BAM

Bundesanstalt für
Materialforschung
und -prüfung

Sicherheit in Technik und Chemie

LABORATORY LEAKAGE TESTING

FOCUS AREA
ENERGY

Task portfolio

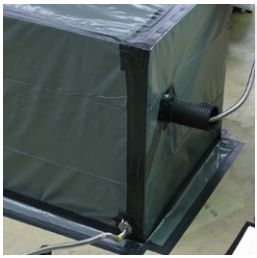
Leakage testing as a form of non-destructive testing is an essential part of fulfilling the requirements for the leak tight containment system of transport and storage containers for radioactive materials as well as capsuled radioactive materials. The leakage tests are not only used to determine a required leakage rate before and after mechanical or thermal tests, but also to localise leaks.

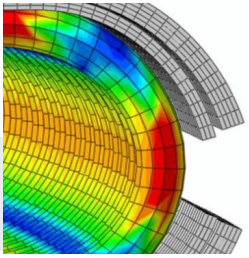
The leak test procedures are carried out according to the state of the art technology in accordance with relevant national and international standards. Depending on the detection limit different leakage test methods are used as overpressure or vacuum techniques: bubble test, pressure change test, sniffing test, bombing test and helium leakage test.

In principle, the leakage test methods are also available for the safety assessment of other technical systems or products. BAM‘s experts will help you to apply suitable methods or to carry out tests.

Application-oriented research at BAM expands the competence and understanding of leak tests and proofs of component safety. For example, metal and elastomer seals of containers and flanges are examined in respect of long-term aspects. This enables to describe the dependence of the material and component behaviour on the sealing properties under the influence of temperature and time.

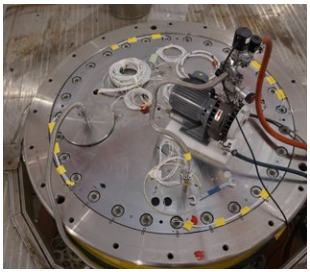
Overview

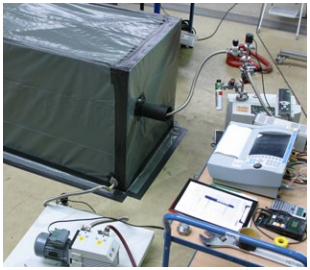


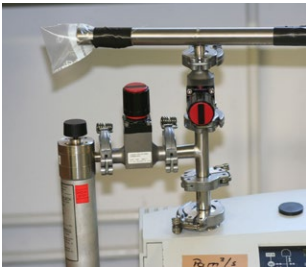


Helium leakage test

The helium leakage test is assigned to the vacuum methods. The test specimen is tested by means of different vacuum methods, integral, partial or local. In all cases, the test specimen is evacuated and connected to a leak detector.







In the integral method, the test specimen is completely capsuled (test chamber or gas-tight foil) and exposed to helium from the outside.

In the partial method, the areas to be tested on the test specimen are covered with gas-tight foil. The volume under the foil is filled with helium.

In the local method, the areas to be tested are sprayed with helium.

In all three cases, the helium penetrating through a leak is detected.

Minimum detectable leakage rate: 10^{-12} Pa m^3/s

Bombing test

The test sample is pressurised with helium (5-20 bar) in a pressure chamber for a defined time.

In the event of a possible leak, the helium can penetrate the test sample. After the pressurisation time has elapsed, the test specimen is removed from the pressure chamber, cleaned of the externally adhering helium with inert gas (nitrogen). Subsequently the helium leakage rate is determined in a vacuum chamber.

This test method is used for capsuled components without a test connection, such as sealed radioactive materials.

The helium pressure test is assigned to the overpressure methods.

Minimum detectable leakage rate: 10^{-6} to 10^{-9} Pa m^3/s

Bubble test

The bubble test methods belong to the overpressure methods and can be differentiated in the following:

Immersion techniques
In the immersion test, the test specimen is placed under increased pressure by means of air or nitrogen and is completely covered by a surface-relaxed liquid. In the event of a possible leak, the rising of gas bubbles can be observed. With the help of a measuring cylinder above the gas bubbles, these can be collected, and the leakage rate can be determined.

Bubble test with foaming mediums
As with the immersion method, the test sample is placed under increased pressure. Then the leakage points to be tested are wetted with a foam-forming liquid. Foam formation can be detected at the leaking points.

Vacuum bubble test by means of vacuum bell jar or test frame
The area of the test specimen to be tested is wetted with foam-forming agents. Then a vacuum of up to about 500 hPa is created by means of a vacuum bell jar. In case of a leak, air is sucked in under the vacuum bell jar due to the pressure difference and the applied foaming medium creates a foam fungus. This method can be used for unpressurized (open) objects.

