TOTAL GUIDE TO LEAK TEST METHODS

A manufacturers' guide to understanding different leak test methods and how to choose the right one for your applications

innomatec
LEAK TEST SOLUTIONS

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Introduction

Leak testing is an important part of the manufacturing process across many industries as a way of ensuring product quality. Product defects related to leaks can greatly affect the performance of a part or assembly, making leak testing one of the most common quality checks on the manufacturing line.

Factors such as the type of part, volume of the part, target cycle time, and more impact which leak test method will be best for your application.

Leak testing can be challenging, but innomatec makes it easier

innomatec has worked with manufacturers in Europe and across the globe for 40 years, helping them find the right leak test methods and implementation for their applications. In this ebook, we will review the different leak testing methods, the procedures of each, pros and cons of the different methods, and how to identify which is best for your application.

What is tight?

Before we discuss the different types of leak testing methods, let's first understand what it means for a part to be considered "tight".

First, let us state that there is no such thing as absolute tightness. Everything leaks (e.g. diffusion through the material). Therefore, a quantifiable and measurable quantity must be specified for each leak test. The required tightness of a part will depend on its application and function.

Leakage rates

The term leakage rate is used to define this tightness. The leakage rate is a quantity of air, gas, or liquid that flows through a leak; volume/time at a given pressure differential.

Permissible leakage rates

Several characteristics contribute to the likelihood of a leak in a part, including hole size, length of any possible leak paths, operating pressure, temperature, viscosity of the fluid flowing through the part, and more. Identifying permissible leak rates will be based on several factors, including the type of matter or fluids that could be flowing through the part, and the typical operating conditions.

In the example below (Fig. 1), it is evident that the oil or water molecule is large enough that it will not flow freely through the presented leak—but there is a leak present. By contrast, it is evident that a certain amount of air, helium, or forming gas are small enough that they could pass freely through the leak. Therefore, you may identify a permissible air or helium leakage rate to ensure water or oil tightness, provided that the test pressure corresponds to the operating pressure.

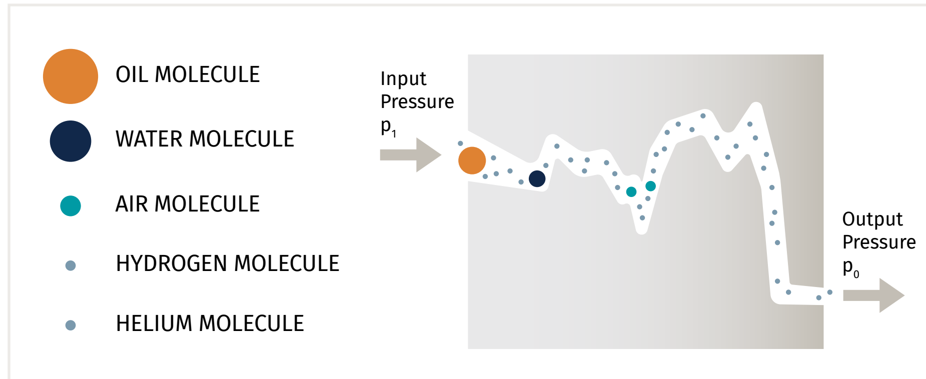


Fig. 1 — Example of how different molecules leak in a part

Correlating a leakage rate with the best leak test method

Different test methods will test to varying leakage rates (see Fig. 2 as example). Generally, air and water leak test methods are useful for standard leakage rate requirements, while helium and tracer gas methods are best for smaller, more strict leakage rate requirements.

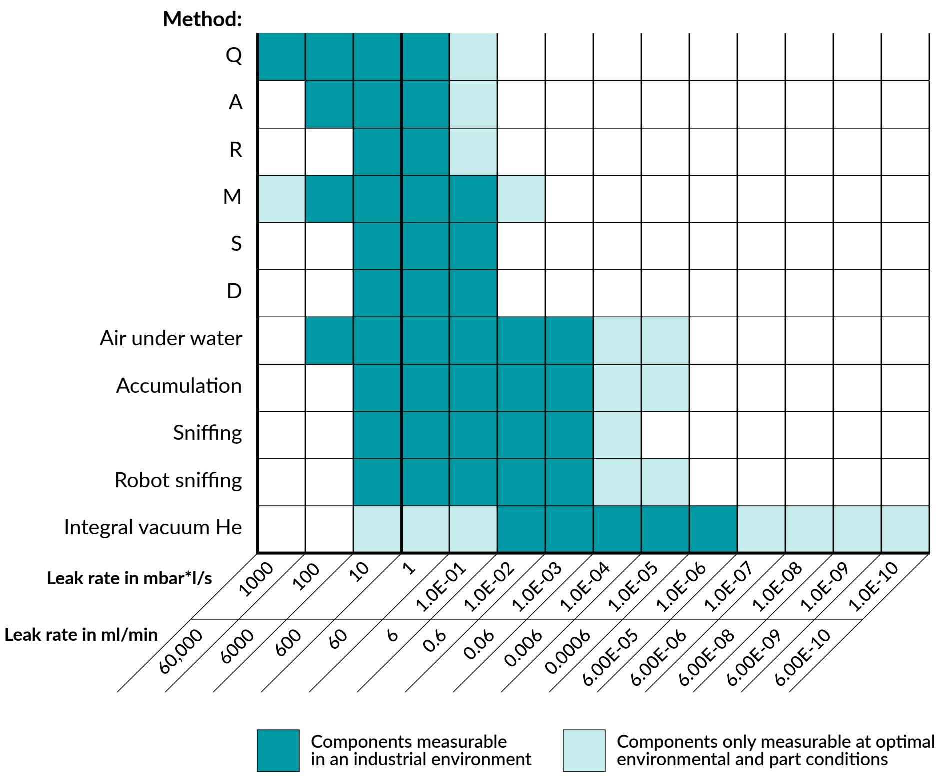


Fig. 2 — Overview of leak test methods and corresponding leak rates

FACTORS IN CHOOSING THE BEST LEAK TEST METHOD

Choosing the best leak test method for your application requires more consideration than just leakage rate requirements. Several factors need to be considered before identifying the best leak test method, including:

- Test pressure
- Leakage rate
- Testing time
- Test quantity
- Pressure direction
- Test item material, volume, stability, temperature, and cleanliness
- Environmental conditions
- Test data documentation
- Degree of automation
- Investment costs (budget)
- Testing costs, TCO (cost to use, manage, and maintain the test over time)

Overview: Leak Test Methods

Every manufacturer is confronted with different quality assurance requirements and complexities to consider when selecting the right leak test method. Characteristics such as the type of part, application of part, component size and volume, operational reliability/failure safety, integration into the running process and many more, must be considered in the selection of the ideal measuring method and leak tester.

In this ebook, we will discuss the following leak test methods and which parts and applications are best suited to each:

- **Underwater Leak Tests:**
  - Underwater visual inspection
- **Air Leak Tests:**
  - Pressure change method A
  - Pressure differential method R
  - Pressure increase method S
  - Closed component DA, DR
  - Volume determination method C
  - Mass flow method M
  - Flow measurement method Q
- **Helium/Tracer Gas Leak Tests:**
  - Manual leak detection
  - Accumulation method
  - Vacuum integral method
- **Bursting Pressure Tests:**
  - Air
  - Water/oil

Underwater leak testing

The underwater visual inspection leak test is the most simple, common leak test method. During the underwater leakage test, a gas-filled test specimen is placed under water or partially wetted with water and then bubble formation from leakage sites are visually inspected by the test operator. See leak rate equivalency chart below in Fig. 3.

Leak rate in cm^3/min	1 bubble with a 2 mm diameter rises up...
6	23 bubbles / s
0,6	2 bubbles / s
0,006	4,2 s
0,0006	42 s
0,00006	7 min
0,000006	70 min

Fig. 3 — Calculating leak rate using air bubbles underwater

The independence of environmental conditions such as temperature, drafts, vibrations, etc. allows the detection of very small leakages under longer observation time—sometimes smaller than with **pressure change measurement methods**— to a detectable leakage rate of >0.05 cm^3/min 1 bubble Ø 1 mm/4.2 sec (volume and pressure dependant).

Even temperature-treated, unstable and very large components can be tested for leaks under water, sometimes at very high test pressures.

However, this method can be limiting. Depending on your parts and the accuracy you require, you may be better suited to an **air leak test method**, or **helium / tracer gas leak test method**.

