SLOVENSKI STANDARD
SIST EN 13192:2002

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Neporuġitveno preskuġanje - Preskuġanje tesnosti - Umerjanje referenļ ne tesnosti za plin

Non destructive testing - Leak testing - Calibration of reference leaks for gases

Zerstörungsfreie Prüfung - Dichtheitsprüfung - Kalibrieren von Referenzlecks für Gase

Essais non destructifs - Contrôle d'étanchéité - Etalonnage des fuites de référence des gaz

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Non destructive testing - Leak testing - Calibration of reference leaks for gases

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Zerstörungsfreie Prüfung - Dichtheitsprüfung - Kalibrieren von Referenzlecks für Gase

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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of an identical text or by endorsement, at the latest by May 2002, and conflicting national standards shall be withdrawn at the latest by May 2002.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association. This European Standard is considered to be a supporting standard to those application and product standards which in themselves support an essential safety requirement of a New Approach Directive and which make normative reference to this European Standard.

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 draft European Standard specifies the calibration of those leaks that are used for the adjustment of leak detectors for the determination of leakage rate in everyday use. The preferred calibration method in this case is a comparison with a standard leak. In this way the leaks used for routine use become traceable to a primary standard as the ISO 9000 series of standards require.

The comparison procedures are preferably applicable to helium leaks, because this test gas can be selectively measured by a mass spectrometer leak detector (MSLD) (the definition of MLSD is given in EN 1330-8).

Calibration by comparison (see methods A and B below) with known standard leaks is easily possible for leaks with reservoir and leakage rates below 10^{-7} Pa·m^3/s.

From 10^{-7} Pa·m^3/s to 10^{-4} Pa·m^3/s no leaks reliable enough to be used as transfer standard exist. Leaks in this range can only be calibrated by measurement of flow in a calibrated capillary tube (see method C below).

Leakage rates greater than 10^{-4} Pa·m^3/s can be measured by flow meters calibrated against primary national standards.

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 13625, *Non-destructive testing - Leak test - Guide to the selection of instrumentation for the measurement of gas leakage.*

3 Terms and definitions

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

3.1
unknown leak
leak having a stable and repeatable leakage rate of known order of magnitude that can be determined by calibration

3.2
calibration of a reference leak
set of operations which establish, under specified conditions, the relationship between leakage rate values represented by an unknown leak and the corresponding known values of the leakage rate by general definition in: "International vocabulary of basic and general terms in metrology"

NOTE 1 In the case of calibration by comparison, the known values of the leakage rate are represented by a standard leak.

NOTE 2 Normally, the result of a calibration is given as the leakage rate value for the reference leak.

For proper usage of the different definitions of leakage rate, the following should be carefully considered:

In leak detection, leakage rates are commonly given in units of pV-throughput (Pa·m^3/s, mbar l/s). These are only a precise measure of gas flow if the temperature is given and kept constant.

Flow units such as mass flow (g/y) or molar flow (mol/s) are sometimes used to overcome this problem.

4 Classification of leaks

4.1 Permeation leak

This type of leak is normally made with a tracer gas reservoir. It has the best long-term stability but an appreciable temperature coefficient (approximately 3,5 %/K). Typical leakage rates are in the range from 10^{-10} Pa·m^3/s to 10^{-4} Pa·m^3/s.

4.2 Conductance leaks

4.2.1 Capillary leak

This type of leak is available with or without a tracer gas reservoir. It has a low temperature coefficient (approximately 0,3 %/K) but easily blocks if not handled with care. Typical leakage rates are greater than 10^{-7} Pa·m^3/s

4.2.2 Aperture leak (orifice)

Orifice leaks are seldom used in practice, as they are difficult to manufacture and even more prone to blocking than capillaries.

4.2.3 Compressed powder leak

This type of leak uses metal powder compressed into a tube. They are usually offered without reservoir. They are used for routine check of the sensitivity of leak detectors but they are not stable enough to be used as calibration leaks.

5 Apparatus

5.1 Mass Spectrometer Leak Detector (MSLD), for methods A and B (see clause 6)

To calibrate a leak by comparison to a known standard according to methods A and B described in clause 6, a mass spectrometer leak detector is necessary as the transfer device. Such a leak detector shall fulfil the minimum requirements for the measurement of leakage rate, laid down in EN 13625.

The test port of the leak detector shall be equipped with an inlet system consisting of a set of ports with valves (preferably all metal) to couple the standard leak and the unknown leaks to the detection system and to shut off the leaks individually.

The leak tightness of the inlet system shall be checked to a suitable level before a calibration is performed so that ambient tracer (e.g. helium of ambient atmospheric air) will not affect the measurement.

5.2 Capillary measurement tube equipment for method C (see clause 7)

To calibrate a leak by measurement of capillary flow according to method C described in clause 7, a calibrated glass capillary tube (preferably with a suitable vent valve at one end, see Figure1) is necessary.

An indicator fluid (normally water with some surfactant added or special oils) is used to produce the measurement slug in the capillary.

To measure the time of slug movement, a timer or stopwatch will be needed. Instruments based on the timed movements of a film in a tube are also available, e.g. a bubble flow meter.

As conductance leaks normally have no tracer gas reservoir, a separate tracer gas supply is needed or calibration may be performed with filtered atmospheric air.

