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Non-destructive testing - Leak test - Guide to the selection of instrumentation for the measurement of gas leakage

Zerstörungsfreie Prüfung - Dichtheitsprüfung - Anleitung zur Auswahl von Geräten zur Messung von Gasleckagen

Essais non destructifs - Contrôle d'étanchéité - Guide pour la sélection des instruments utilisés pour le mesurage des fuites gazeuses

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 138 "Non-destructive testing", the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2002, and conflicting national standards shall be withdrawn at the latest by June 2002.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies criteria for the selection of equipment for the leak detection methods described in EN 1779. The minimum requirements for the performance of the instruments used are also given as a guideline for personnel involved in testing. The definite selection of an instrument for a given test is within the responsibility of a qualified operator (at minimum level 2 qualification – see EN 473).

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 1330-8, *Non-destructive testing – Terminology – Part 8: Terms used in leak tightness testing.*

EN 1779:1999, *Non-destructive testing – Leak testing – Criteria for method and technique selection.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1330-8 apply.

In this document the methods and techniques are referred to the annex A of the EN 1779:1999.

4 Tracer gas method - Group A techniques (gas flowing into object)

4.1 Equipment and Material required for all group A techniques

4.1.1 Leak detector

In this type of test, a leak detector (LD) of the mass spectrometer type (MSLD) according to the minimum requirements of Table 1 is used.

4.1.2 Calibration leaks

At least one calibration leak for discharge to vacuum or against atmospheric pressure shall be used. These are used for the direct calibration of the MLSD (if a built-in calibration leak does not exist) or for system calibration (response time, sensitivity). If required, standard leaks shall be used. See Table 2.

4.1.3 Auxiliary pumping system

An auxiliary pumping system should be used if:

— the object volume or desorption gas load are too large for the built-in pumps of the MSLD;

— the leakage rate to be measured is too large for the measurement range of the MSLD.

The auxiliary vacuum pumping system shall comply with the minimum requirements of Table 4.

4.1.4 Connections

Pipes and valves of suitable conductance with a port for vacuum pressure measurement, previously tested for tightness so that they can not influence the test results, are required for:

— connection of the object to the MSLD;

— connection of the calibration leak to the system;

— connection of the object to the auxiliary pumping system (if necessary).

There should be a device for discharging the tracer gas outside the test area.

4.1.5 Tracer gas

Pure tracer gas or a known and homogeneous mixture containing tracer gas shall be supplied to ensure repeatability.

4.1.6 Test condition measurements

Calibrated pressure gauges and thermometers are required to monitor the object conditions. If required, ambient condition (pressure, temperature and humidity) shall also be measured. Response time shall be measured.

4.1.7 Cleaning and drying material and equipment

Solvents or degreasing agents shall be available to clean the surfaces to be tested. Drying is important to eliminate vapours that can increase the evacuation time or can interfere with tracer gas detection.

4.2 Vacuum technique

4.2.1 Vacuum technique total (A.1)

4.2.1.1 Hood or rigid chamber

The hood can be fabricated from a plastic film that is able to enclose entirely the object. It should be leak-tight enough to keep the tracer gas concentration constant.

The rigid chamber shall be leaktight and enclose the object entirely. It should allow easy handling of the test object. It shall be evacuable to purge the internal volume. Suitable crossing in the walls shall allow the connections. The chamber pressure shall be measured.

NOTE The enclosure should present a leakage rate 10 times less than the maximum allowed rate specified.

4.2.1.2 Time measurement

If the test is performed using an accumulation technique, the time from the initial tracer gas application shall be measured.

4.2.2 Vacuum technique partial (A.2)

4.2.2.1 Cups or partial hoods

Parts of the outer surface of the object are covered to admit selectively the tracer gas to the areas under test. Cups shall have soft edges or gaskets to adhere as much as possible to the surface.