Ideal applications:

- Basic leak detection and location applications
- Parts or components that can get wet, submerged in water

Advantages:

- Simple leak localization
- Relatively small leakage rates detectable

Disadvantages:

- Test specimens get wet
- Often high expenditure for water treatment
- Mostly factory-dependent assessment
- Quantitative leak rate determination difficult

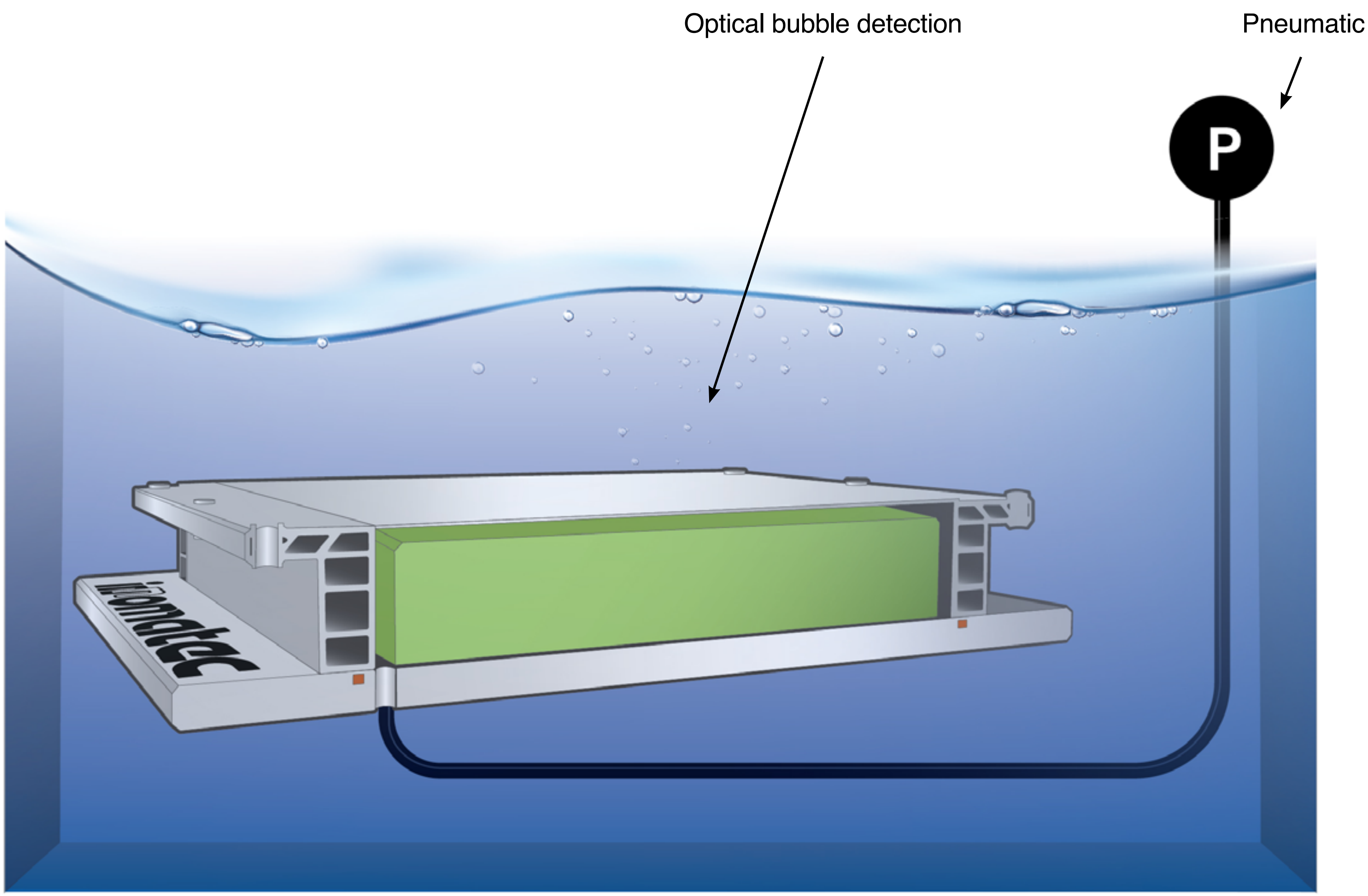


Fig. 4 — Example of an underwater leak test

Air leak testing

Air leak testing is a common method used for leak testing. It is a flexible test method that can be used to leak test a wide variety of parts and applications. Under the umbrella of air leak testing are several specific methods. In this ebook, we'll cover the following types of air leak testing:

- Pressure Change Method A
- Pressure Differential Method R
- Pressure Increase Method S
- Volume Determination Method C, DA & DR
- Mass Flow Method M
- Flow Measurement Method Q

Summary of Air Leak Testing Methodology

Selecting the right air leak testing method for your application starts with identifying your required leak rate, maximum test pressure, and maximum temperature differences likely to occur during test (see the chart in Fig. 4).

Environmental factors can also impact the accuracy of your pressure measurement (tightness control). To ensure accurate and repeatable results, it's essential to create and maintain controlled conditions in your test environment. The smaller the leakage rate (and the greater the test pressure), the greater the effects of environmental disturbance variables.

Test part stability can have big effects on the measurability of components. A chiller behaves different than a tank.

Factors involved in measurement accuracy and repeatability

- Room temperature
- Sample temperature
- Environmental influence
- Location
- Compressed air supply
- Tools
- Stability of sample

Leakage rate	Maximum test pressure	Maximum Temperature-Differences	Possible method
≥ 10.0 Pa/s	10.0 bar	+/- 3,0 °C	Pressure Change, Pressure Differential, Mass Flow
≥ 5.0 Pa/s	6.0 bar	+/- 3,0 °C	Pressure Change, Pressure Differential, Mass Flow
≥ 4.0 Pa/s	6.0 bar	+/- 2,0 °C	Pressure Change, Pressure Differential, Mass Flow
≥ 3.0 Pa/s	3.0 bar	+/- 1,5 °C	Pressure Change, Pressure Differential, Mass Flow
≥ 2.0 Pa/s	1.0 bar	+/- 1,0 °C	Pressure Change, Pressure Differential, Mass Flow
≥ 1.0 Pa/s	5.0 bar	+/- 1,0 °C	Pressure Change, Mass Flow
≥ 0.5 Pa/s	1.0 bar	+/- 1,0 °C	Mass Flow

Fig. 5 — Identify which air leak test method is best suited to your application based on required leak rate, maximum test pressure, and maximum temperature differences likely to occur during test.

How to Choose the Right innomatec Air Leak Tester

By following the below formula, we can determine the right air leak test method and leak tester for your application. innomatec uses a lettered system to indicate different leak testers used for each method, lettered A, R, M, Q. (See below chart for details on each method).

Most important formulas

$$\Delta p * V = Q * t$$

$$p \times V = m \times R \times T$$

SMALL
MEDIUM
HIGH

$$Q = \frac{\Delta p}{\Delta t} V$$ A

$$Q = \frac{\Delta p}{\Delta t} V$$ R

$$Q = \frac{\Delta p}{\Delta t} V$$ M

$$Q = \frac{\Delta p}{\Delta t} V$$ Q

Test Type	When to Use It	Leak Tester
Pressure Change Method (A)	> Small to medium leakage rate, medium to high pressure drop at small to medium volume > Simplest method, everything is recorded by the main pressure transducer	LTC - XXX **A**
Pressure Differential Method (R)	> The volume becomes larger and the pressure drop becomes smaller > The main pressure transducer can no longer reliably compensate for the small pressure drop, an additional differential pressure transducer is installed	LTC - XXX **R**
Mass Flow Method (M)	> Pressure drop decreases farther, but volume and thus leakage rate increases > The leak rate can now be reliably resolved via a flow cell	LTC - XXX **M**
Flow Measurement Method (Q)	> Leakage rate continues to increase > High mass flow, but low/massive pressure drop	LTC - XXX **Q**

Pressure Change Method
(LTC - XXX A)

Test procedure:

The pressure change method is by far the most widely used method in leak testing. Pressure change measurement by means of an absolute/ relative pressure sensor is one of the simplest and most reliable leak test methods on the market.

Using this method, the test specimen is subjected to overpressure or vacuum and the pressure change is determined over time. A distinction is made here between two different sensor types with which the pressure change can be determined:

1. In **absolute pressure measurement**, the test pressure is measured in relation to the ideal vacuum (0 bar absolute).
2. The **relative pressure measurement** compares the test pressure in the test specimen against the ambient pressure. If the test pressure is greater than the ambient pressure, it is referred to as positive pressure, or if it is less than the ambient pressure, it is referred to as negative pressure / vacuum.

The measurement result can be output as a pressure change or as a leakage rate in different units. The simple design, the high reliability, and the price/performance ratio, make the pressure drop method ideal for small volumes and/or larger leak rates.

TEST MEDIUM:
Compressed air/vacuum or nitrogen

DETECTABLE LEAKAGE RATES:
Volume and pressure dependent <1 cm³/min*

METHOD:
Test specimen is subjected to pressure/vacuum. The pressure change in the test specimen caused by leakage is measured and evaluated.

IDEAL APPLICATIONS:
Small volume parts, larger leak rates

ADVANTAGES:

- Simple and inexpensive
- Manageable tools
- Little demand on operating and maintenance personnel (Automated test sequence in mostly 4 phases: Fill/Evacuate, Stabilize, Measure, Venting/ Airing)
- Worker independent assessment

DISADVANTAGES:

- Usable pressure difference resolution depends on the test pressure and volume (thus rarely applicable for leak rates < 1 cm³/min*)
- Thermal and elastic changes on the test specimen influence the measurement result
- Heat of compression is not compensated

