Depending on where we tapped into the machine's hydraulic system, we found pressure spikes of four to more than 20 times steady-state pressure. Pulse width was approximately 0.25 msec–identical to that observed on the die casting machines.

Conclusions from Tests

Results of theses tests-and further tests conducted six months later at the same location–led us to several conclusions:

- Pressure spikes do occur in hydraulic systems. The most severe are generated by rapid changes in system flow, which can be caused by components such as pumps, pistons, rams, valves and control devices.
- Entrapped air in hydraulic fluid increased the magnitude of pressure spikes. Purging air from the system can lower peaks as much as 60%.
- Pressure spikes exceeding 20,000 psi can be generated in a system with a nominal working pressure of only 1300 psi.
- Typical pulse duration of a pressure spike is about 0.25 msec. Most safety valves, pressure relief components and blowout plugs cannot respond to such brief transients.
- The magnitude of the spike transmitted to the transducer depends on its location in the system.
- Pressure snubbers effectively reduce the magnitude of the spike the transducer must endure. Snubbers stop or absorb shocks and pulsations that damage pressure gages.

Recommendations

The following recommendations are intended as a guide in selecting, installing and protecting transducers in systems that experience severe pressure transients.

- Use a transducer with the highest practical pressure range when replacing a transducer already damaged by pressure spikes. For example, replace a damaged 2500 psi transducer with a 3000 or 5000 psi model.
- Bleed air from a hydraulic system before startup.
- Use the absolute minimum length of piping between the transducer and the point of pressure measurement. When measuring ram inlet pressure, install the transducer as close as possible to the ram inlet port.
- Avoid installing the transducer at the end of long, straight pip runs.

- The most damaging spikes are generated by rapid change in system flow rate. Pressure rise can be extremely high if fast-acting solenoid valves stop flow. If possible, slow valve closure rates to reduce or even eliminate the shock pulse. This applies to all fast-acting flow controls.
- Install a properly sized pressure snubber at or near the transducer to protect against pressure spikes.

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