The plastic hoods shall be sealed, for example with adhesive tape. It should be leak-tight enough to keep the tracer gas concentration constant.

4.2.3 Vacuum technique (local) (A.3)

4.2.3.1 Spray gun

A spray gun with regulating valve is needed. If a tracer gas mixture is required for the test, the mixture can be obtained using a proportioning spray gun.

4.2.3.2 Calibration leak

A conductance leak, calibrated for discharge to vacuum shall be used to verify the response time and the signal amplitude at the scanning speed.

This calibration leak should be in the same range as the expected maximum leakage rate.

5 Tracer gas method - Group B techniques (gas flowing out of the object)

5.1 Equipment and materials required for all group B techniques

5.1.1 Leak detector

Except for the Ammonia Technique (B.1) a leak detector with recorder is required. The leak detector (except for bombing test) shall be able to sample at a relatively high pressure (20 kPa to 100 kPa). The MSLD shall have a regulating inlet valve or a sampling probe to adjust the inlet pressure to the maximum working pressure.

5.1.2 Calibration leaks

Calibration leaks for discharge to atmosphere shall be used. These leaks should have a leakage rate close to the maximum allowable in the case of acceptance test or close to the minimum rate in leak location.

5.1.3 Test condition measurements

Calibrated pressure gauges are required to monitor the object pressure. If necessary, overpressure protection devices shall be used to avoid damage to the object and danger to personnel. If required, the object temperature and ambient conditions (pressure, temperature and humidity) have also to be measured.

Response and impregnation time shall be measured.

5.1.4 Connections

Piping system, with port for pressure - and, if necessary, temperature-measurement, previously tested for leak tightness, is required for:

— filling the object with tracer gas;

— connecting (if necessary) any enclosure to the LD and to the pumping system.

Piping system is also required to discharge the tracer gas outside the area where the test is being conducted.

5.1.5 Gases

Pure tracer gas or a constant mixture containing tracer gas shall be supplied at the pressure required for the test.

Other dry (or dried) gases are necessary for purging the object or the enclosures.

5.2 Ammonia technique (B.1)

5.2.1 Chemical material

The reagents are generally colour-changing compounds, either in liquid form or supported on paper band. Their reactivity shall be verified before the test.

For preparation after cleaning, passivation using dilute nitric acid (a volume fraction of 5 %) is required. The application of the reagent is made using a spray gun or a brush. Warm, dry air or inert gas, is needed to dry the applied reagent. The paper band is fixed with adhesive tape.

The tracer gas shall be dry ammonia or a certified mixture of ammonia in inert gas, having a pressure and concentration sufficient to meet the test specifications.

5.2.2 Drying, pressurization, ammonia discharge

A suitable pumping system is necessary for drying after the cleaning-passivation, for pressurization with ammonia mixture and for the removal of tracer gas from the system.

5.2.3 Pressure and concentration control

An absolute gauge with a full scale range of 0,4 Mpa to 0,5 MPa is needed for evacuation/pressurization monitoring.

Ammonia concentration shall be checked using reactive tubes in the following ranges:

— concentration for test : range..... 1 % to 10 %

..... 10 % to 100 %;

— concentration after purging: range..... 5×10^{-6} to 500×10^{-6}

..... $0{,}05 \times 10^{-6}$ to 5×10^{-6}.

pH Indicating equipment is required to check the wastes before the discharge.

5.2.4 Ammonia disposal equipment

Equipment to discharge and treat used ammonia, in accordance with local regulations, shall be used.

5.2.5 Illumination and visual equipment

The reagent-covered surface shall be examined with white light, either directly or with instruments able to show spots larger than 1 mm. A minimum illumination of 350 lx shall be attained and measured.

5.3 Vacuum box technique, for large enclosures or open walls (B.2.1, B.2.2)

5.3.1 Vacuum box

The rigid vacuum box shall have a soft seal to adhere as effectively as possible to the object wall. The leak-tightness of this seal is very important to increase the test sensitivity and to minimize the inlet of contaminated air from the ambient.