Smaller leak rates possible for small pressures and small volumes

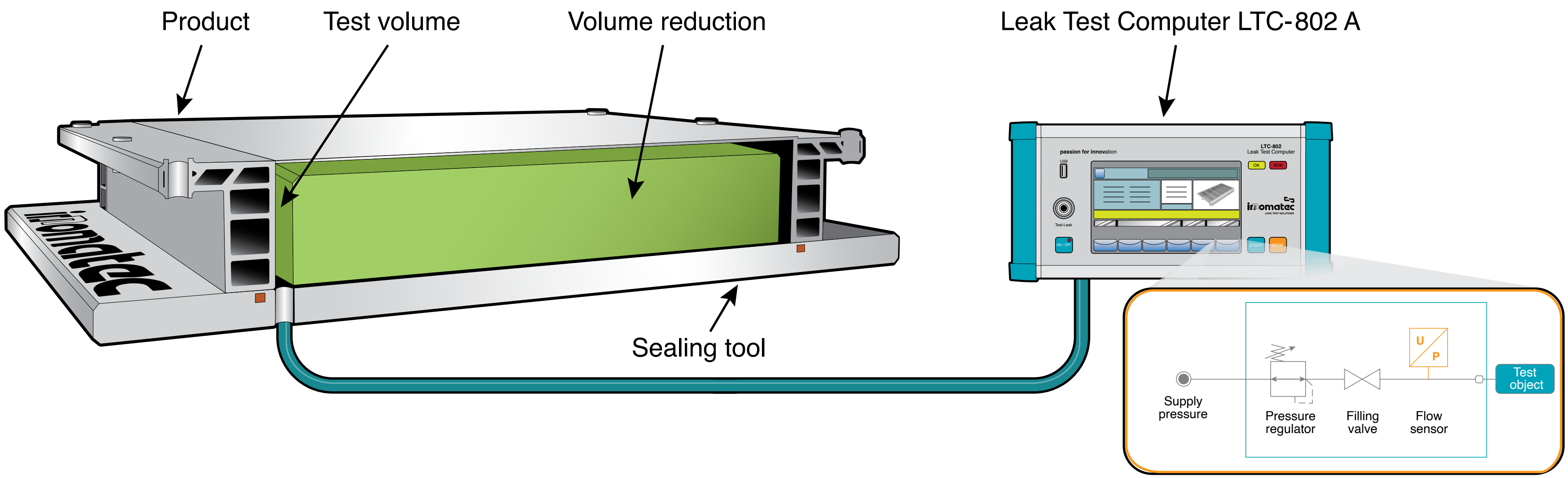


Fig. 6 — Example of a Pressure Change Method leak test

Pressure Differential Method
(LTC - XXX R)

TEST MEDIUM:
Compressed air/vacuum or nitrogen, hydrogen, helium

DETECTABLE LEAKAGE RATES:
Volume and pressure dependent >1 cm^3/min
For very small volumes also < 1 cm^3 / min

METHOD:
Test specimen is subjected to pressure/vacuum. The pressure change in the test specimen caused by leakage is measured and evaluated.

IDEAL APPLICATIONS:
Small volume parts that require fast test times

Test procedure:

The pressure differential method with reference volume is a very popular method in leak testing. Using this method, pressure is applied to a reference volume in addition to the test specimen. The reference volume can be either a small internal volume or, for example, a master test specimen. After the stabilization time, the pressure change between these two volumes is measured by a highly sensitive pressure difference sensor.

An additionally installed absolute or relative pressure sensor only monitors the pressure in the test specimen. This allows the test pressure to be adjusted either absolutely to the ideal vacuum or relative to the ambient pressure and checked for rough leakage.

Since the pressure difference sensor is pressurized from both sides, high pressures can also be tested with very accurate measurement resolution and low leakage rates. The static test pressure therefore plays almost no role in this test type.

Typical applications for this test method are those with small volumes that require fast test times, including cooling ducts, cooling hoses, electrical connectors, and membranes.

ADVANTAGES:

- Low investment
- Low operating costs
- Complete detection of the leakage rate
- All features as with the absolute pressure method
- Good measuring signal resolution, even at high test pressure
- External reference volume also advantageous for elastic parts, as better compensation of volume expansion
- Reference volume under the same thermal conditions ensures short cycle times

DISADVANTAGES:

- Sensitive to temperature changes and other environmental influences
- Not suitable for large pressure drops or burst tests

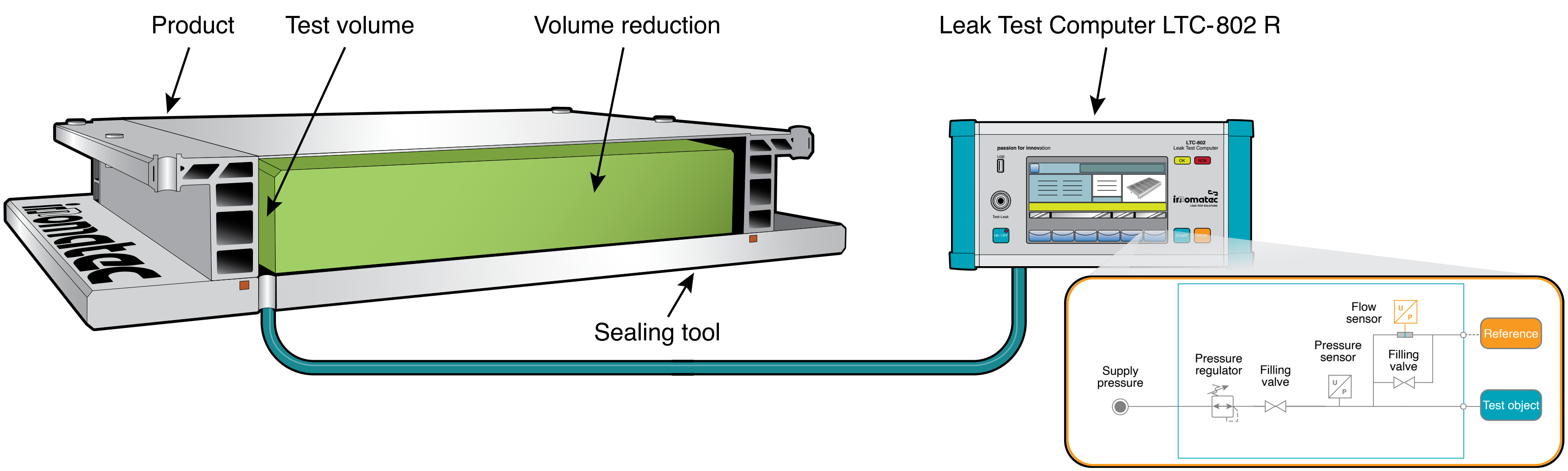


Fig. 7 — Example of a Pressure Differential Method leak test

Pressure Increase Method
(LTC - XXX S)

TEST MEDIUM:
Compressed air/vacuum or nitrogen
Test pressures up to 1,000 bar possible

DETECTABLE LEAK RATES:
Volume-dependent >0.1 cm³/min

METHOD:
Test specimen is subjected to pressure/vacuum. The pressure change caused by leakage in a bell surrounding the test specimen is measured and evaluated.

IDEAL APPLICATIONS:
Parts with high test pressure (up to 1,000 bar), parts where chamber volume is smaller than the part volume, short test times

Test procedure:

As in the pressure-drop method (R), the pressure increase method begins with the test specimen being pressurized and adjusted in absolute or relative terms to the ambient pressure. The actual measurement takes place in a measuring chamber (bell) located around the test specimen. Any leakage in the test specimen leads to a pressure change within this chamber, which is recorded and evaluated by means of a pressure transducer.

The output of the measurement result can be output as a pressure change or as a leakage rate.

The possibility of being able to test specimens at very high pressures (up to 1,000 bar), with very short cycle times, makes the pressure increase leak test method a good alternative to trace gas methods.

The pressure increase method is sometimes performed in combination with the pressure reduction method (e.g. oil cooler). It is also used for seat tightness tests of valves.

ADVANTAGES:

- Test high pressures (up to 1,000 bar)
- Very fast cycle time (usually no stabilization phase required)
- Small leakage rates down to 0.1 cm³ / min possible
- Worker independent assessment
- Bell provides mechanical protection in case of bursting of the test specimens, etc.

DISADVANTAGES:

- Often high mechanical effort due to the use of a volume-optimized test chamber (bell jar)
- Test specimen and adaptation are only partially visible or not visible at all through the test chamber
- A leaking bell can lead to incorrect results
- The test chamber can also be subjected to slight overpressure or underpressure to detect leaks in the chamber

