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BSI Standards Publication

Respiratory protective devices - Methods of test

Part 7: Determination of particle filter penetration

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Contents

Page

European foreword

This document (EN 13274-7:2019) has been prepared by Technical Committee CEN/TC 79 “Respiratory protection devices”, the secretariat of which is held by DIN.

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text or by endorsement, at the latest by month year of December 2019, and conflicting national standards shall be withdrawn at the latest by month year of December 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13274-7:2008.

The following main technical changes have been made compared to EN 13274-7:2008:

a) reference to EN 13274-5 in storage test (5.5) deleted;

b) test equipment for sodium chloride test and test conditions clarified and summarized in one subclause;

c) procedure for sodium chloride test revised;

d) calculation of the penetration for sodium chloride revised;

e) test equipment for paraffin oil test and test conditions clarified and summarized in one subclause:

f) procedure for paraffin oil test revised;

g) figures adapted to the changes made in the test procedures, where appropriate.

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Introduction

This document is intended as a supplement to the specific device standards for respiratory protective devices. Test methods are specified for complete or parts of devices. If deviations from the test method given in this document are necessary, these deviations will be specified in the relevant device standard.

1 Scope

This document specifies the procedure for testing particle filter penetration for respiratory protective devices.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 132, *Respiratory protective devices — Definitions of terms and pictograms*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 132 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

• IEC Electropedia: available at http://www.electropedia.org/

• ISO Online browsing platform: available at http://www.iso.org/obp

4 Pre-requisites

In order to implement this document, at least the following parameters need to be specified in the appropriate device standard:

— items to be tested;

— number of samples;

— test method(s);

— flow rate through the filter;

— sequence of conditioning phases, where more than one is required;

— specification of any observations to be carried out;

— sample preparation and orientation;

— sample holding;

— in the case of the exposure test, the specified mass of test aerosol;

— pass/fail criteria;

— any deviations from this method.

5 Test requirements

5.1 General

Two test aerosols are used for measurement of filter penetration:

a) Sodium Chloride, using the equipment specified in Clause 6;

b) Paraffin Oil, using the equipment specified in Clause 7.

The test aerosol is fed into the test chamber, where the particle filtering device under test is mounted in a leaktight manner on a suitable adaptor. Aerosol is passed through the device and the aerosol concentration is measured immediately before and after the particle filtering device by the photometer.

Laboratories should give consideration to the following factors.

— Test chamber should be designed to minimize air velocity variations across the surface of the filter under test.

— Localized high air velocity ("jets") can result in artificially high filter penetration.

5.2 Nominal values and tolerances

Unless otherwise specified, the values stated in this European Standard are expressed as nominal values. Except for temperature limits, values which are not stated as maxima or minima shall be subject to a tolerance of ±5 %. Unless otherwise specified the ambient temperature for testing shall be in the range between 16 °C and 32 °C with a relative humidity of (50 ± 30) % and the temperature limits shall be subject to an accuracy of ±1 °C.

For each of the required measurements performed in accordance with this standard, a corresponding estimate of the uncertainty of measurement should be evaluated [1].

This estimate of uncertainty should be applied and stated when reporting test results, in order to enable the user of the test report to assess the reliability of the result.

5.3 Penetration test

The measurement of penetration, in accordance with 5.1, shall be taken as the average over a time of $\begin{pmatrix} 30 \, ^{+3}_{0} \end{pmatrix}$ s, beginning 3 min after the start of the test.

5.4 Exposure test

Penetration shall be recorded throughout the test at sample intervals not exceeding 5 min.

Continuous recording of penetration is recommended.

For particle filtering devices being tested using paraffin oil, continue the test until the particle filtering device has been exposed to the specified mass of the test aerosol as defined in the appropriate device standard.

For particle filtering devices being tested using sodium chloride, continue the test until the particle filtering device has been exposed to the specified mass of the test aerosol as defined in the appropriate device standard, unless:

a) for single shift use particle filtering devices, the penetration shows continued decline for 5 min or 5 sample intervals, whichever is the greater;

b) for re-useable particle filtering devices, the penetration shows continued decline for 5 min or 5 sample intervals, whichever is the greater, and the maximum penetration is lower than when tested using paraffin oil test aerosol.

If these conditions are met, the exposure test may be terminated early.

Report the maximum penetration during exposure.

5.5 Storage test

For re-useable particle filtering devices the storage test shall be performed immediately after the completion of the exposure test.

Remove the particle filtering device from the penetration test chamber and store the particle filtering device for a duration of (24 ± 1) h under ambient conditions as specified in 5.2, ensuring that particle filtering devices are not in contact with each other.

