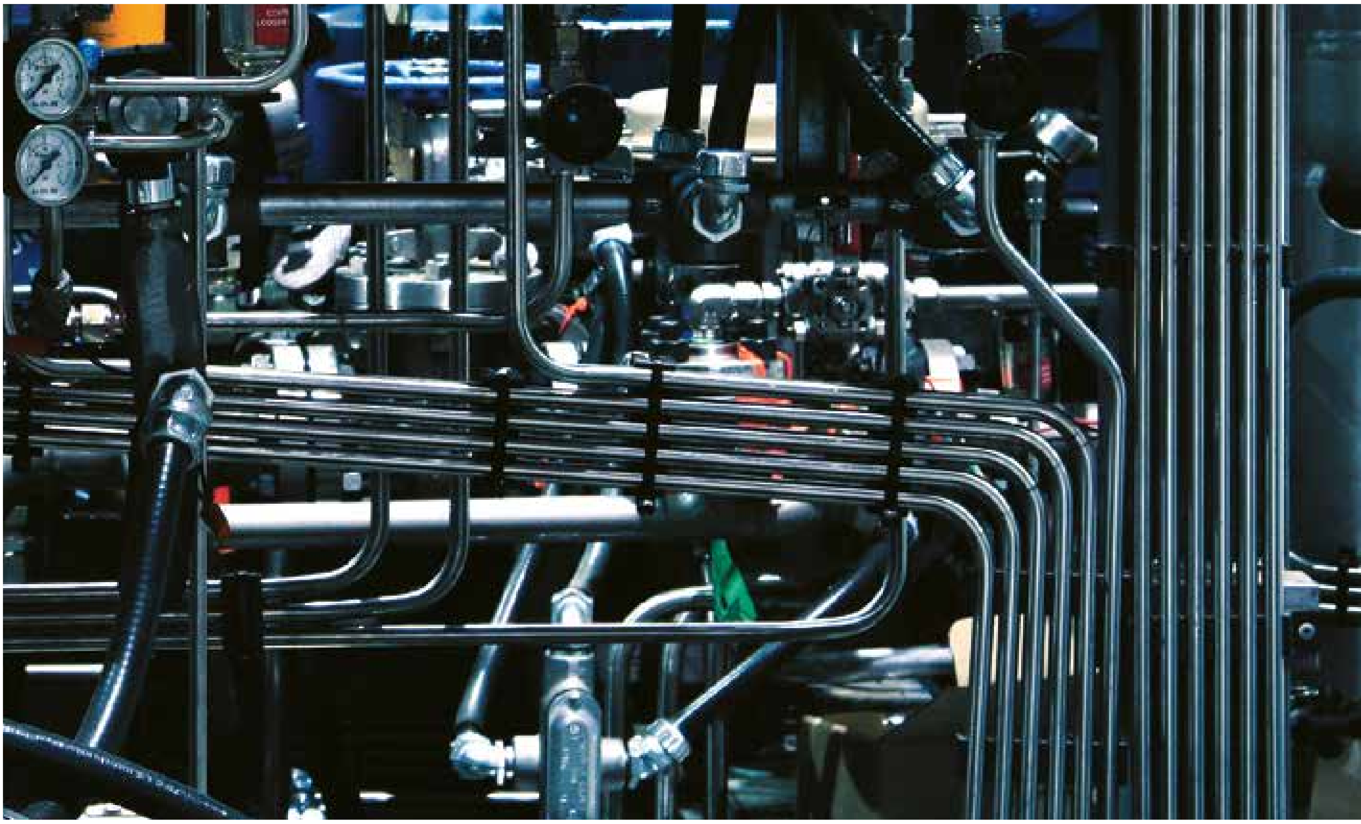
Helium leak detection:
How to test thin gas lines faster with Helium detection?

Fast and efficient gas line testing is crucial for process reliability and installation safety. With Helium Leak detectors, it is possible to locate leaks in gas distribution lines, tanks, gas cabinets and any devices that store or transport gas.