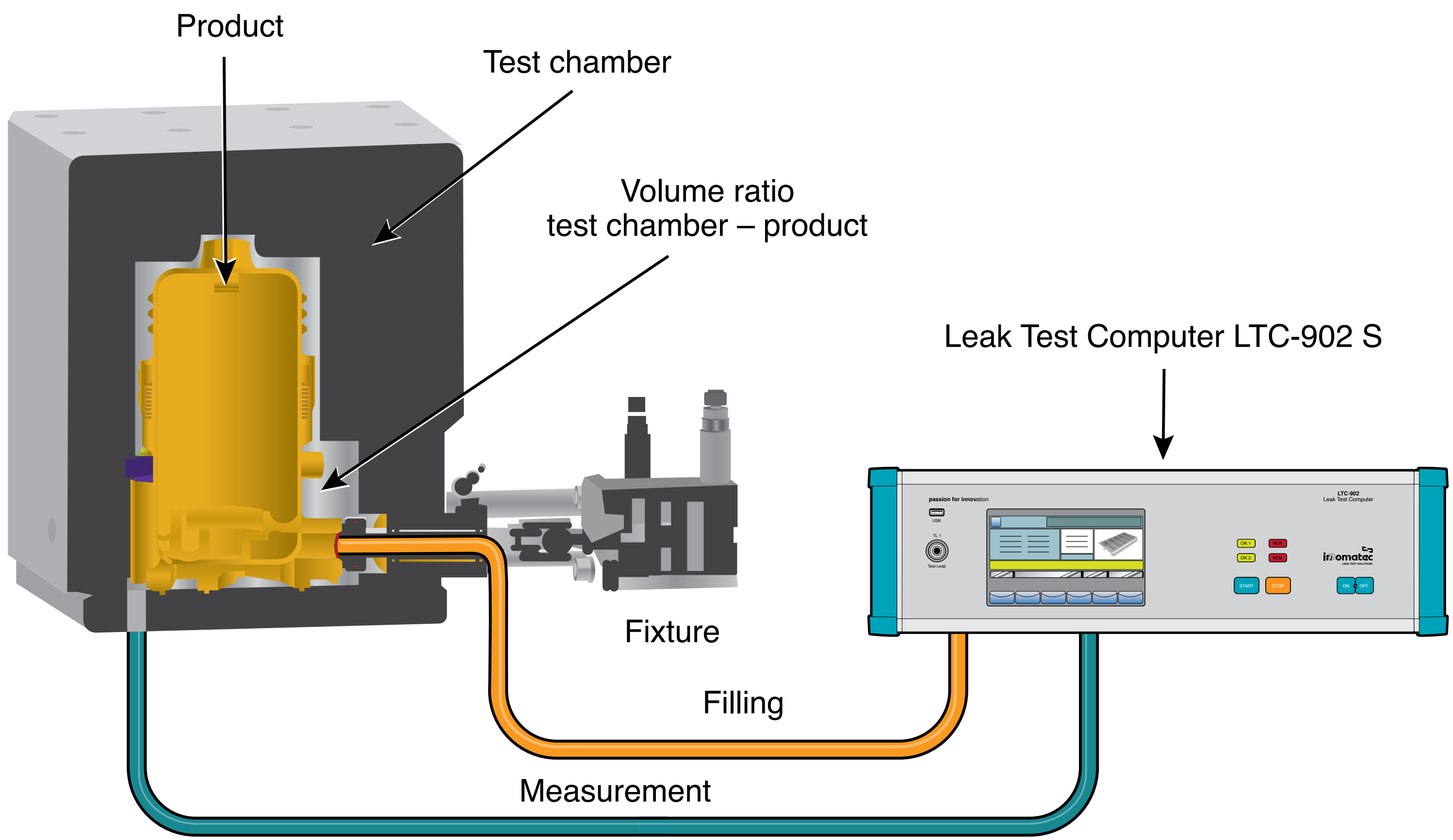


Fig. 8 — Example of a Pressure Increase Method leak test

Closed Component

(LTC – XXX DA, DR)

TEST MEDIUM:
Compressed air/vacuum or nitrogen

DETECTABLE LEAK RATES:
Volume and pressure dependent > 1 cm^3 / min

DETECTABLE VOLUME DIFFERENCES:
2-3% of the measuring volume, depending on the internal volume of the component

METHOD:
A known pre-fill volume is pressurized/vacuumed and stabilized. This gas volume is then fed into the test specimen or into the test specimen chamber. The resulting pressure is a measure of the volume and is used to detect coarse leaks. The additional pressure change caused by leakage is measured and evaluated.

IDEAL APPLICATIONS:
Closed/sealed components that cannot be exposed to test gas via an opening (e.g. consumer electronics, etc.)

Test procedure:

The closed component, or dosing, method is used for completely closed components that cannot be exposed to test gas via an opening, e.g., watches, cell phones, control units, etc.

The completely closed test specimen is placed in a measuring chamber (bell) which is then closed.

This measuring chamber is not directly pressurized with positive or negative pressure but is dosed via a previously evacuated or filled pre-volume.

The volume between the test specimen and the measuring chamber is known, so that a defined pressure ratio is expected.

Any leakage in the test specimen changes this ratio and thus leads to a change in pressure, which is recorded and evaluated by means of a pressure transducer (A) or pressure difference sensor (R).

The principle of the dosing method can also be integrated into other measuring methods in order to perform a volume determination, a component interrogation or an exact gas quantity determination.

The following standard measuring procedures with the dosing principle are available:

- **Closed component method** with pressure change method **DA**
- **Closed component method** with pressure differential method **DR**

ADVANTAGES:
- Simple and inexpensive method
- Volume determination, testing of closed parts possible if they have a free internal volume which is not less than approx. 10% of the free chamber volume
- Standard method for waterproof consumer goods

DISADVANTAGES:
- Relatively long test duration
- Pressure shocks are possible due to the procedure

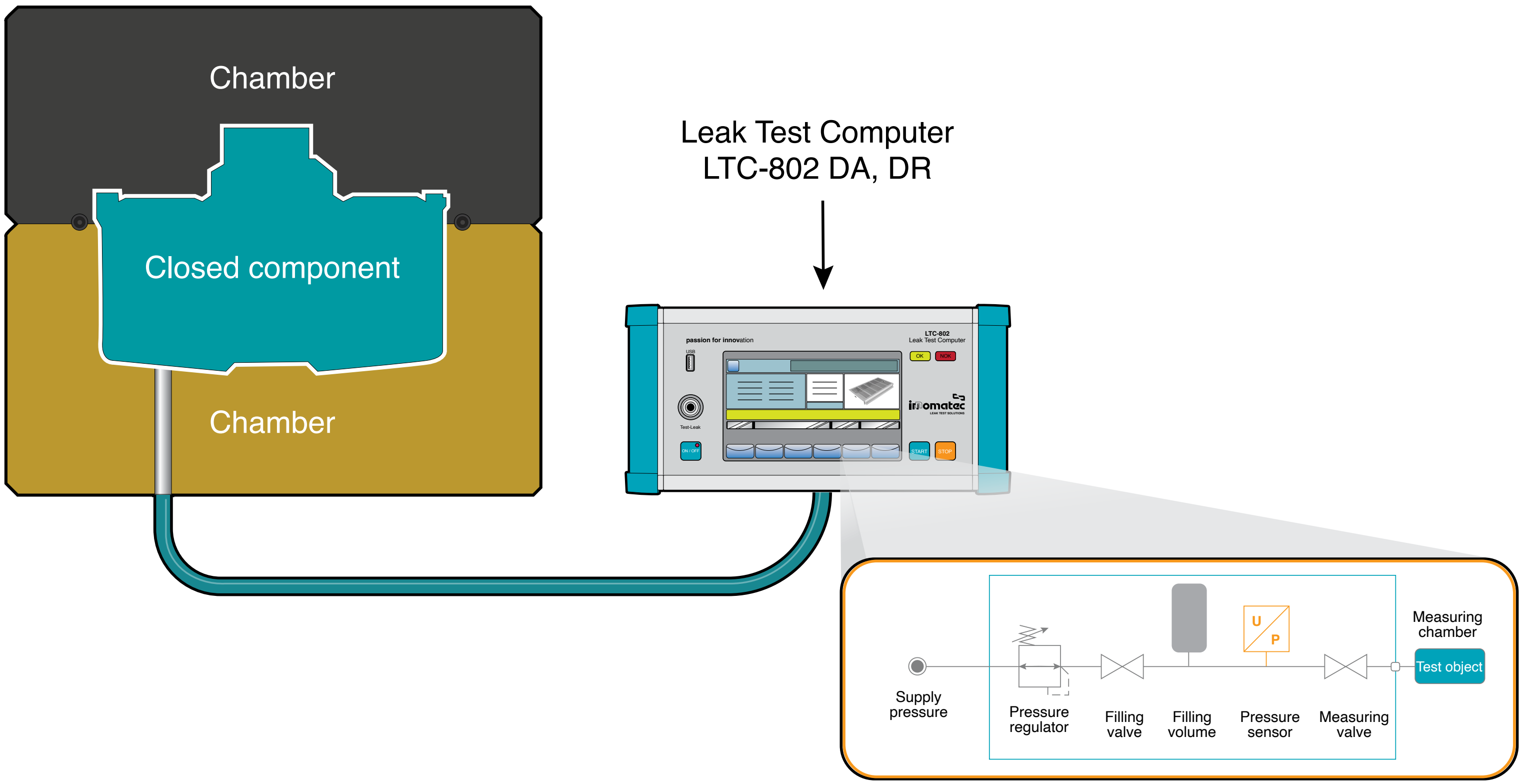


Fig. 9 — Example of a Closed Component test

Volume Determination
(LTC – XXX C)

TEST MEDIUM:
Compressed air/vacuum or nitrogen

DETECTABLE LEAK RATES:
Volume and pressure dependent > 1 cm^3 / min

DETECTABLE VOLUME DIFFERENCES:
2-3% of the measuring volume, depending on the internal volume of the component

METHOD:
A known pre-fill volume is pressurized/vacuumed and stabilized. This gas volume is then fed into the test specimen or into the test specimen chamber. The resulting pressure is a measure of the volume and is used to detect coarse leaks. The additional pressure change caused by leakage is measured and evaluated.

IDEAL APPLICATIONS:
Closed/sealed components that cannot be exposed to test gas via an opening (e.g. consumer electronics, etc.)

ADVANTAGES:

- Simple and inexpensive method
- Volume determination, testing of closed parts possible if they have a free internal volume which is not less than approx. 10% of the free chamber volume
- Standard method for waterproof consumer goods

DISADVANTAGES:

- Relatively long test duration
- Pressure shocks are possible due to the procedure

Test procedure:

As an alternative to the dosing method, the volume determination is used to determine the volume of the test specimen. It offers the same pros and cons as the closed component approach.

A known pre-volume is filled or evacuated with a known test pressure and then expanded in the test specimen. The volume of the test specimen is determined with the resulting pressure.

The principle of volume determination can also be integrated into other measurement methods.

Mass Flow Method
(LTC – XXX M)

TEST MEDIUM:
Compressed air/vacuum or nitrogen

DETECTABLE LEAK RATES:
Volume and pressure dependent >0.5 cm³/min

METHOD:
Test specimen is subjected to pressure/vacuum. The air escaping due to leakage is compensated via a reference volume. The compensation flow is measured via a mass flow meter and is a measure of the leakage rate.

IDEAL APPLICATIONS:
Large volume components

Test procedure:

The mass flow test method is used for test specimens with large volume. The mass flow method is characterized by the direct measurement of the result in cm³/min. This is calculated with the volume factor (ratio between test and reference volume) and output as leakage rate.