5.3.2 Pumping system

The pumping system shall be able to achieve and maintain the vacuum box pressure at a specified level.

5.3.3 Cups or spray gun

For open objects the tracer gas is applied on the opposite side of the wall using cups, bags or a spray gun.

5.4 Enclosure techniques (B.3, B.6)

5.4.1 Tight enclosure

The enclosure can be a rigid chamber or a plastic bag, it shall entirely contain the object, and, allow for easy handling. For leakage rate measurement, the internal free volume shall be known and this is best achieved using a rigid chamber.

The tightness of the enclosure shall be previously verified. The maximum allowed leakage rate shall be related to the test sensitivity.

Suitable flange in the walls shall allow the connections of the chamber to the LD, to a known leak, to the pumping system and a suitable feed through may be needed to connect the object to the tracer gas supply. The chamber pressure shall be monitored.

NOTE The enclosure should have a leakage rate 10 times lower than the specified maximum allowable rate for the test object.

5.4.2 Time

The tracer gas accumulation time shall be measured.

5.4.3 Pumping system

A pumping system is used to evacuate the rigid chamber for purging. For sealed object that cannot support specific differential pressure, it shall be able to achieve and maintain the tight chamber pressure at the specified vacuum level.

5.5 Direct sample probing technique (B.4)

The sampling probe should be designed for industrial use, with a robust and flexible hose at least two meters long and exchangeable filters or similar devices to protect against clogging by dust and grease.

The probe tip should be compact enough to sniff leaks at positions difficult to access.

The sampling gas flow should be high enough for a response time in the order of seconds and low enough for a detection limit below 10^{-6} Pa·m^3/s.

The hose material should be appropriate for the tracer gas minimizing any memory effect.

5.6 Pressurizing-Evacuation technique (B.5)

5.6.1 Pressure vessel and tight chamber

A rigid, tight enclosure (or two separate ones) is needed for “bombing”, purging and detect the tracer gas. Suitable feed through in the walls shall allow the connections of the chamber to the LD, to a known leak, to the pumping system and to the tracer gas supply. The enclosure(s) shall be monitored for pressure, vacuum, and temperature.

5.6.2 Leak detector

The LD shall be a MSLD for vacuum test, with recorder.

5.6.3 Pumping system

The pumping system is used to evacuate the chamber for purging. It shall also be able to:

— evacuate the chamber in the time specified for the degassing step;

— maintain the tight chamber pressure at the specified level.

5.6.4 Reference object

This shall consist of a leak-tight sample of the same materials and with the same surface conditions as the test object used to establish the test parameters.

5.7 Sealed object by vacuum technique (B.6)

5.7.1 Tight chamber

The chamber must be rigid, clean and not contaminated by tracer gas. The empty chamber shall be tested before the test, performing a leak test cycle and the leak indication should be two orders of magnitude less than the required acceptance level for the leak test.

5.7.2 Tracer Leak Detector

The LD should be a MSLD for vacuum test, with recorder.

5.7.3 Vacuum pump

The pump shall be able to evacuate the chamber for a pressure lower than the maximum inlet pressure of the tracer gas detector.

6 Bubble test method - Group C techniques

6.1 Immersion technique (C.1)

6.1.1 Pressurization devices

Dry and filtered gas, from bottles or from a compressor, is required to pressurize the object to the specified level. Devices to prevent over pressurization shall be present to avoid damage to the object or risks to personnel performing the test.

6.1.2 Test liquid

A pool or a suitable container, the dimensions of which are sufficient to completely contain the object, is filled with a liquid, the suitability of which has been verified.

The test liquid shall:

— be transparent;

— not contain components detrimental to the object materials;

— not rapidly evaporate in the case of test carried out at elevated temperature or under reduced pressure;

— wet the object walls without formation of surface bubble.