Swagelok Nederland

The Hidden Costs of Leakage

Table of Contents

Introduction

This chapter discusses why leakage is a serious consideration in the design, construction, and operation of fluid control systems. Components must be leak-tight to ensure the reliable performance of fluid systems.

What Is Leakage?

The uncontrolled flow into or out of a pipe or tube system, such as leakage to the atmosphere

Causes of Leakage

- Unreliable metal-to-metal seals
- Improperly installed tube fittings
- Poor tubing selection and preparation

Figure 10-1 Leakage.

Leak Testing Terminology and Principles

Leak rate: The rate of fluid leakage flow per unit of time under known conditions. Properly expressed in units of volume per unit of time (Umin, std cm^3/s).

Leakage: Leaks can be referred to as ***real*** or ***virtual.***

Figure 10-2 Leakage.

Real leak (also referred to as ***true, mechanical, orifice, or capillary*** leak): Occurs when a pressure barrier fails to contain or isolate a system fluid from the surrounding environment. Real leaks can be the result of cracks or gaps between sealing surfaces or permeation through seal materials. There are three types of real leaks:

1. **Inboard:** Flow into a fluid system from outside containment, such as dirt getting into a fluid system.
2. **Outboard:** Flow out of containment into the environment.
3. **Internal:** Flow across an internal pressure barrier within containment. This type of leak is commonly associated with valve seats.

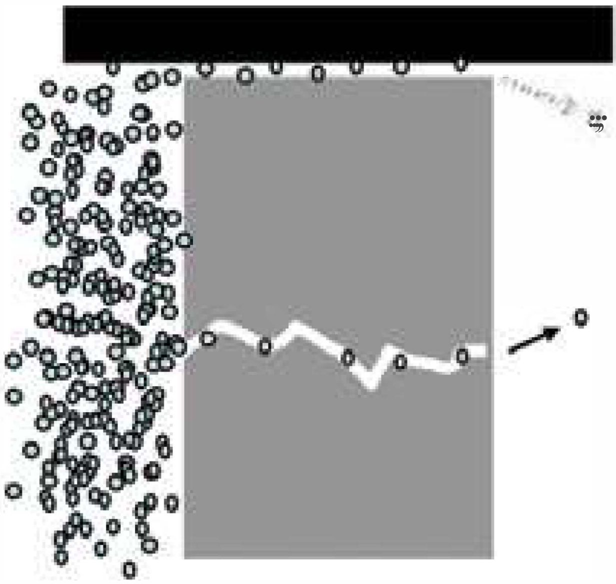

Figure 10-3 Real leak.

Virtual leak: A release of internally trapped fluid into a fluid system due to material ***outgassing,*** absorbed or adsorbed fluids, entrapment in cracks, or dead legs.

Outgassing: The escape of gas from a material in a vacuum.

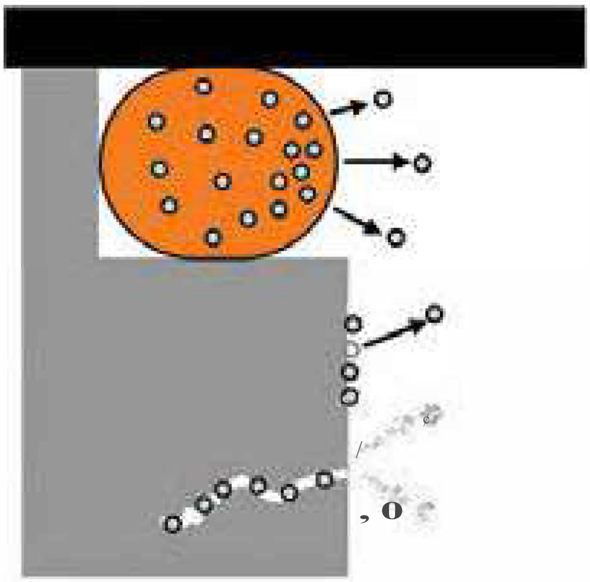

Figure 10-4 Virtual leak.

Permeation: The passage of fluid into, through, and out of a pressure barrier having no holes large enough to permit more than a small fraction of the molecules to pass through any one hole. This leakage is typically associated with PTFE hoses.

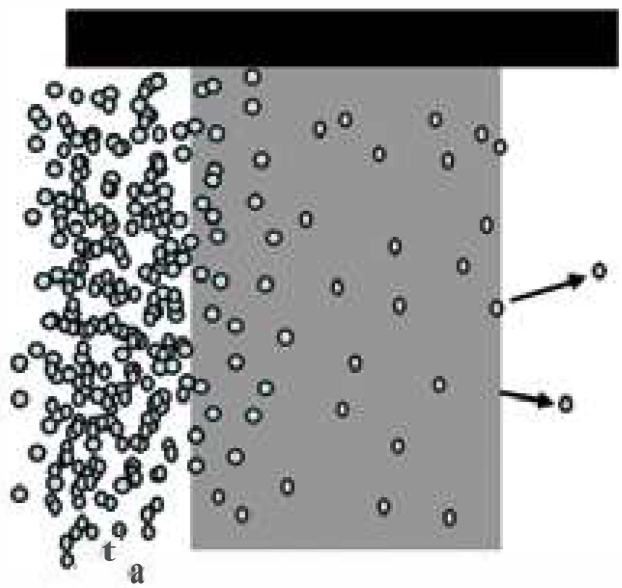

Figure 10-5 Permeation leak.

