LEAK TESTING

Leading solutions for your leak detection and integrity test challenges

PFEIFFER VACUUM

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Leading solutions for your leak detection and integrity test challenges

Why leak tests?

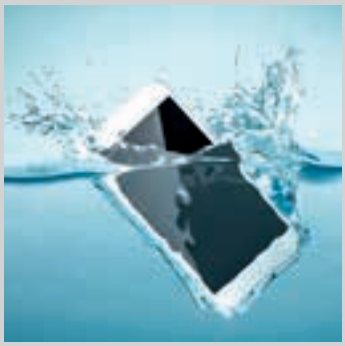
Leak tests play an important role in our daily safety, environmental protection and the reliability of production processes and products of our daily lives.

The application spectrum is diverse. A large part of the applications can be found in the automotive industry. Fuel, brake, cooling and airbag systems are just a few examples for the importance of reliable leak tests. In addition, refrigeration and air conditioning technology as well as packaging integrity in the medical, pharmaceutical and food industries are important applications of quantitative leak testing. Qualitative, localizing tests are of great interest in the semiconductor industry as well as in research and development. Even emerging sectors such as electromobility, energy storage or fuel cells require leak testing on an industrial scale.

Typical requirements

In an industrial serial test, the leak detection method is explicitly adapted to each individual application. The first step is to define the desired tightness or leak rate. The next step is to determine the correct test method and test procedure. Important features of a test procedure include detection limit, sensitivity of environemtal influences, accuracy and repeatability, ease of use and operating costs.

Application examples



IP protection class

Pharmaceutical packaging

Refrigeration and air conditioning

Fuel tank

Pfeiffer Vacuum

Pfeiffer Vacuum is one of the world's leading suppliers of testing equipment and vacuum technology. In addition to powerful detection systems, our product portfolio also includes vacuum pumps, measuring and analysis equipment, components and vacuum chambers. We benefit from more than 50 years of experience in leak detection.

Our know-how

Pfeiffer Vacuum unites the leading pioneers in the field of leak detection. Our French development teams brought the first commercial helium leak detector to market in 1966. Only two years later, Pfeiffer Vacuum introduced the counter-flow principle in Germany, which is still the basis for almost all modern tracer gas leak detectors. Pfeiffer Vacuum know how has been reinforced in 2017 with the acquisition of ATC, bringing a wide expertise of MicroFlow leak testing. This combination of expertise and a comprehensive portfolio makes Pfeiffer Vacuum your perfect partner for all leak detection challenges.

Partner for your solutions

As a provider for all components necessary for a all-in-one-solution, we will support you throughout the entire process. This includes feasibility studies and the implementation of leak detection solutions in the production process. You also benefit from our comprehensive product portfolio beyond leak testing, consisting of vacuum pumps, vacuum chambers and measuring instruments. In addition, we also maintain a network of partners assisting you with fully automated solutions.

Pfeiffer Vacuum – core competencies in leak detection

Solutions from a single source for all leak detection requirements:

- Assistance in determining your tightness requirements
- Technical support in selecting the optimal and safest leak detection solution for your application
- Wide range of solutions: Leak detection using tracer gas or air with special solutions for hermetically sealed products
- Calibration services and a complete vacuum product portfolio with pumps, chambers and equipment
- Integrated all-in-one solutions, including consulting and a network of partners for automated systems

At Pfeiffer Vacuum, we are committed to your success and to limiting risk when selecting and carrying out leak tests.

LEAK DETECTION CHALLENGES

From the definition of the requirements to the selection of the correct method to the execution of the test procedure

Leakage rate requirements

The selection of the optimal leak detection method often begins with the definition of the necessary tightness requirement. This is often stated in the refrigeration and air-conditioning technology in a mass loss per time, for example, „grams per year“ or „ounces per year“. Other industries describe a leak by its diameter in micrometer. Other common units are the SI-unit Pa · m^3/s or mbar · l/s. The table opposite gives an overview of the different sizes of leaks, leak diameters and the time it takes for air to escape from leaks of different diameters. These guidelines are then related to typical requirements such as „waterproof“, „bacteria-proof“ and „gas-tight“.