The flow measurement is usually measured using either thermal mass flow or laminar flow sensors. During the test, the test specimen and the reference volume are simultaneously filled with positive or negative pressure. After the stabilization phase, the flow direction and mass flow between the two volumes is determined.

This test method is particularly suitable for large-volume components such as fuel tanks, battery housings, body parts, etc., due to the high accuracy and the compensation of volume and temperature fluctuations.

ADVANTAGES (COMPARED TO PRESSURE DIFFERENCE METHOD):

- Low operating costs
- Even with large volumes, small leakage rates of a few cm³/min can be measured.
- Relatively short measuring time possible, since sensor response time < 1 sec.

DISADVANTAGES (COMPARED TO PRESSURE DIFFERENCE METHOD):

- More effort in the measuring device and you need a reference.
- A good ratio of reference volume to test sample is required. Otherwise, small fluctuations can result in a large difference in measurement.

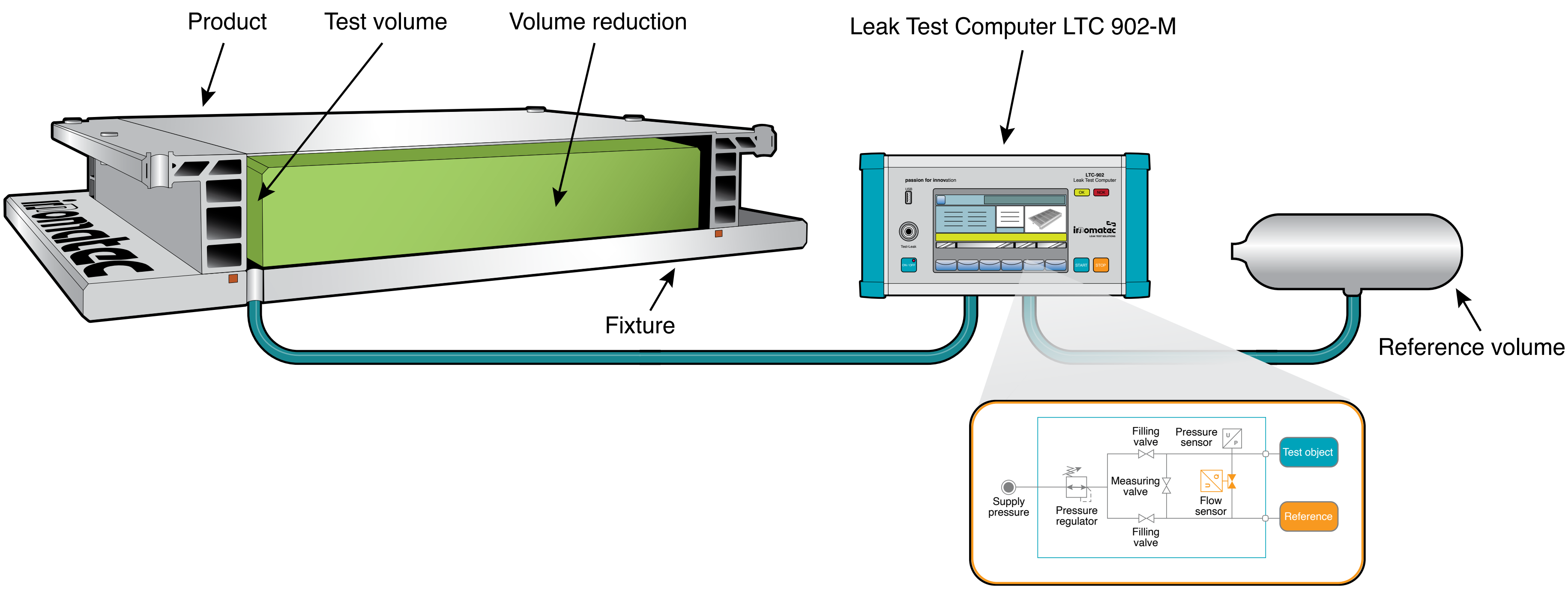


Fig. 10 — Example of a Mass Flow leak test

Flow Measurement Method
(LTC - XXX Q)

TEST MEDIUM:
Compressed air, nitrogen (special versions for water, etc. on request)

TEST PRESSURES:
Varying measuring ranges, 0.1 - 10 bar as standard, special applications up to 200 bar

FLOW MEASURING RANGE:
1.5 - 50 ml/min, resolution 0,05 ml/min with high performance model, flow ranges up to 400 l/min, special versions higher

METHOD:
Test pressure is built up in the component, with help of a pressure regulator. Through the external pressure measuring point, internal pressure is detected at a set pressure measuring point. The mass flow is then recorded via a mass flow meter.

IDEAL APPLICATIONS:
Parts with designated inside diameter or flow channel

Test procedure:

The flow method measures flow rates of air, nitrogen, etc. through the test specimen. Depending on the flow size, it can be a leak rate or a flow measurement of gases. The flow-through method is used when a test specimen is not closed and its continuity must be checked for quality. Flow measurement is one of the fastest leak measurement methods with air and can usually be realized in a cycle time of less than 2 sec.

The flow measurement is performed using either a thermal mass flow or laminar flow element and must be taken close to the test specimen (outside the leak test unit).
For larger flow rates, a Pitot tube is usually used for pressure measurement. A precision pressure regulator is used to adjust the pressure in the test specimen throughout the test so that the volume flow at the input of the test specimen can be measured. Since the measured value is evaluated directly by the sensor and output in a leakage rate, the actual measurement can take place directly after filling. A stabilization phase as with pressure change measurements is not required.

ADVANTAGES:
- Simple, accurate, fast leak test method
- Fast cycle times, under 2 sec possible
- Applicable for large leakage rates
- Volume independent of test volume
- Test complex components with multiple openings
- Easy commissioning

DISADVANTAGES:
- High costs

Alternatively, a flow measurement can also be carried out using the dynamic pressure method. In this case, it is not the flow rate that is measured, but the change in test pressure when the cross-section is tapered or widened. Dynamic pressure measurement identifies bottlenecks in the component caused by accumulating gas. This allows a production defect to be detected very quickly and effectively. Particularly in the automotive sector, dynamic pressure tests are frequently used to determine partial closures, e.g. > 30%.

Combinations of the methods are also possible, e.g. for testing pressure control valves or functions of Venturi nozzles.

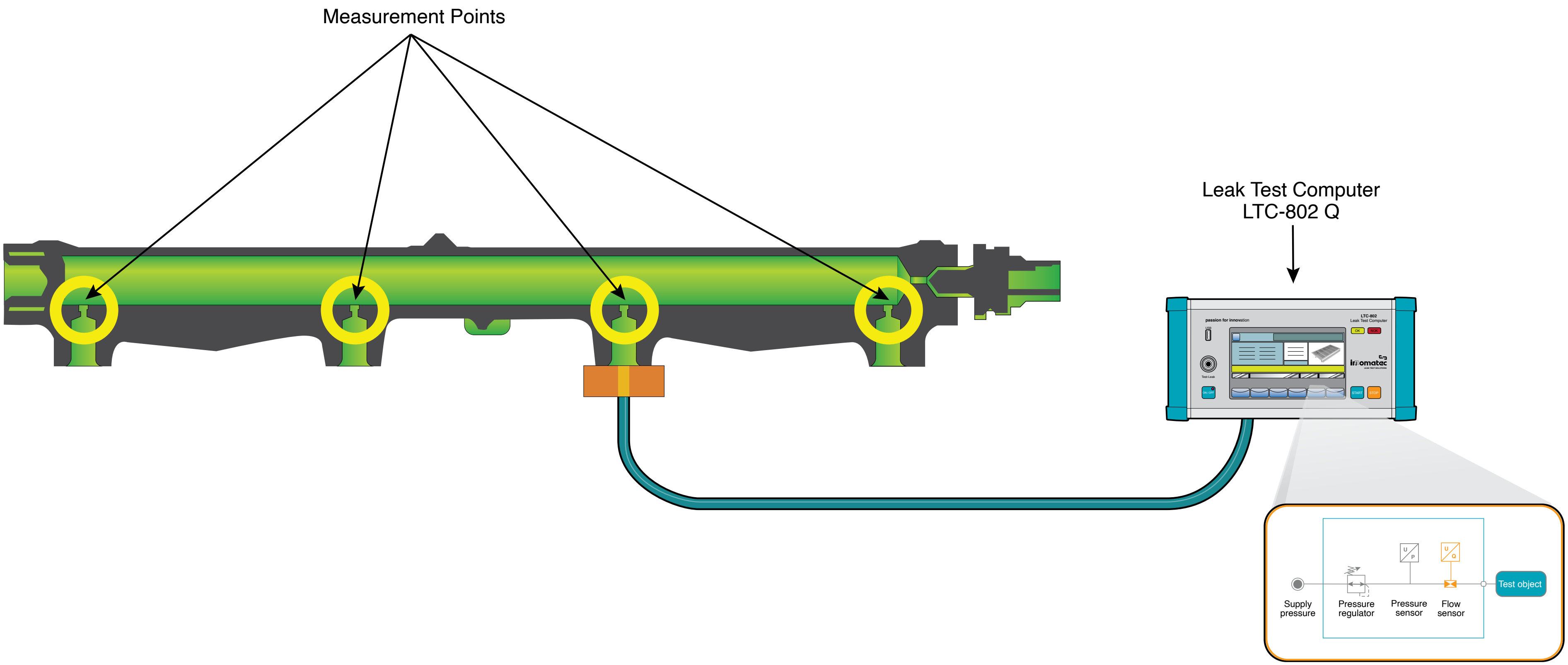


Fig. 11 — Example of a Flow Measurement test

Helium / Tracer Gas Leak Testing

Tracer gas leak testing is a simple and effective method for leak testing parts with very low leak rates that cannot be met using conventional air leak testing methods. Tracer gas leak testing can also be used as an alternative to underwater leak testing when greater accuracy is required.

