Common Causes and Costs of Fluid System Leaks

Fluid system leaks are a common occurrence in most plants. Because you're charged with maintaining your plant's safety and profitability, even the smallest leak can present an issue. That's why it's helpful to understand how and why leaks occur, how to locate and test for them, and ultimately how to develop a strategy to address and reduce leaks plantwide.

Three Common Causes of Leaks

It may be surprising to learn most leaks aren't the result of substandard parts. Rather, they occur due to human error – whether from the design and installation of a component or from the component selection itself. Choosing the right components and installing them correctly can enhance plant safety and save significant time and cost.

To help your team better understand and mitigate leaks at your plant, Swagelok's field engineers have documented the following top three common causes of leaks:

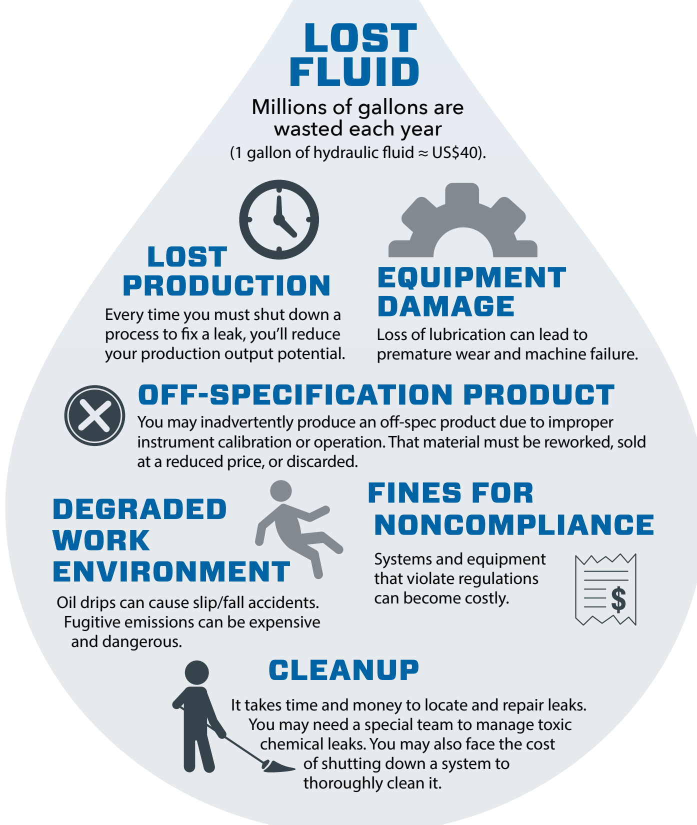
1. **Unreliable Metal-to-Metal Seals:** Making and keeping highly reliable metal-to-metal seals can be difficult, especially over time. Manufacturer guidelines must be followed precisely to avoid leaks when using these "packless" seals. In some cases, you may even want to replace the component with one featuring an adjustable packing to enable a more reliable long-term seal.

2. **Improperly Installed Tube Fittings:** Properly assembling tube fittings will greatly reduce the likelihood of experiencing leaks and enhance your plant's safety. Be sure your technicians are trained in how to properly make up a fitting, including orienting the ferrules properly and using a gap gauge to verify the right amount of pull-up.

3. **Poor Tubing Selection and Preparation:** Your tubing selection and preparation can also increase your leak potential. Tubing materials that are incompatible with the process fluid or external environment will be prone to corrosion, premature failure, and leaks. In addition, unevenly cut tubing or tubing that has not been deburred may compromise the sealing ability of the fitting.

The Lowdown on Leaks

While leaks are a common occurrence in plants, there are many reasons to address them quickly and develop a plan to prevent future ones.



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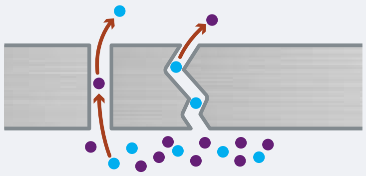
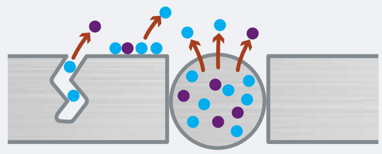
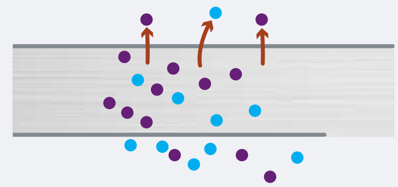
Three Types of Leaks
Understanding the type of leak will help your team determine the appropriate corrective measures to address it.



Real Leak
A leak resulting from the failure of a pressure barrier to contain or isolate a system fluid from the surrounding environment; occurs due to cracks or gaps between sealing surfaces



Virtual Leak
A release of internally trapped fluid into a fluid system due to material outgassing (the escape of gas from a material under test in a vacuum), absorbed or adsorbed fluids, entrapment in cracks, or deadlegs



Permeation
A passage of fluid into, through, and/or out of a pressure barrier that does not have holes large enough to permit more than a small fraction of the molecules to pass through any one hole

Know the Leak Detection Methods

A good leak detection program increases worker safety and decreases risks to your operation. When testing for leaks, there are five main nondestructive test (NDT) methods to consider. It's helpful for your team to understand the differences among the tests to determine which one is right for various applications throughout your plant.