Typical leak detection procedures

The table summarizes fundamental leakage testing procedures. Important criteria for the selection of the relevant test method are the required detection limit and the pressure load of the component during operation. It must also be clarified whether air or a specific tracer gas should be used for the test and whether quantification and/or localization of the leak is required.

Another crucial factor is the desired test or cycle time. Not only the mere test time has to be taken into account, but also the time additionally required due to the pre- and post-treatment of the test specimen (e.g. drying) or sequences in the actual test (e.g. stabilization or tracer gas filling). Furthermore, the test methods are divided into destructive and non-destructive methods. Here, the value of an item or the contents of a package should be taken into account when selecting the method.

Leak detectors by Pfeiffer Vacuum

Pfeiffer Vacuum has the widest product range for leak detection and leak testing on the market.

Micro-Flow/Mass Extraction

Fast and reliable leak testing for packaging and electronics as well as for industrial and medical applications.

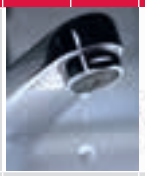
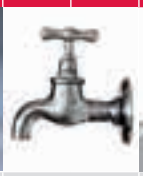
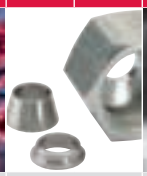
Optical emission spectroscopy

Integrity test for drug packaging and hermetically sealed components.

Tracer gases helium and hydrogen

High sensitivity and leak detection for demanding applications, such as in the automotive, medical and semiconductor industry.

Overview of typical leak detection procedures

Method/sensor technology	Tracer gas	Tested object under overpressure	Tested object under vacuum	Quantitative test	Localization	Leakage rate in mbar·l/s[6]											
						10^{0}	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}
						Leak rate in standard ccm											
						60	6	0.6	0.06	0.006	0.0006	0.00006					
																	
Description						Dripping water		Waterproof		Oil-tight		Sterile		Gas-tight		Technically tight	
Leak diameter, pipe-shaped geometry[1]					µm	100		30		10		3		1		0.1	
Leak diameter, orifice-shaped geometry[2]					µm			10	3	1	0.3	0.1					
Outflow of 1 cm^3 air[3]						1 s	10 s	100 s	16 min	3 hrs.	1 d	12 d	4 mth.	3 yrs.	30 yrs.	300 yrs.	
Bubble test	any	■		□[4]	■												
Sound or ultrasonic sensor	any	■			■												
Ultrasonic bubble test	any	■		■	■												
Pressure rise	any		■	■													
Pressure decay	any	■		■													
Micro-Flow	various	■		■													
Mass Extraction	various		■	■													
Optical emission spectroscopy	N_2, Ar, CO_2,H_2O		■	■													
Leak detector, mass spectrometry, sniffing	Tracer gases ^4He, ^3He, H_2	■		■[5]	■												
Leak detector, mass spectrometry, vacuum	Tracer gases ^4He, ^3He, H_2		■	■	■												

[1] Leak diameters are calculated according to different models. Different models can achieve different correlations between leakage rate and hole diameter.

[2] Classification according to "Leak Detection Index 2" for sterile packaging, FDA USP <1207.2>

[3] Phenomenological observation of a gas flow according to DIN EN 1593". This does not include any statement about the driving force for the outflow, i.e. the test pressure.

[4] Quantification possible with bubble collection and volumetric analysis.

[5] Quantification with accumulation test (sniff-shell method) and carrier gas method possible.

[6] Calculated leakage rates according to traditional flow models at 1 cm wall thickness and a temperature of 20°C.

How to choose the right test method?

