A White Paper on Solenoid Valve Leakage–

Identifying Root Causes and Methods for Eliminating Leakage

Leakage in solenoid are classified as external and internal. External leakage is generally easy to identify and eliminate. The majority of external leakage comes from degraded O-ring seals, either worn out from usage or incorrectly installed. The solution to eliminate this leakage is to correctly install a new O-ring. Solenoid valves that use diaphragms as a sealing member can also experience external leakage via wicking through the diaphragm. Wicking is a process whereby the pressurized fluid journeys through the diaphragm material between the rubber and reinforcing material of the diaphragm. Solutions to eliminate wicking would be to use a non-reinforced diaphragm (or solid diaphragm), or use anti-wicking compounds of the diaphragm material.

The focus of this white paper will be on internal leakage, or often termed, seat leakage. Internal leakage is defined as the process fluid passing through between the valve seat and sealing member (Obturator) when the valve is in the closed position. The obturator or disc can be either soft (elastomeric), or hard (metal to metal).

When specifying seat type, the factors to consider when determining what type of seat material to be used are:

- Process medium differential pressure, temperature,
- Fluid type (gas versus liquid),
- Process medium composition (chemical resistance and fluid compatibility with seat material)
- Customer preference/specification.

The effects of seat leakage can range from just an annoyance in non-critical applications to damaging in systems that cannot tolerate any amount of leakage. In any case, seat leakage is generally not an acceptable condition. However, there are some cases where a design specification will allow for certain leakage rates. This is typical in metal to metal or hard seating constructions.

What are the causes of seat leakage?

Normally, the main cause of seat leakage is foreign materials in the process medium. Particles in the medium become trapped between the seat and the sealing disc causing seat leakage, either by creating a gap between the parts or creating an indentation or cut in the parts. Typically, these seat leakages start out small. However, depending on the process fluid and the pressure of the fluid, a small leakage can escalate quickly to a high leakage rate. In these cases, the surfaces of the seat and disc can erode in

ways like steam flashing and high velocity erosion. The high velocity of the liquid traveling thru the leakage path can erode the sealing surfaces, eventually leading to a high rate leakage and/or failure.

The installation of the valves into the piping system, whether by NPT threads or welding, can introduce foreign materials. Pipe tape or dope, and weld slag are notorious for causing leakage in systems. Activities upstream of the valve can also introduce foreign particles to cause leakage. It is good standard practice to always thoroughly flush the lines after the installation of the valves and/or upstream maintenance activities to ensure that foreign particles are washed out of the system and eliminated as possible causes for leakage. Additionally, foreign materials may also be generated from corrosion/erosion byproducts in piping systems or organics, due to improper chemistry control, that are deposited on seating surfaces.

Another cause for seat leakage is improper assembly of valve parts. Always follow the manufacturer's instructions for disassembly and reassembly of the valves, and use the correct parts as detailed in the operating and maintenance manual (OMM) provided for specific valves.

Misapplication of a valve can also lead to seat leakage. For example, using a hard seated valve when a soft seat valve is required, or using a valve with an elastomer or other materials that are not compatible with the process fluid. These factors can lead to failure. Work closely with the manufacturer and provide all the technical details needed for the manufacturer to design or specify a suitable valve for the application.

Other issues with seat leakage

In applications where seat leakage is considered critical, it is customary that the leakage rates of the valves in these systems are measured periodically to determine compliance. It is imperative that the seat leakage test is performed as described in the OMM. Improper testing could lead to erroneous results in leakage rates. For example, many solenoid valves are designed to use the pressure of process fluid (or delta P) to provide the seating force for closure or seating. This design is often referred to as "pressure over the seat." During the leakage test, the operating pressure differential should be duplicated while measuring leakage. If a lower delta P is used during testing, this may not provide the adequate force to help close the valve, and therefore, may provide a higher leakage rate than the actual rate during normal operation.

Another common mistake in leakage testing of solenoid valves is to use the wrong fluid during testing. For example, a valve that is designed to handle a liquid should not be tested with a gas. The seat design of a valve to handle a fluid is different than one designed to handle gas. One is sure to experience a higher than expected rate of leakage with a water valve that is tested with nitrogen.

Eliminating leakage

Now that we know some of the causes for seat leakage and the common mistakes in diagnosing leakage, let's discuss some methods for eliminating leakage.

After verification of an unacceptable leakage rate, a simple method to eliminate leakage is to operate the valve for a few cycles with fluid pressure. Often in systems where a valve is not required to cycle or cycled regularly, foreign material can get lodged on sealing surfaces. A few cycles of operation can dislodge or flush this material and allow for the valve to seal properly again.

If after 10 cycles or so of operation, the valve is still leaking, then it is time to go inside for closer observation. Make sure to follow the step-by-step instructions of the Maintenance Manual to disassemble the valve. Then, make sure all sealing surfaces and pilot passage ways are clean and clear of any foreign materials. If the disc is nicked or eroded, contact the manufacturer for replacement parts per the Maintenance Manual. Also examine the seat in the body for nicks or erosion. If the disc is nicked or eroded, chances are the body is also nicked or eroded. To change out the disc and leave the disc seat untouched is a mistake that will quickly lead to leakage problems. The seat needs to be lapped before installation of the new disc. Follow the manufacturer's instructions for lapping. With proper lapping and a new disc, seat leakage can be eliminated.

Contact the valve manufacturer if leakage is a continual problem. The application may require installation of a new valve or installation of a different valve construction altogether. Understanding the causes of leakage and following the solenoid valve's Maintenance Manual for proper operation and maintenance techniques will ensure proper operation and maximum life of the valve.

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