Bubble Testing is a fast, simple, and inexpensive test that can be performed using immersion or film solution techniques.

Methodology	Leak Rate	Advantages	Limitations
Pressurize the component to create a pressure differential	As low as 1×10^{-5} std. cc/sec.	Simple, fast, inexpensive Fairly sensitive Especially useful for leak location Entire component can be evaluated at once Allows the observer to distinguish between real and virtual leaks	Cannot be used to provide a specific leak rate Small leaks take longer to detect Component must be cleaned or dried following testing Limited to gas (not liquid) pressurized systems

Pressure Leak Testing is an excellent proof test that is best for determining a leak location. Hydrostatic and pneumatic tests are the two techniques with the best results.

Methodology	Leak Rate	Advantages	Limitations
Gradually pressurize the component with water or air to a specified pressure and then hold for a predetermined length of time	As low as 1×10^{-2} std. cc/sec. or less (if using additives to enhance leak detection)	Excellent proof test Inexpensive, simple, clean Good for leak location Entire assembly can be evaluated at once Generally safe	Slow Water can temporarily seal small leaks Water is not very sensitive Cannot be used to provide a specific leak rate Assemblies must be cleaned and dried following testing

Airborne Ultrasonic Testing is performed by a handheld device that can sense medium to large leaks. Used mainly to locate leaks in compressed air systems.

Methodology	Leak Rate	Advantages	Limitations
Measure the magnitude of ultrasonic noise produced when fluid leaks with enough velocity to cause turbulence	1 x 10^{-2} std. cc/sec.	Can be used to quantify (estimate) leak rates Can be used to quickly scan large areas for leaks Can be used to locate leak sources from a distance Noncontact Convenient for auditing services Can measure higher leak rates where Snoop® is blown off without forming bubbles	Equipment training needed Difficult to use in environments with a lot of competing noises Cannot identify leak rates below a lower threshold or an ambient noise level Lower limit is similar to a “medium” leak by the Snoop perspective

Mass Spectrometry Testing is a versatile, reliable method of locating and measuring leaks. Five techniques are: hood, tracer probe, detector probe, accumulation, and bell jar.

Methodology	Leak Rate	Advantages	Limitations
Use a mass spectrometer to measure the amount of tracer gas (usually helium) present in the component by creating a pressure differential between the component and the mass spectrometer. The presence of tracer gas inside the mass spectrometer indicates a leak.	Typically used to measure leak rates between 1 x 10^{-4} and 1 x 10^{-10} std. cc/sec.; it is not used to detect leak rates larger than 1 x 10^{-4} std. cc/sec.	Can measure a great degree of reliability and sensitivity Ability to measure leakage and locate leaks Cleans	High initial costs, and equipment is costly to repair High helium cost Requires a skilled operator Sensitive to background helium levels and outgassing Requires a comprehensive test plan when used on large or complex systems

Pressure Change Measurement Testing determines total leakage in a simple, inexpensive way. Four common techniques are: pressure decay, pressure change absolute, pressure change reference, and volume or flow measurement.

Methodology	Leak Rate	Advantages	Limitations
Measure the pressure change across a pressure boundary caused by leakage. A decrease in pressure indicates leakage.	Calculate and evaluate the leak rate to ensure the amount of leakage is within acceptable limits. The pressure decay technique is commonly used, but it is optimal for small systems with volumes less than 7.5 cubic feet.	Determines total leakage No special tracer gas Inexpensive Simple Largely operator-independent Increased sensitivity in small-volume applications	Many factors affect sensitivity (especially in larger-volume applications) Internal volume must be known Cannot locate leaks

Prioritizing Leaks

It's likely not possible to address every leak in your plant right away. Instead, categorize leaks to help prioritize:

- **Dangerous Leaks:** Any leak that presents a safety issue should be a top priority. This includes leaks of noxious gases and caustic chemicals, as well as leaks that create slip/fall hazards. Have your risk managers identify these safety issues first, and then send your best maintenance technicians to fix them right away.
- **Costly Leaks:** Collectively, all the leaks in your plant may add up to a significant loss. However, some leaks – even small ones – can be responsible for a sizable percentage of that loss. Fixing a small leak of expensive argon gas, for example, may offer drastically greater savings compared with stopping a large leak of lower-cost compressed air.
- **Nuisance Leaks:** Finally, you may have a wide variety of minor leaks that don't present safety hazards and are not responsible for major losses. You can wait to address these low-priority leaks when your maintenance staff is not crunched with other more critical duties.

We find it helpful to train – and retrain – engineers and technicians in a variety of topics to enhance their skills in identifying and addressing leaks. Training may include everything from education on proper material selection to hands-on, skill-building courses in tube bending and tube fitting installation procedures. When your trained team has its focus on identifying and stopping leaks, your plant will realize safer, more cost-effective operations.

To learn more about how to identify and address leaks, as well as train your team on best practices, contact your local **Swagelok sales and service center.**