- Definition of requirements for tightness
- Determine the allowable pressure/vacuum ranges for your product
- Required test time for the test procedure including parts preparation, parts handling, etc.
- Product application conditions and desired test direction
- Quantitative integral check and/or localization test
- Destructive/non-destructive
- Accuracy and process control
- Scope of testing - occasional sample testing in the laboratory, statistical process control or 100% inspection of all parts with traceability
- Desired degree of automation

LEAK TESTING WITH AIR: MICRO-FLOW OR MASS EXTRACTION

Fast and reliable leak detection for packages and electronics as well as for industrial and medical applications

ATC by PFEIFFER VACUUM

Micro-Flow – The leading air leak testing technology

The Micro-Flow technology measures the volume flow through a leak. If gas leaks out of the part to be tested, the equipment maintains a dynamic pressure balance by replenishing the gas flow. This gas flow is passed through the sensor and measured. The patented geometry of the sensor amplifies the signal and allows the measurement of very low leakage rates up to $5 \cdot 10^{-4}$ mbar·l/s. The use of a buffer volume and the compensation of ambient temperature and pressure result in high robustness against changes in the ambient conditions.

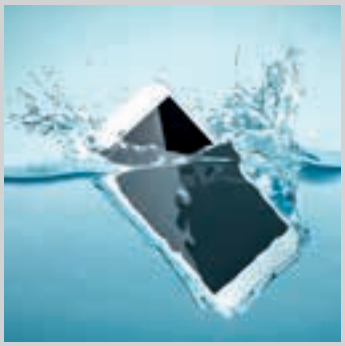
Mass Extraction – The leak test procedure under vacuum without tracer gas

The mass extraction method is carried out under vacuum. This results in an improved detection limit and thermal decoupling due to the vacuum's insulating effect. This type of test is particularly suitable for packaging of sealed objects such as encapsulated electronic assemblies. During the test, the test unit is placed in a vacuum chamber and the chamber is evacuated. The leakage rate of the test unit is determined by the flow from the test unit to the vacuum reservoir. With this method a detection limit of up to $7 \cdot 10^{-7}$ mbar·l/s can be achieved. In an alternative process of this measuring principle, the interior of the test unit is evacuated and the penetrating ambient air is measured. This method reduces the costs of the test equipment because it does not require a vacuum chamber.

Core competencies

The main benefits of the Micro-Flow and Mass Extraction technology compared to other air testing methods are the higher speed of the test and the lower sensitivity to environmental influences. In addition, they offer lower detection limits, higher accuracy and better reproducibility. Long calibration intervals of up to one year are another advantage of this non-destructive, quantitative method.

Application examples



IP protection class

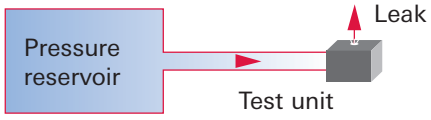
Air cooling

IV bag

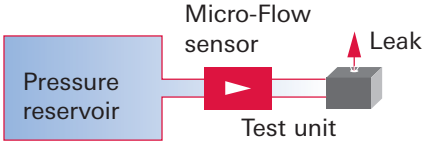
Product examples
For a more complete overview of our products, visit our website. www.atcinc.net

	Pressure or vacuum E-PDQ	Pressure – Micro-Flow E2	Vacuum – Mass Extraction ME3
			
Pressure/ vacuum range	0 to 4.5 bar	up to 12 bar	less than 69 mbar
Sensitivity	$5 \cdot 10^{-4}$ mbar·l/s (pressure) $5 \cdot 10^{-6}$ mbar·l/s (vacuum)	$2 \cdot 10^{-3}$ mbar·l/s (pressure) $2 \cdot 10^{-5}$ mbar·l/s (vacuum)	$7 \cdot 10^{-7}$ mbar·l/s (defect size 0.2 µm)
Dimensions (L x W x H) mm	102 x 159 x 254	305 x 305 x 305	172 x 283 x 565
Description	Tightness control for small parts in automated production systems with short cycle times.	High throughput leak test for medium-sized parts. Robust, industrial applications. Antiseptic and clean room applications.	Tightness control for medium-sized parts in automated production systems with short cycle times. Use of several instruments for inline testing. Suitable for hermetically-sealed packaging and equipment.
Typical applications	■ Consumer electronics ■ Medical equipment ■ Small packaging	■ Automotive industry ■ Refrigeration and air conditioning ■ Medical equipment	■ Packaging ■ IP protection class testing ■ Medical equipment ■ Sealed components