Be aware that a leak detector using a gas such as helium cannot tell the difference between the helium that gets detected from a real leak and that from a virtual leak, permeation, or outgassing.

One way of detecting system leaks is to use SNOOP liquid leak detector, as shown in the following illustrations.

NOTE: Numerous small bubbles can be observed at the back of the nut.

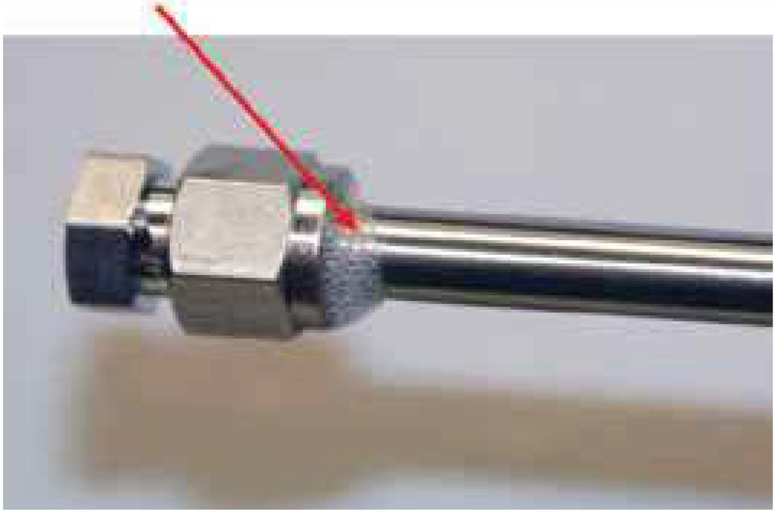

Figure 10-6 Small leak being identified by Snoop liquid leak detector.

Figure 10-7 Medium-sized leak.

Snoop liquid leak detection fluid illustrates a leak in the medium range; larger, more frequent bubbles are escaping from the back of the nut. The important thing to remember with Snoop versus detecting leaks with simple soap and water is that the Snoop will continue producing bubbles for a short period of time after being applied, whereas the soap and water may only give you one set of bubbles to observe before dissolving.

Figure 10-8 Larger leak displays large bubbles.

A large leak identified with Snoop may display large bubbles, similar to the photograph above, or Snoop may be completely blown off the nut by the escaping media. If a large leak is suspected, use caution when checking for leakage.

Leakage Formula

The leakage formula was created in an effort to determine how much leakage may exist throughout a system.

Q = Leak rate, ft3/s

dP = Pressure drop, $(P_1 - P_2)$, psi

H = Height of gap between sealing surfaces, in.

W = Circumference of seal, in.

96 = Mathematical constant

μ = Absolute viscosity, $lb \cdot s/ft^2$

L = Length of leakage path, in.

$$Q = \frac{\Delta P \times H^3 \times W}{96 \times \mu \times L}$$

Figure 10-9 Leakage formula.

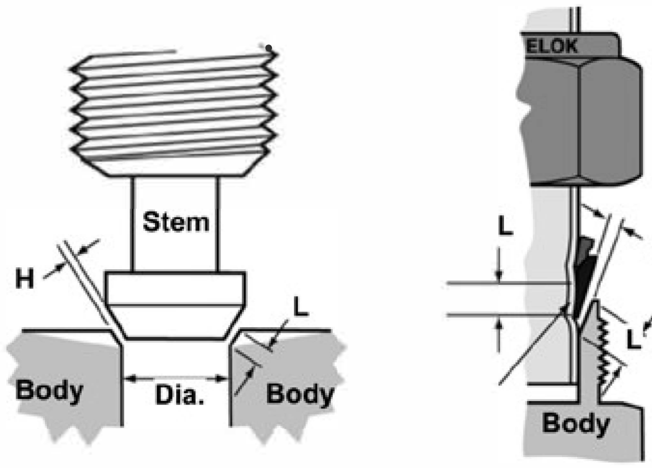

Figure 10-10 Previously assembled Swagelok tube fitting (shown disassembled).

Swagelok tube fittings and valves are designed and manufactured to create a long, smooth seal that performs properly in a variety of customer applications. The gap (H) and length (L) are the only factors in the formula Swagelok can control. Gap can be a problem if tubing surface finish is poor. Because we cannot control operating pressure, seal diameter, or fluid viscosity, we must work within the parameters of gap and length of seal to make good, reliable, repeatable seals.