6 Calibration by comparison (methods A and B)

There are two ways of calibrating leaks by comparison with known standard leaks. Both methods require the knowledge of the order of magnitude of the leakage rate to be measured. The methods differ in using one or two standard leaks, resulting in different uncertainties of measurement. In the following, the two methods are designated as A and B:

Method A: Comparison to one standard leak normally with a leakage rate of the same order of magnitude

Method B: Comparison to two standard leaks with leakage rates normally lying on either side of the unknown leakage rate

Method A is most suitable for use on site as only one standard leak is used. It is generally applicable but is most reliable when the leakage rate of the unknown is close to that of the standard leak. This is because the measurement uncertainty is directly dependent on the linearity of the leak detector in use. (See 8.1.2.2). As the linearity error cannot be measured independently, it has to be estimated. To keep the linearity error small, the operating characteristics of leak detector should not change during calibration (e.g. automatic ranging should be disabled).

For more precise calibrations, where a definite measure of uncertainty is required or if a standard leak with a leakage rate close to the unknown is not available method B should be used. By the use of two reference leaks, the non-linearity of the leak detector is accounted for (see 8.1.2.3).

6.1 Preparation of leaks and apparatus

6.1.1 Warm-up of leak detector

The leak detector used as a transfer device shall be set up according to the manufacturer's manual. The warm-up time shall be at least 2 h.

6.1.2 Temperature accommodation

The unknown leak and the standard leak(s) for the comparison shall be stored in the same room where the test is to be carried out for at least 12 h to allow for temperature equilibration (an air-conditioned room is not necessary if there are no rapid temperature changes. Because of temperature fluctuations, an air-conditioning system can even increase the measurement uncertainty). The leaks shall be pumped out during the phase of thermal accommodation. After temperature accommodation, to prevent any temperature changes during measurement, thermally insulating hoods (made of plastic foam or similar material) should be put over the leaks.

6.1.3 Connection to the leak detector

The standard and unknown leaks are connected to the inlet system of the MSLD after temperature accommodation and pumped with their valves (if any) open for at least 30 min to remove any tracer gas that may have accumulated in seals or valves. For the calibration of more than one leak, a separate pumping system and set of valves is useful to keep all the leaks pumped until they are measured.

6.2 Measurement

6.2.1 Set-up

The leak detector is adjusted so that the major of the used leaks gives approximately a full-scale indication. It is important to ensure that the effective pumping speed is not changed during the measurements. If possible, either with the leak detector or in an auxiliary device a long averaging time may be used to decrease the statistical measurement uncertainty. Further a recorder taking data over some time can be used for that purpose. All those measurement instruments should be used in such a way that they give nearly full-scale deflections for the biggest leak.

6.2.2 General measurement sequence

Generally, each reading shall be obtained under steady flow conditions constant signal from the MLSD. A sufficient number of readings have to be taken to achieve the lowest possible statistical uncertainty. For this purpose, digital

meters may be used and a large number of measurements obtained. In this way a measure of statistic deviation can also be found. The general sequence of measurements is as follows:

a) zero signal determination: all valves closed;

b) open standard leak n°. 1, wait for steady flow and measure the resulting output signal (method A and B);

c) close standard leak n° 1;

d) open standard leak n° 2, wait for steady flow and measure the resulting output signal (only method B);

e) close standard leak n° 2;

f) open unknown leaks, wait for steady flow and measure the resulting output signal;

g) repeat a) to f) at least three times.

NOTE The leak valves should be kept closed for as short a time as possible to prevent extensive helium accumulation resulting in long equilibration time.

7 Calibration by direct flow measurement (method C)

This method is only applicable to conductance leaks in the range of 10^{-6} Pa·m^3/s and greater. Leaks from 10^{-7} Pa·m^3/s to 10^{-6} Pa·m^3/s can be calibrated, but with a rather large uncertainty. In that range, if a suitable reference leak is available, methods A or B should be employed to give lower uncertainty. Leakage rates greater than 10^{-4} Pa m3/s should be measured with flow meters traceable to a National Standard.

Two types of flow conditions that may be considered are those established by gas flow:

- from over-pressure to atmosphere (see 7.2.1);
- from atmosphere to vacuum (see 7.2.2).

In both cases one has to consider whether air or a specific tracer gas has to be used. The third possible flow condition, pressure to vacuum, cannot be measured with method C (if this is required, a calibration with tracer gas and atmospheric pressure against vacuum has to be made initially and afterwards the pressure dependence shall be measured with a suitable MSLD).

7.1 Preparation of leaks and apparatus

7.1.1 Temperature accommodation

The unknown leak and the calibrated capillary shall be stored in the room where the test is to be carried out for at least 12 h to allow for temperature equilibration (an air-conditioned room is not necessary if there are no rapid temperature changes. Because of temperature oscillations, an air-conditioning system can even increase the measurement uncertainty).

7.1.2 Connection of leak to capillary tube

The capillary tube and vent valve shall be cleaned with alcohol and purged with pressurised air to remove any dirt from the surfaces that might disturb the free movement of the liquid slug during measurement. The connection between the leak and the capillary tube shall be made with a thick elastomer connecting hose fitting tightly on both the leak outlet and the vent valve of the capillary. The smaller the unknown leak the more important is it to keep all dead volumes as small as possible to reduce measurement errors.

7.1.2.1 Pressure to atmosphere

In this case, the leak inlet is connected to the tracer gas supply and the outlet to that end of the capillary tube where the vent valve is. The capillary tube is open to atmosphere at the other end (see Figure 1).