Micro-Flow

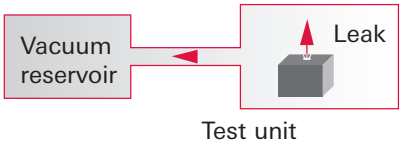


Air path: Pressure reservoir to test unit

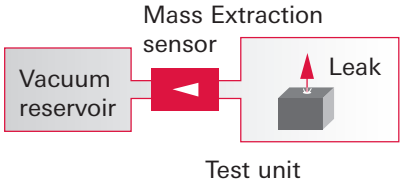


Measuring with Micro-Flow sensor:
Tracer gas flow (mostly air)

Mass Extraction



Air path: Test unit to vacuum reservoir



Measuring with Mass Extraction sensor
Extracted gas (mass)

Key advantages/ customer benefits

- Multi-standard approved test method (such as USP <1207>, pharmaceutical and SAE, automotive) ensures process safety
- Higher efficiency of the test procedure compared to pressure change methods thanks to 25% to 40% shorter test time
- Low sensitivity to environmental influences allows a higher test reliability
- Easy to use by factory calibration, no daily calibration required
- Insensitive to changes in product volume; a test recipe can be suitable for several parts with different volume

OPTICAL EMISSION SPECTROMETRY

Integrity test for highly sensitive drug packaging and advanced sealed components

The procedure

The AMI by Pfeiffer Vacuum is particularly suitable for pharmaceutical applications with its optical emission spectroscopy. Reliable integrity of primary packaging of pharmaceuticals is of paramount importance to ensure sterility and prevent the ingress of microbiological substances, oxygen or moisture.

No specific tracer gas is required for this patented procedure. Instead, the gas mixture present in the cavity of the packaging is used to perform highly sensitive tests over a wide dynamic range. The test method can be applied to various types of packaging, such as blister packs, bags, vials and plastic bottles. It can also be used to test sealed components such as battery enclosures.

Core competencies

Due to the large measuring range, the AMI can replace helium leak tests and gross leak tests in one system. This method provides an operator-independent, objective good/bad result and also allows the quantification of leak integrity testing. Traceable test leaks are used to validate and calibrate the device. Depending on the type of packaging, the AMI achieves a sensitivity of <1 µm, which corresponds to integrity class 1 according to USP <1207>.

The software solutions used for AMI comply with the Standard 21 CFR Part 11. Optional software solutions are available for a Manufacturing Execution System. Trend analyses can be implemented in the software to detect gradual deviations or slow drifts in production and packaging systems at an early stage.

With comprehensive test results and high accuracy and repeatability, the AMI is particularly well-suited for validation and stability testing, and for use in R&D laboratories.

AMI 1000

Application examples

Glass bottles | Syringes | Blister packs | IV bags | Glass bottles | Plastic bottles

Versatile and high performance technology for various applications

Specific test chambers are designed according product format.

Key advantages/ customer benefits

- Low detection limit and wide measuring range increase the efficiency compared to conventional methods
- Safety through user-independent and deterministic test results with high repeatability
- Easy to use due to automatic calibration based on traceable test leaks and good/bad results
- High flexibility - Applicable for various types of packaging such as blister packs, pouches, vials, plastic bottles and other components
- Cost efficiency due to rapid return on investment

LEAK DETECTION WITH TRACER GAS

Highest sensitivity for leak detection in high-end applications, for example, in the automotive, medical and semiconductor industry

The procedure

The leak detection with tracer gases – in particular, helium leak detection – is still the commercially used test method with the lowest detection limit on the market. In addition to its high sensitivity, the leak detection with tracer gas offers additional advantages. It is non-destructive, of high repeatability, conforming to a variety of standards and faster than other methods. Additionally, the tracer gas detection can locate the position of the leak.

Tracer gases

The most commonly used tracer gas for leak detection is helium; it offers the lowest detection limit. The environmentally-friendly noble gas offers maximum safety for users and test units due to its inertness and approved as an additive for food and pharmaceuticals. Hydrogen can be used as an alternative tracer gas. Although it is less expensive compared to helium, the same detection sensitivity cannot be achieved.