PFEIFFER VACUUM

Helium leak testing is indeed a non-destructive test method with high sensitivity and a wide dynamic range. Since helium leak detection works with test gas, it is governed by the laws of fluid mechanics. High internal flow resistances of individual test objects can severely impair the effectiveness of helium leak detection. This is especially true for long, thin gas pipes used, for example, for the construction of high-purity media supply systems or coil-wound heat exchangers.

Leak detection by spraying with helium

After connecting and evacuating the gas line, the outer surfaces are sprayed with helium using a finely adjustable spray-gun. Helium enters the gas line through leaks and can be transported to the detection device. The response time during the measurement is determined by the volume of the gas line and the effective pumping speed of the helium gas test setup.

ASM 340 – Best in class leak detector for high reliability testing

The effective pumping speed for helium is made up of the helium pumping speed of the leak detector used, the flow resistances of the gas line as well as the piping components forming the connection between the leak detector and the gas line.

Conventional helium leak detectors reach their maximum sensitivity in what is known as “fine leak mode“ at a comparatively low test pressure.

For this experiment, a cuboid-shaped container with a volume of 1.5 liters and gas lines with a length of 7 meters and 20 meters and an inside diameter of 4 mm were used.

When the thin gas pipe is measured, the background signal is thus higher by a factor of 50 than when measured on a flow-optimized component.

With the cuboid, a background signal of 10^{-9} mbar·l/s is achieved within roughly one minute. On a gas line, the remaining helium content of the air can only be pumped out of the gas pipe very slowly due to the high flow resistance of the pipe and the background signal stabilizes at a value of $5 \cdot 10^{-8}$ mbar·l/s. When the thin gas pipe is measured, the background signal is thus higher by a factor of 50 than when measured on a flow-optimized component. In order to achieve an identical signal-to-noise ratio, a test leak of $5 \cdot 10^{-6}$ mbar·l/s is used for the gas pipe.

With the cuboid, the test gas is instantaneously shown. The increase in the gas pipe is roughly as fast. However, if the gas pipe is extended to 20 meters, the time until a helium signal is first observed is delayed to 80 seconds. Even after more than eight minutes, no stabilization to the nominal leakage value is observed. The measured value remains more than a factor of 50 below the test leak used.