Helium is the most commonly used tracer gas. Helium makes the test less susceptible to external environmental factors, like temperature changes, and helps manufacturer's achieve shorter cycle times. However, the popularity of helium combined with a low supply on the market can cause it to be unavailable or quite expensive.

Forming gas is a cost-effective alternative to helium that can be used as a during tracer gas leak testing. Typically a mixture of 5% hydrogen and 95% nitrogen, it is a safe, non-flammable, and effective alternative that can be used for many testing applications.

TRACER GAS LEAKAGE RATE UNITS

- Tracer gas leakage rates are measured as 1 mbarl/s
- 1 mbarl/s: If the pressure in an evacuated component with a volume of 1 liter increases by 1 mbar in 1 second

Common notations for helium applications

Since the measured values for helium applications are normally very small, the below scientific notations are often used to better represent small numbers.

Decimal notation	Scientific notation
0,000001	1,00E-06
0,00001	1,00E-05
0,0001	1,00E-04
0,001	1,00E-03
0,01	1,00E-02
0,1	1,00E-01
1	1,00E+00
10	1,00E+01
100	1,00E+02
1000	1,00E+03

Leak Detection / Sniffing

TEST MEDIUM:
Helium, helium mixture (air or nitrogen), forming gas (5% H / 95% N)

TEST PRESSURES:
Stepless from 0.01 - 16 bar

DETECTABLE LEAK RATES:
Volume and component dependent < 1 x 10-5 mbar*l/sec (in industrial environment)

METHOD:
The test specimen is filled with a tracer gas or a tracer gas mixture. The gas escaping through any leakage points is analyzed using a sniffer probe and leak detector.

IDEAL APPLICATIONS:
Precise leak location, troubleshooting after failed air leak test

Test procedure:

Manual leak detection, or "sniffing", makes it possible to locate the exact location of leaks and is mostly used for troubleshooting, as well as for process optimization. The test specimen is filled with helium or a helium/air mixture and then checked for leaks using a sniffer probe (either manually or robot-guided).

Leak detection can be used as a downstream process to a leak test of the total leakage rate, or as a stand-alone process. A distinction is made between focusing on the exact position accuracy and leak size (leakage evaluation) or rapid leak detection (position and IO/NIO evaluation).

This test method offers localization of leaks on pressure or vacuum stable test specimens and leak rates up to approx. 1x10-5 mbar l/s.

ADVANTAGES:

- Low investment costs
- Single leak rate detection
- Exact detection of the leak position
- Not dependent on ambient and component temperature
- Not dependent on the stability of the test specimen (small volume changes, vibrations, etc.)
- No component contamination (e.g. by leak detection spray)

DISADVANTAGES:

- Handling of inert gas required
- Manual handling; high operator costs; not fail-safe
- Only partial detection (weld/adhesive seam), full-area detection takes a very long time
- Measurement results dependent on measuring distance and, in the case of manual detection, operator care

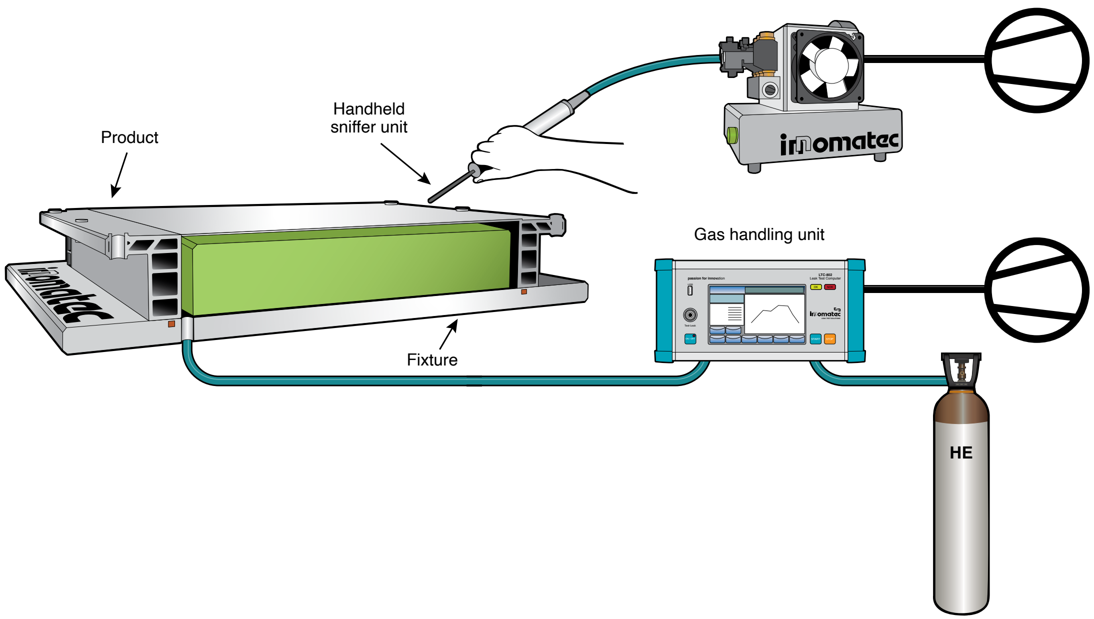


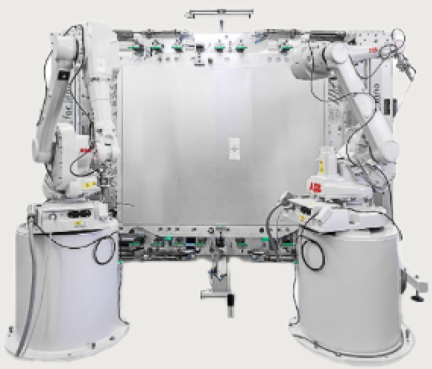
Fig. 12 — Example of a manual sniffing leak test

Robotic Leak Detection

Robot-guided leak detection adds automation to sniffer leak detection. The constantly adjustable speed and distance to the test item, as well as the special precision, enable fast and accurate measurement results in leak localization.

Leakage evaluation: Thanks to very constant distance and traversing speed monitoring, as well as a high sampling rate, individual leakages can be evaluated very precisely. By means of the stored parameters, the machine decides whether an individual leakage must be reworked or not.

Rapid leak detection: If the actual inspection is performed by a total leakage rate (one value for the entire test specimen), leak detection is usually only used to find the position for the subsequent rework process.



Accumulation

TEST MEDIUM:
Helium, helium mixture (air or nitrogen), forming gas (5% H / 95% N)

TEST PRESSURES:
Stepless from 0.01 - 1,000 bar

DETECTABLE LEAK RATES:
Volume and component dependent < 1 x 10-3 mbar*l/sec (in industrial environment)

METHOD:
The test specimen is filled with a trace gas or trace gas mixture and the gas escaping through any leakage points is evaluated via a leak detector inside a closed analysis chamber.

IDEAL APPLICATIONS:
Very small leak rates, hot/warm parts, parts with large or unstable volumes

Test procedure:

During accumulation leak testing, a simple accumulation hood is used to form a test space surrounding the test specimen. The test specimen is then filled with tracer gas. Inside this hood, the increase in trace gas concentration over a period (x) is measured under atmospheric ambient pressure.

This allows significantly smaller leaks to be detected, as is the case with the pressure change method. The greatest advantage, however, is the independence from environmental influences such as the temperature of the test specimen or the environment, drafts, vibrations, etc.

This allows, for example, leak testing of recently welded or otherwise thermally treated test specimens. Even specimens with very large and unstable volumes, can be tested quickly and efficiently. Leakage test on pressure-stable test specimens and leakage rates up to approx. 1x10-5 mbar l/s.

The accumulation process using trace gas is a good compromise between the highly sensitive vacuum integral process and the low-cost pressure change processes using air.

ADVANTAGES:

- Medium investment costs
- Complete detection of the total leakage rate
- Not dependent on ambient conditions (temperature, air movement, etc.)
- Not dependent on the stability of the test specimen (small volume changes, vibrations, etc.)
- Smaller leak rates than detectable with air
- Worker independent assessment

DISADVANTAGES:

- No assurance of the test gas concentration depending on the volume of the test vessel
- Handling of trace gas required
- Higher fixture and test rig costs (compared to air testing)
- Cleaning system for “contaminated environment” required (enclosure venting)
- No leak localization