Key features

Pfeiffer Vacuum offers the largest portfolio of helium leak detectors on the market. The modern product line includes portable solutions, universally applicable devices, modular leak detectors and high-performance products with easy-to-use operator interfaces with color/touch displays and high connectivity.

Application examples

Pacemaker

Fuel tank

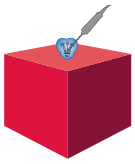
Accelerators

Product examples
For a more complete overview of our products, visit our website www.pfeiffer-vacuum.com

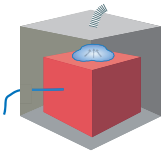
	Portable ASM 310	Multipurpose ASM 340	High performance ASM 390/392	Modular ASI 35
				
Smallest detectable leakage rate for He (vacuum test)	$5 \cdot 10^{-12}$ mbar·l/s	$5 \cdot 10^{-12}$ mbar·l/s	$1 \cdot 10^{-12}$ mbar·l/s	$5 \cdot 10^{-12}$ mbar·l/s[1)]
Smallest detectable leakage rate for He (sniffing)	$1 \cdot 10^{-7}$ mbar·l/s	$5 \cdot 10^{-9}$ mbar·l/s	$1 \cdot 10^{-8}$ mbar·l/s	$1 \cdot 10^{-8}$ mbar·l/s
Inlet test pressure max.	15 mbar	25 mbar	20 mbar	18 mbar[2)]
Pumping speed for He	1.1 l/s	2.5 l/s	ASM 390: 10 l/s ASM 392: 25 l/s	6 l/s[1)]
Dimensions (L x W x H) mm	350 x 245 x 414	393 x 547 x 375	1072 x 455 x 1025	Vacuum module: 279 × 264 × 197 Electronics module: 216 × 317 × 111
Description	Combination of light weight (21 kg) and exceptional performance	The best leak detector in its class for reliable testing in a variety of helium and hydrogen applications, various equipment available with backing pumps	Optimized mobile unit for fast evacuation and short response times for large test objects	Modular tracer gas leak detector - the best performance with helium and hydrogen for industrial leak detection systems
Typical applications	■ Semiconductor industry ■ Analytics and Research & Development ■ Industrial Applications ■ Power plants	■ Research & Development ■ Aeronautic and aerospace industry ■ Engineering ■ Refrigeration ■ Air conditioning	■ Semiconductor industry ■ Large-area coating ■ Solar industry ■ Gas panels or ultra-pure media supply	■ Automotive applications ■ Air conditioning & refrigeration technology ■ Packaging industry ■ Mechanical parts

[1)] Highly sensitive leak test mode
[2)] Gross leak test mode

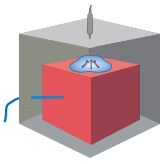
Gas flow from the object



Sniffing test

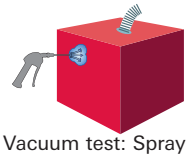


Integral vacuum test

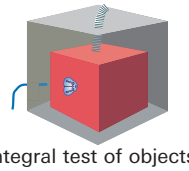


Sniffing test: Integral test at atmospheric pressure

Gas flow into the object



Vacuum test: Spray test



Integral test of objects, under vacuum

Key advantages/ customer benefits

- Helium leak detection has the lowest detection limit of all commercial test methods
- Additional advantages in terms of test time and accuracy
- Pfeiffer Vacuum has the most experience in tracer gas leak detection
- Modern and easy-to-use user interfaces
- Largest product portfolio of tracer gas leak detectors with the perfect solution for every challenge

VACUUM SOLUTIONS FROM A SINGLE SOURCE

Pfeiffer Vacuum stands for innovative and custom vacuum solutions worldwide, technological perfection, competent advice and reliable service.

COMPLETE RANGE OF PRODUCTS

From a single component to complex systems:
We are the only supplier of vacuum technology that provides a complete product portfolio.

COMPETENCE IN THEORY AND PRACTICE

Benefit from our know-how and our portfolio of training opportunities!
We support you with your plant layout and provide first-class on-site service worldwide.

Are you looking for a perfect vacuum solution? Please contact us:

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