Minimum detectable leakage rate: 10^{-3} to 10^{-7} Pa m^3/s

Pressure change test

Using the pressure decay method, the test sample is pressurised via a test port and then tightly sealed. A possible pressure drop is then measured over a certain time and a leakage rate is calculated from this. This method is one of the overpressure methods.

Detection limit: 10^{-6} Pa m^3/s

The pressure rise method is one of the vacuum methods. The test sample is evacuated via a test port and then tightly sealed. Afterwards, a possible pressure increase is measured over a certain time and a leakage rate is calculated from this.

Minimum detectable leakage rate: 10^{-5} Pa m^3/s

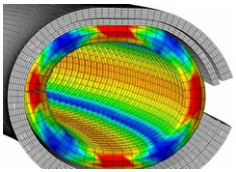
Sniffing test

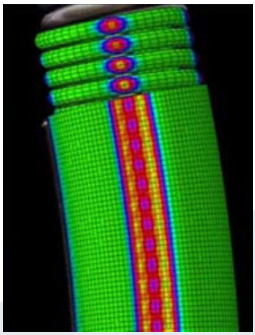
The sniffing test is one of the overpressure methods. The test sample is pressurised with helium via a test connection so that an overpressure is present. The sniffer probe which is connected to a leak detector can detect the helium escaping from a leak.

Minimum detectable leakage rate: 10^{-7} Pa m^3/s

Research topics

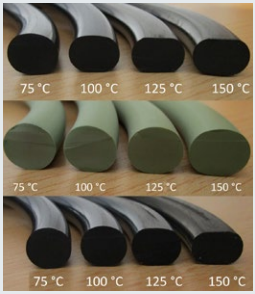
An essential criterion for transport and storage containers is the protection objective of a safe containment of the radioactive contents. This is largely determined by the long-term behaviour of the bolted lid sealing systems using metal and elastomer seals. Therefore, in addition to component testing the available testing technology is also used to carry out research work. One objective is to gain a more precise understanding of the time- and temperature-dependent sealing behaviour of elastomer and metal seals. The investigations cover both; component tests, in order to assess changes of the functionality, as well as material investigations to elucidate the underlying mechanisms and to enable numerical simulation. In addition, special testing devices are developed and used, e.g. for the partial unloading or the continuous force measurement for components are developed and used.





Particularly regarding potential interim container storage times of up to 100 years, the ageing behaviour and the lifetime assessment is one of our focus areas. An overview of our published findings can be found under the following link:

https://opus4.kobv.de/opus4-bam/home



Seals not only have a decisive function for packages of dangerous goods. The findings of our investigations can also be applied to other technical applications.

Quality management

Our testing personnel is certified according to DIN EN ISO 9712 and competent for leak detection up to level 3 (LT).

Our range of services extends over four business areas, which bundle our products of our organization:

- research and development,
- knowledge and technology transfer,
- scientific and technical services and
- sovereign and public services.

In performing our tasks, we pursue the goal of ensuring and developing safety in the fields of material technology and chemistry.

The order- and rule-compliant execution of our services is supported by a quality management system that contains the basic regulations of the organizational and technical infrastructure.

For our scientific and technical services, we meet the requirements of the ISO 17000 international series of standards. This concerns ISO/IEC 17025 for testing and calibration activities.

Our approval, certification and expert activities are based on international conventions, European directives and national law.

Our quality goals are the fulfilment of the requirements placed on our services, considering the demands of our customers and stakeholders from the fields of business, science, politics and society; ensuring the technical quality of our results and their national and international acceptance; the continuous improvement and optimization of our processes and the maintenance and development of the skills of our employees.

The complete BAM quality mission statement can be found under the following link:

www.bam.de/quality-mission-statement

Testing standards and committee work

Our testing personnel is involved in the further development of standards and norms for the application of leak testing procedures. In the standards committees our experience and knowledge of the state of the art in science and technology are continuously contributed.

Relevant standards

- DIN EN ISO 20484, Non-destructive testing - Leak testing - Vocabulary
- ISO 20485, Non-destructive testing - Leak testing - Tracer gas method
- DIN EN 13184, Non-destructive testing - Leak test - Pressure change method
- DIN EN 1593, Non-destructive testing - Leak test - Bubble test method
- ISO 9978, Radiation protection - Sealed sources - Leakage test methods
- DIN EN 1779, Non-destructive testing - Leak testing - Criteria for method and technique selection

Committees

- DIN Standards Committee NA062-08-26 AA „Leak test“
- DGZfP expert committee for leakage testing

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