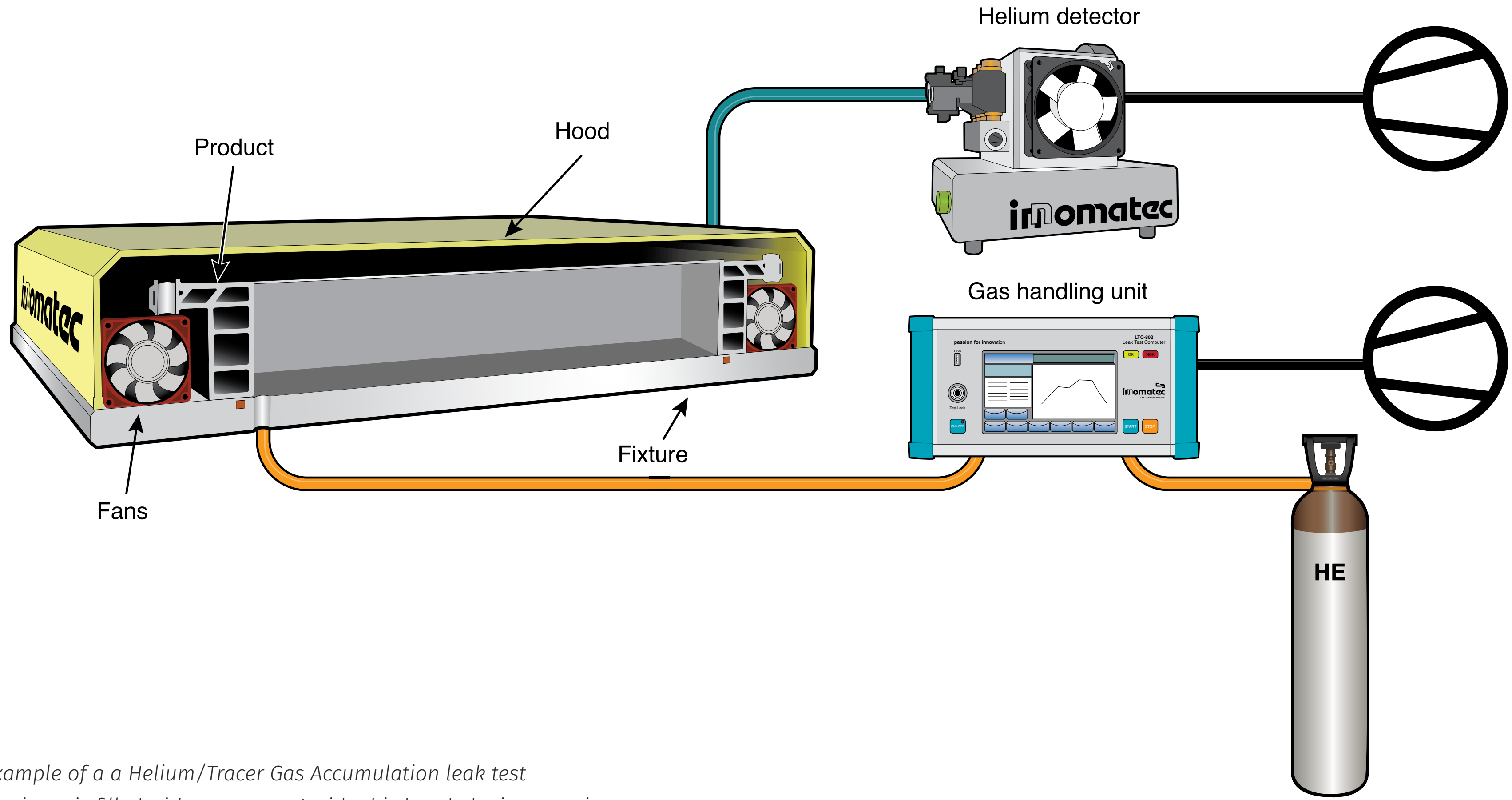


Fig. 13 — Example of a a Helium/Tracer Gas Accumulation leak test

The test specimen is filled with tracer gas. Inside this hood, the increase in trace gas concentration over a period (x) is measured under atmospheric ambient pressure.

Vacuum Integral

TEST MEDIUM:
Helium, helium mixture (air or nitrogen), forming gas (5% H / 95% N)

TEST PRESSURES:
Stepless from 0.01 - 1,000 bar

DETECTABLE LEAK RATES:
Volume and component dependent < 1 x 10-9 mbar*l/sec (in industrial environment).

METHOD:
The test specimen is filled with a tracer gas and the gas escaping through a possible leakage is evaluated via a leak detector inside the vacuum chamber. Due to the vacuum atmosphere in the analysis room, a very high accuracy and speed is achieved.

IDEAL APPLICATIONS:
Very small leak rates, short test times, high test pressures

Test procedure:

The test specimen is filled with tracer gas. The test chamber is placed under vacuum and the tracer gas leak detector is switched on. The high vacuum transports the escaping gas atoms to the leak detector. During the leak test, the amount of escaping trace gas within the vacuum chamber is analyzed by a leak detector and output in a leak rate.

A vacuum chamber and the fine vacuum generated in it (~1x10-4 bar) form a very neutral measuring environment, which means that even the smallest leaks can be detected in the shortest possible time under very high test pressures. No other measuring method combines this precision with the shortest cycle times and the ability to use in an industrial environment.

ADVANTAGES:

- Detection of a single leak rate
- Component volume only influences media consumption, not relevant for measurement
- Not dependent on all environmental conditions
- Not dependent on the stability of the test specimen (small volume changes, vibrations, etc.)
- Smallest leakage rates detectable
- Short cycle time, which can be adapted to the process by the design of the test stand
- Worker independent assessment

DISADVANTAGES:

- Handling of inert gas required
- High investment costs
- High fixture and test rig costs (compared to air or accumulation testing, can be offset by faster cycle time and higher machine availability)
- No localization of the leak

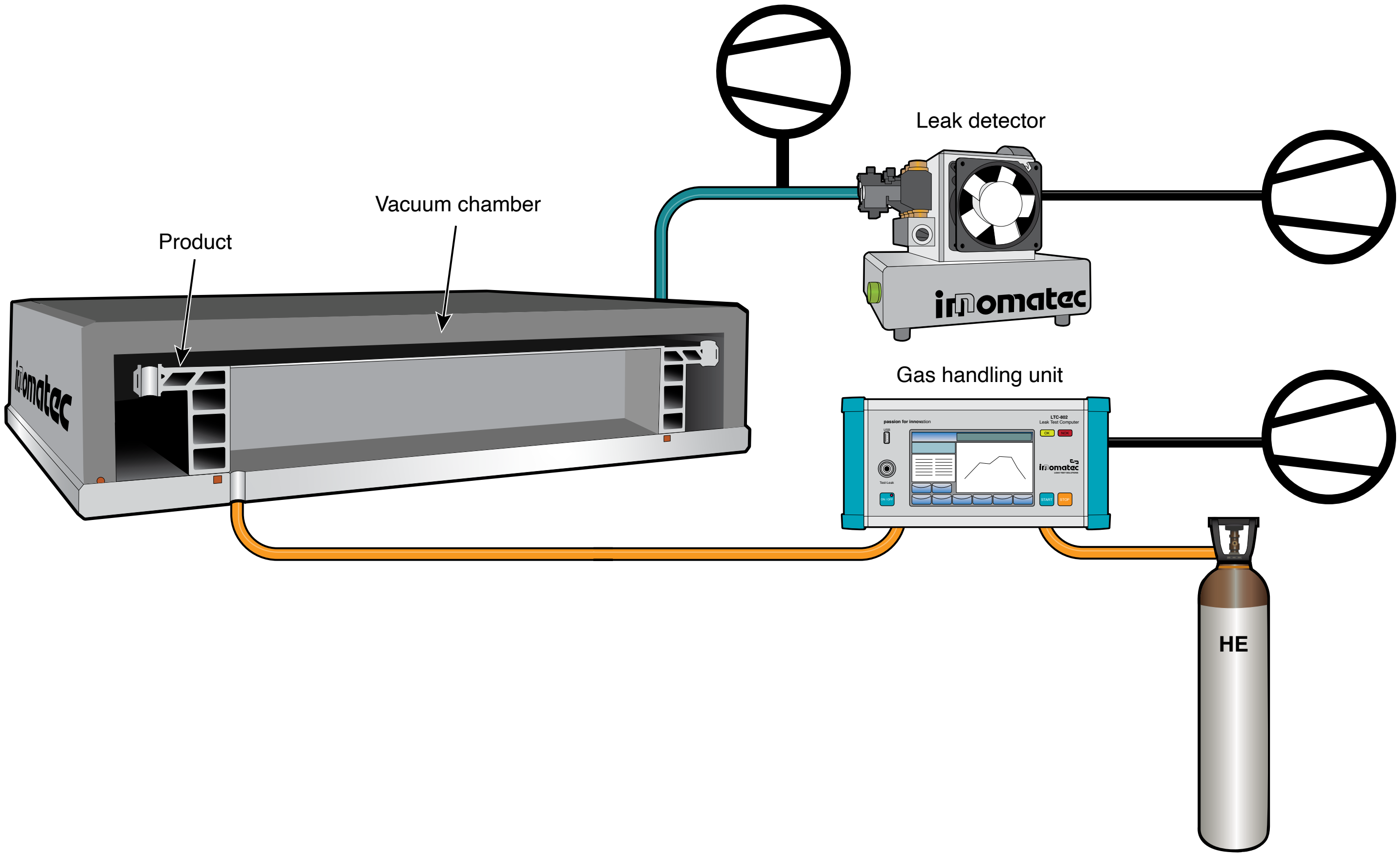


Fig. 14 — Example of a Vacuum Integral leak test

Burst pressure testing

Burst testing involves applying controlled pressure to the test specimen, gradually increasing the pressure over a specified test duration. The test can be controlled to ensure the part is tested without experiencing damage, or it can be configured to continuously increase pressure until the product fails to measure its precise maximum pressure before failure.

Burst testing can be performed with air or fluid (water or oil). We will discuss both scenarios below.

Burst Pressure Test with Air

TEST MEDIUM:
Air

BURST PRESSURES:
Stepless from 0.01 - 50 bar (maximum test pressure depending on component volume)

METHOD:
The test specimen is filled with air, gradually increasing the pressure over a specified test duration, or until failure (burst). The bursting point or pressure curve is recorded by the equipment.

IDEAL APPLICATIONS:
Very small parts, highly sensitive components

Test procedure:

Burst testing using air is most effective for very small test specimens, and for those containing highly sensitive components that need to be monitored until failure, such as safety valve switching points (especially for gases).