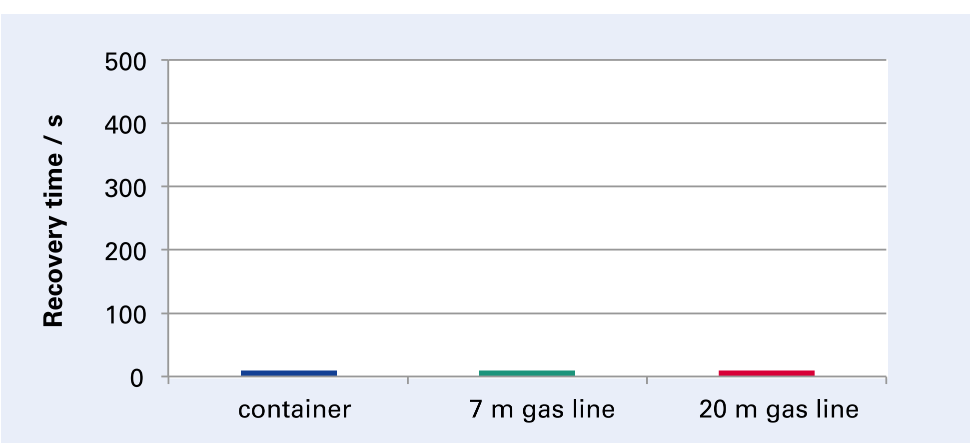


Figure 1: Recovery time without carrier gas

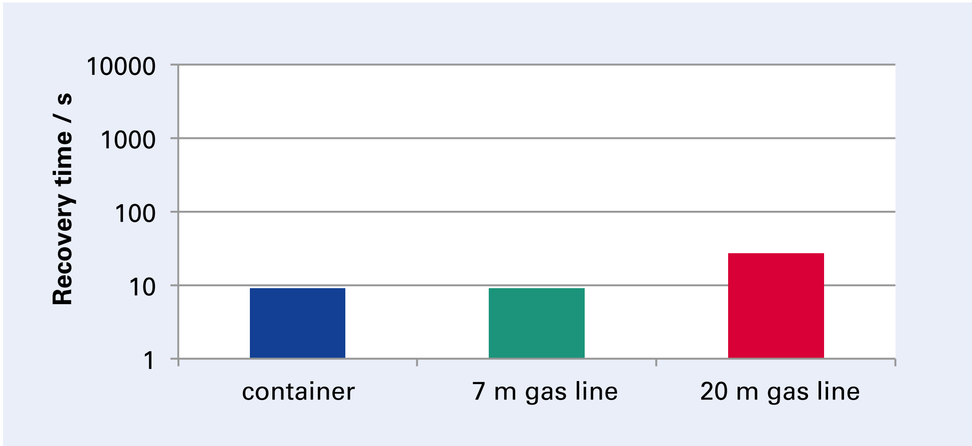


Figure 2: Recovery time with carrier gas

The graph in Figure 1 shows the recovery time after closing a test leak of a container as compared to a pipe section with a length of 7 meters and 20 meters and an inside diameter of 4 mm. Please observe the logarithmic scale.

The recovery time after closing the valve to the leak test takes nine seconds with the cuboid and approximately four and a half minutes with the 7 meter gas pipe. With the 20 m gas pipe, the experiment was terminated after 25 minutes with no result.

Figure 2 shows the same gas lines with tracer gas measurement with the identical scale. For all subsequent measurements, a test leak with a value of $1.0 \cdot 10^{-7}$ mbar · l/s is used.

Important: The tracer gas flow is adjusted in such a way that the ASM 340 type leak detector only just reaches the threshold pressure for the NORMAL test mode of 0.5 hPa.

The conductivity of the 20 m pipe at 0.5 hPa is approximately 5 times higher than at 0.01 hPa. This means that when tracer gas is used, it also results in significantly shorter measuring times!

Rise times and recovery times are short and provide clear Identification of the leaks. The use of the test leak not only allows in-situ calibration of the leak rate, but also determination of the maximum time required for the measurement.

A comparison of the response times for calibration and the actual measurement over the length of the gas line allows the leak to be localized.

