A White Paper

Using Acoustic Emissions to Determine In-Service Valve Seat Leakage

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Using Acoustic Emissions to Determine In-Service Valve Seat Leakage

The Problem

Evaluating the condition of in-service valves that process fluids is difficult. Diagnostic methods that require valve movement often cannot be utilized while the plant is in operation and future maintenance is being planned. As a result, maintenance either schedules what may be unnecessary valve work for upcoming shutdowns or doesn't schedule maintenance at all. Delaying valve maintenance may eventually result in future, costly, unplanned maintenance while the plant is in operation. Not only can unplanned maintenance be expensive but typically the associated loss of production is far more expansive than the maintenance operation itself.

The Service Solution

Use of acoustic emissions equipment on closed, in-service valves can be used to predict valve trim condition by detecting valve seat leakage. This information is valuable in maintenance planning for future shutdowns. Being able to quantify valve leakage can help a plant make an informed decision as to whether a valve must be repaired immediately, at an upcoming plant shutdown, or deferred to a future date.

The Principle

During leakage, fluid loss is accompanied by acoustic energy loss. The method of using the release of acoustic energy to detect leaks is called Acoustic Emission (AE). When used with an experience base, the amount of measured AE can also be related to the actual leakage rate.

The necessary elements for carrying out an on-site AE leak detection include a high quality monitoring device, an experience base on how the part produces AE when leaking, and an operator with the training and knowledge to make a quality measurement and apply the valve-specific experience base to the acoustic measurement.

The Benefits

Use of AE equipment to determine valve seat leakage helps plants to:

- Prevent unplanned shutdowns and maintain consistent product output.
- Minimize the need for valve tear downs during plant shutdowns.
- Learn about valve maintenance problems before they become critical and more effectively manage engineering and maintenance personnel.
- Improve plant health and safety.
- Avoid unnecessary maintenance on valves that have minimal trim damage.

Valve Seat Leak Detection

The Payback

AE seat leakage testing can be performed by personnel visiting the plant for routine work, thereby minimizing added cost. Capital costs are not incurred by the plant because the service is typically covered under service contracts already in place.

The Equipment

Effective AE equipment uses a sensor capable of detecting or "hearing" signals in the range of 60 to 600 kilohertz. A leaking valve will generate noise as the process fluid leaks past the valve sealing surfaces. This noise is transmitted through the fluid and through the pipe and valve walls where it can be picked up by the sensor. To facilitate the transfer of the signal from the outer pipe and valve walls, a silicone couplant is used to bridge the air gap caused by any surface irregularities. By filtering this signal, it is possible to tune out extraneous noise not associated with valve leakage. The resultant signal is measured in units dB (AE).

The Use of AE Data

Extensive field and laboratory testing of valves has resulted in algorithms that can be used to predict leakage rates associated with dB (AE) readings. Predicted seat leakage rates take a number of factors into account, including:

- Type of process fluid
- Fluid density
- Pressure differential across the valve
- Valve type (globe, gate, butterfly, etc.)
- Sealing surface type
- Valve size
- Pipe size
- Waveguide use

The Measurement Considerations

Highly accurate readings can be obtained by direct contact (with couplant) between the sensor and pipe/valve wall; however, current sensors cannot survive sustained temperatures above 125°Celsius (257° Fahrenheit). For measurements where surface temperatures are above 125°C (257°F), a wave guide must be used to transmit the signal from the surface to the sensor. However, use of wave guides results in signal attenuation, which must be accounted for when interpreting the measurement results. This leads to additional uncertainties in correlating dB (AE) with leakage rates. Hot surfaces are also typically insulated for personnel protection and/or to reduce loss of thermal energy, which makes access to the test subject difficult. To access the metal surface, insulation must either be removed or a hole drilled through it for access by the wave guide. For visibility to ensure a good piping/valve surface for measurement, it is recommended to make the hole 2 inches in diameter. This size is conveniently consistent with the size of re-sealable access ports available on the market for use with UT thickness monitoring.

Valve Seat Leak Detection

The Accuracy

Acoustic energy levels correlate well with leakage rates over a wide range. With low-noise modern electronics, measurable acoustic signatures can be discerned while the associated leakages are still undetectable from the fluid loss.

In obtaining an actual leak rate from acoustic measurements, several of the most important variables are part specific. Emerson engineers have developed acoustic correlation experience for all Fisher® valve parts that they manufacture. This correlation gives the method a level of accuracy not obtainable without part specific experience. With attention to the most important influences on the acoustic-leak rate relationship, the part specific experience has been used to minimize uncertainty in the leak rate determination.

AE leak detection equipment manufacturers state a variety of accuracies for their leakage predictions. Ongoing testing will further refine accuracy predictions, but to-date, significant sensitivity to a variety of factors remains, making blanket accuracy statements questionable.

The Validity

General instrumented acoustic or ultrasonic leak detection has been practiced for over half a century. Acoustic detection of leaks specific to valves has been used for decades. The ongoing use of this technology has been justified by its ability to deliver consistent results relevant to a valve under its actual operating conditions. Historic industry use coupled with ongoing testing strongly validates the use of acoustic emissions to predict valve seat leakage.

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