The sealing material, surface finish, and load as a result of installation impact the leak rate regardless of the system conditions involved in valve and fitting installations.

Seals are designed to prevent leaks from occurring, and there are two basic types of seals: static and dynamic.

Static seals are not intended to be broken or penetrated during service. Tube fittings generally use static seals. Leaks from static seals are commonly associated with vibration, overpressurization, or degradation of the seal material due to chemical attack.

Dynamic seals must seal effectively where motion is involved, which is more common in valve operation.

Leakage costs industry billions of dollars each year. These losses are in many forms:

1. Lost fluid: It is estimated that millions of gallons of hydraulic oil are lost each year from oil circulating and hydraulic systems just through leakage.

2. Equipment damage: Loss of lubrication due to leakage can damage equipment.
3. Lost production: Loss of lubrication or hydraulic line leakage can shut down machines and stop production.
4. Energy conservation: Power is used to pressurize hydraulic systems and to compress air.
5. Unsafe work places: Oil drippage can cause accidents.
6. Degraded environment: Fugitive emissions (leakage) can be expensive, illegal, and dangerous and can lead to a lowering of the quality of life for workers and the surrounding population.
7. Product contamination: Food, beverage, pharmaceutical, or other plants making products for human consumption cannot have hydraulic or other contaminates in their system.

When process gases, analyzer gases, nitrogen, helium, and hydrogen are considered, the cost of leakage alone can make the difference between profit and loss. This is in addition to the fire or explosion danger and the damage to the quality of life. As well, improperly calibrated or operating instruments can result in off-specification product.

What Is Energy Management?

Energy management is the process by which energy costs and system leakage are controlled.

This can be accomplished by:

- Identifying and reducing energy loss from system leakage
- Efficiently and cost-effectively reducing the potential for loss of energy
- Improving overall fluid system component efficiency and performance

Managing energy means energy savings.

Energy management impacts you by:

- Establishing an efficient leak detection and repair program
- Documenting energy savings
- Reducing downtime
- Lowering overall system costs, which translates into increased profitability
- Decreasing maintenance costs

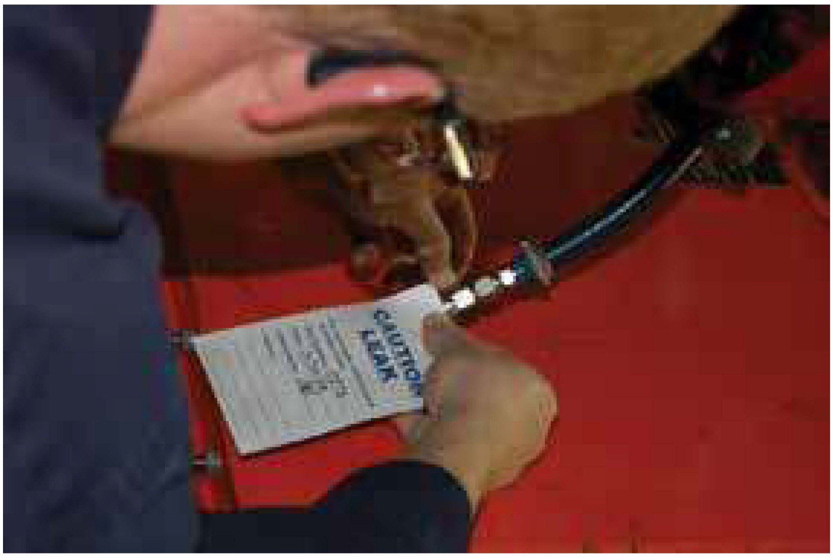

Figure 10-11 Detect and identify leaks.

Reducing downtime, lowering overall system costs, and decreasing maintenance costs can all be achieved by effectively documenting energy savings. The *Swagelok Energy Emission Survey* program is designed to identify the presence of leakage in gas systems at a facility. A Swagelok Authorized Sales and Service representative can assist in performing a *Swage/ok Energy Emission Survey.* The following are conditions to consider prior to conducting a survey.

1. Preparation is essential. In creating an effective survey, it is necessary to:
    a. Plan
    b. Document
    c. Verify
2. Documentation is a requirement. Using appropriate data collection forms will improve the accuracy in recording results.
3. Validation of survey results by a site representative is mandatory.
4. Site representatives will be made aware of visual identification of fittings from other manufacturers to more accurately authenticate the results.
5. Survey site selection is to be determined by the site representative.
6. All tube fitting and instrumentation or small process valve end connections and packing, regardless of the brand, should be surveyed.
7. Results of survey data collection will be presented, in person, to site representatives.

Request the results of energy surveys at info@swagelok.nl.