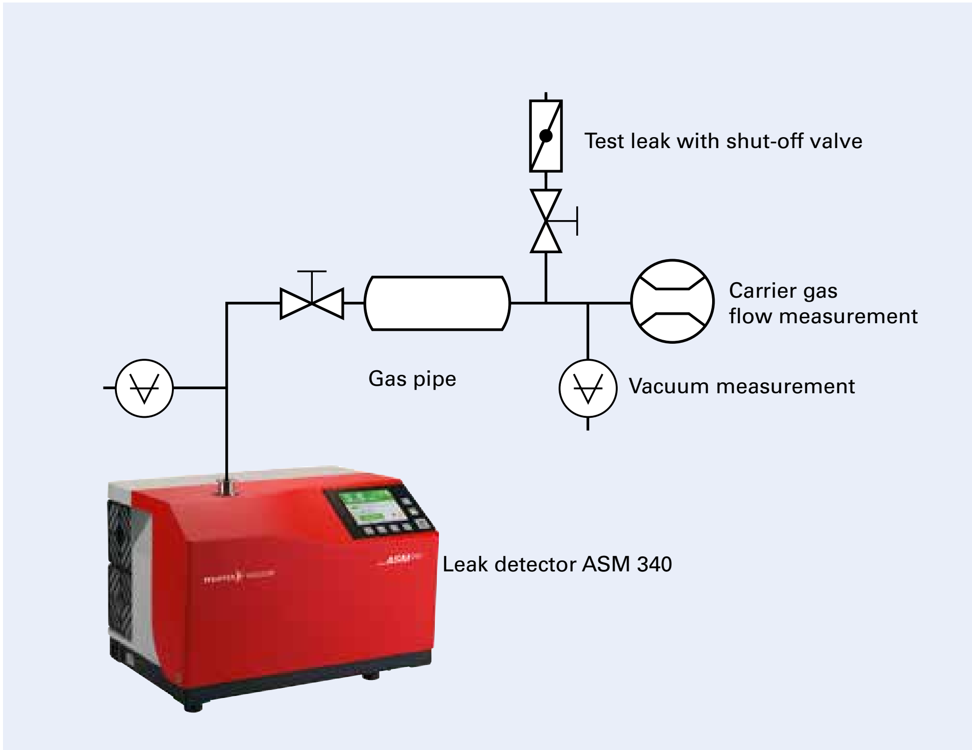


Figure 3: Helium spray test with tracer gas. An exemplary experimental setup consists of an ASM 340 leak detector with ASM View software. At both ends of each specimen, type TPR 280 Pirani tubes with a TPG 262 DualGauge measurement instrument are used as pressure gauges.

The achievable detection limit depends primarily on the residual helium content of the tracer gas used and the required signal-to-noise ratio. The residual helium content in nitrogen with a standard purity of 99.8 % (nitrogen 2.8) produces a background signal of $3.8 \cdot 10^{-6}$ mbar · l/s. Even with background suppression, a detection of a leak in the range of $5 \cdot 10^{-8}$ mbar · l/s is not possible. The residual helium content of nitrogen 5.0 produces a background signal of approxi-mately $1 \cdot 10^{-9}$ mbar · l/s.

This makes it possible to detect significantly smaller leaks. The use of an inert tracer gas also allows leak detection of toxic, reactive, explosive or combustible media in gas pipes during initial installation or after maintenance.

For standard application of the leak detection method described, Pfeiffer Vacuum offers the ASM 340 or ASM 340 D models.

The advantages of these leak detectors are:

- Powerful integrated backing pumps allow a high carrier gas flow and resulting short response times during measurements
- A high switching threshold between gross leak and normal mode provides maximum flexibility in the selection of test pressure and sensitivity
- For demanding applications where oil-free leak detection systems are stipulated, the models ASM 340 D with a bypass option and ASM 390 can be used.

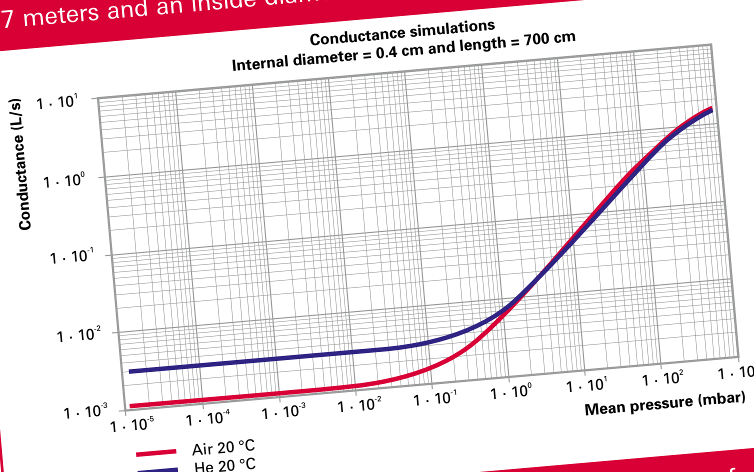
The powerful ASM View software package can be used to document measured values. This software package controls all current Pfeiffer Vacuum leak detectors and can be downloaded for free from the download area of our website:

http://www.pfeiffer-vacuum.com/downloads/

Infobox

Conductivity modeling of a pipe

In the graph, the conductivity of a pipe with a length of 7 meters and an inside diameter of 4 mm is modeled.



At atmospheric pressure, the pipe has a conductivity of just over one liter per second. At 0.01 mbar, the fine leak threshold of many commercial leak detectors, the same pipe has a conductivity for air of only 10^{-3} l/s.

Conductivity = 1/flow resistance

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