The pressure increase can be abrupt, pulsating, or uniform over a ramp. Depending on the desired sampling rate and accuracy, this can be displayed as a pressure value over time in a diagram.

The burst testing systems must be designed and constructed in accordance with the applicable safety guidelines for the safety of test operators and the daily production routine surrounding it.

ADVANTAGES:

- Very inexpensive and accurate measuring method
- Testing of moisture-sensitive components, which must remain dry during measurement
- No handling of liquids, such as oils or water

DISADVANTAGES:

- High demands on machine safety because of compressible medium (high stored energy)
- In case of bursting, the compressed gas quantity is released abruptly, resulting in a loud bang
- Danger from possible flying parts

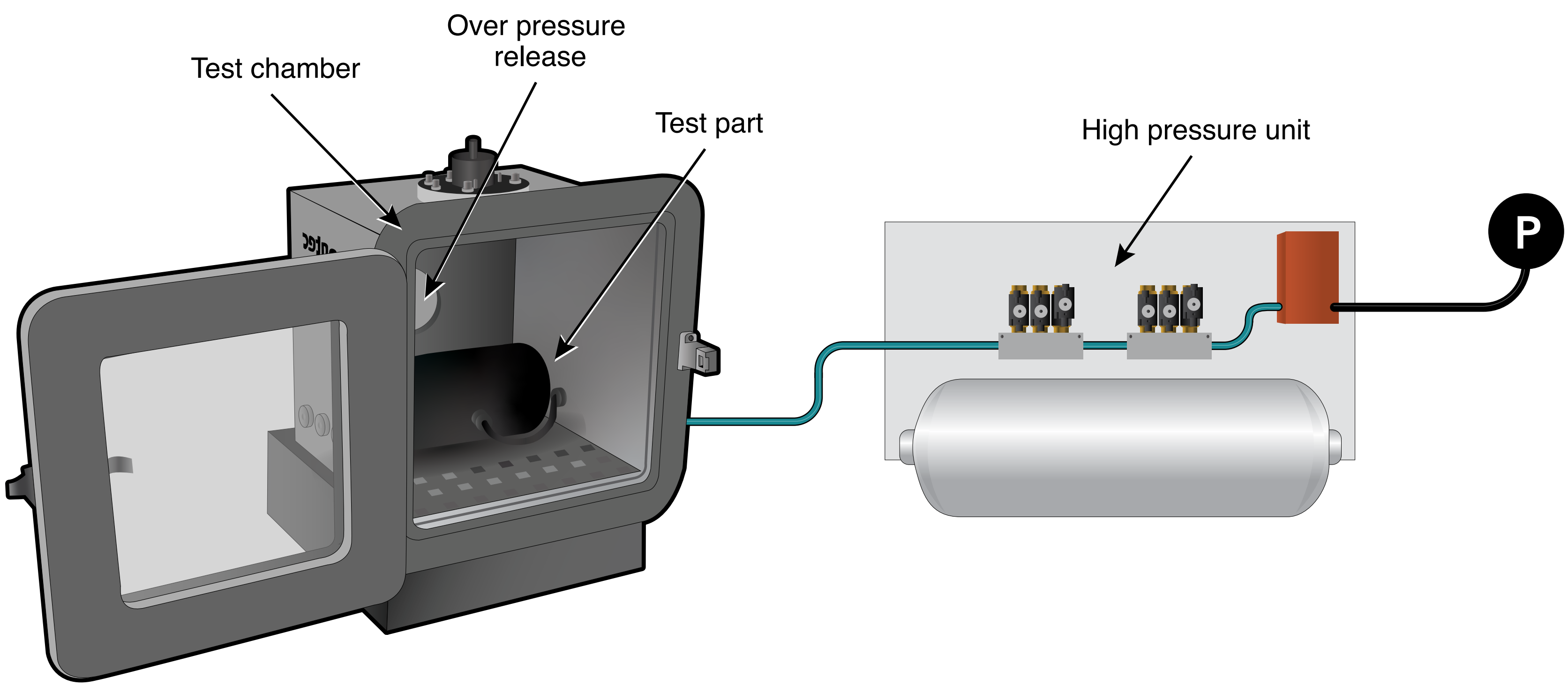


Fig. 15 — Example of a Burst Pressure test with air

Burst Pressure Test with Water/Oil

TEST MEDIUM:
Water/oil

BURST PRESSURES:
Stepless from 0.01 - 1,000 bar (maximum test pressure depending on component volume)

METHOD:
The test specimen is filled with water or oil, gradually increasing the pressure over a specified test duration, or until failure (burst). The bursting point or pressure curve is recorded by the equipment.

IDEAL APPLICATIONS:
Very high bursting pressures, large volume parts

Test procedure:

The burst pressure test method with water or oil, allows very high burst pressures, even with large volumes. The test specimen is filled with the bursting medium and must be vented as best as possible. Larger air cushions must be avoided by technical measures such as pre-evacuation, purging and special component positioning, as these store energy in the form of compressed gas.

The pressure increase can be pulsating or uniform over a ramp. Depending on the desired sampling rate and accuracy, this can be displayed as a pressure value over time in a diagram.

Special hardware allows the combination of fast pressure rise ramps, with high pressure control at the same time.

Depending on the medium, production plants are built in such a way that the medium can be reused through filtration and intermediate storage.

Although the stored energy within the component is significantly lower than in the case of burst testing systems with air, the testing systems must be designed and constructed in accordance with the applicable safety guidelines for the safety of test operators and the daily production routine surrounding it.

ADVANTAGES:

- Very accurate method for function and burst testing
- Low stored energy enables very high test pressures even with large volumes

DISADVANTAGES:

- Handling of water/oil requires special plant design and filtration techniques
- Venting of the test specimen partly very complex and cost-intensive in terms of design

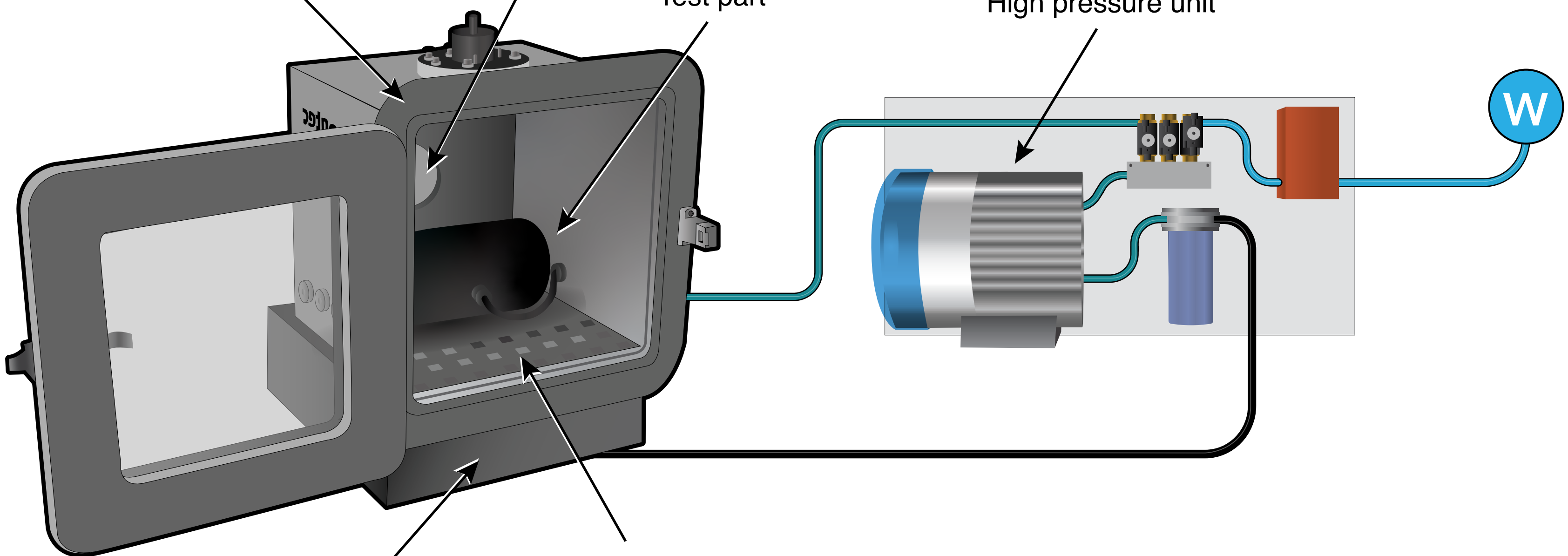


Fig. 16 — Example of a Burst Pressure test with water or oil

Why innomatec?

innomatec has 40 years' experience working with manufacturers across a variety of industries. Our expertise has informed the development of our broad product line to serve the leak testing needs of manufacturers across the globe. Depending on your needs, innomatec can deliver **leak testers**, **connec® quick connectors**, or **turnkey leak test benches**.

innomatec's passion for innovation is evident in our line of leak test computers (LTC), expertly engineered to perform at the highest standard on the production line. As leak test computers, our instruments provide the power and flexibility of a PC, enabling the customization, configuration, connectivity, and data management that today's manufacturers require.

innomatec's LTC's are designed to meet the daily needs of manufacturers, including:

> Flexible for a wide range of leak test methods and test programs
> Adaptable to meet customer requirements and processes
> Easy to use, user-friendly interface
> Easy to configure, easy to operate
> Easy integration into your network
> Excellent repeatability, highly accurate leak test results

See which innomatec LTC is right for you

LTC-802: Single-channel leak test computer

LTC-902: Multi-channel leak test computer

LTC-502: Entry-level leak test computer

LEAK TEST SOLUTIONS

Contact innomatec to answer your questions and find the best leak tester for your application.

Contact us

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