The particle filtering device shall not be removed from the suitable adaptor if this can result in damage to the device.

After storage, immediately repeat the penetration test in accordance with 5.3.

6 Sodium chloride test method

6.1 Principle

An aerosol of sodium chloride particles is generated by atomising an aqueous solution of the salt and evaporating the water. The concentration of this aerosol is measured before and after the filter under test by means of flame photometry. Determinations shall be possible in the range < 0,001 % to 100 % filter penetration.

6.2 Test equipment

The apparatus is shown schematically in Figure 1. The test apparatus consists of four modules:

1) sodium chloride aerosol generator;

2) flow control;

3) filter test chamber;

4) flame photometer aerosol detector.

The test aerosol produced by the generator is polydisperse and shall have the following properties:

— the number median of the particle size distribution is between a diameter of 0,06 µm and 0,10 µm with a geometric standard deviation between 2,0 and 3,0;

— the aerosol concentration is within the range 4 mg/ m^3 to 12 mg/m^3;

— the variation of the concentration over a period of 5 min is not greater than ± 3 % and is not greater than ±10 % during the exposure test;

— the relative humidity is 40 % or less at (22 ± 3) °C.

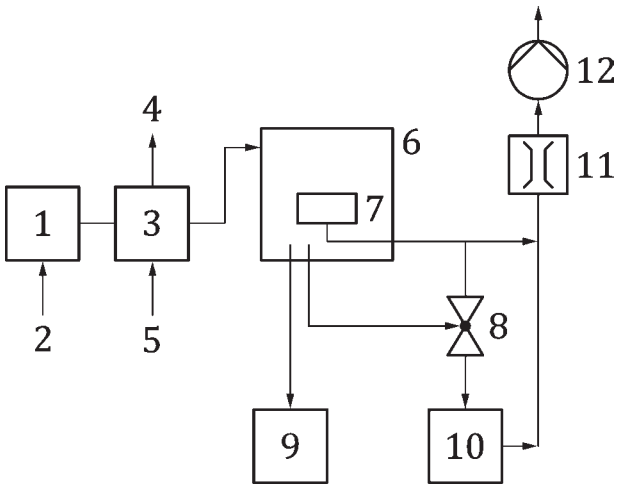
The aerosol mass concentration, particle size distribution and humidity shall be measured within the filter test chamber.

It is recommended that an electrical mobility method be used to determine the particle size distribution. Additional information on electrical mobility measurements can be found in ISO 15900.

The sodium chloride solution shall be completely replaced and not replenished in order to maintain the correct solution concentration.

The sodium chloride aerosol is detected before and after the filtering device under test by flame photometry. Sodium chloride particles in air passing through the flame tube are vaporized giving the characteristic sodium emission at 589 nm. The intensity of this emission is proportional to the concentration of sodium in the air flow.

The photometer used for this analysis can be any suitable instrument having the required sensitivity.



Key

1 sodium chloride aerosol generator
2 compressed air supply
3 flow control module
4 air bleed (test flows less than the output of the generator)
5 make-up air (test flows greater than the output of the generator)
6 filter test chamber
7 filter under test
8 two-way sample selection valve
9 second aerosol flame photometer (optional)
10 aerosol flame photometer
11 flow meter
12 suction pump

Figure 1 — Schematic example of sodium chloride aerosol test apparatus

6.3 Procedure

The test aerosol is fed into the test chamber, where the filter under test is fixed. The specified flow is passed through the filter and the aerosol concentration is measured immediately before and after the filter by the photometer at each determination of filter penetration.

Where the specified test flow is less than that supplied by the generator, a bleed shall be incorporated to reduce the flow through the filter to the required rate.

Where the specified test flow through the filter is greater than that supplied by the generator, a supply of clean air of less than 40 % relative humidity shall be added to the output of the aerosol generator so as to obtain the required flow rate. The air shall be added prior to the test chamber so as to ensure a homogeneous aerosol concentration within the test chamber. This procedure will also have the effect of reducing the aerosol concentration before the filter which shall be taken into account when calculating the filter penetration in accordance with 6.4, [Formula (1)].

6.4 Calculation of the penetration

$$P(\%) = \frac{C_2 - C_0}{C_1 - C_0} \times 100 \quad (1)$$

Where

P is the penetration;
C_1 is the sodium chloride aerosol concentration in front of the filter;
C_2 is the sodium chloride aerosol concentration behind the filter;
C_0 is the sodium chloride aerosol photometer reading for clean air.

7 Paraffin oil test method

7.1 Principle

An aerosol of paraffin oil droplets is generated by atomising paraffin oil (paraffinum perliquidum). The concentration of this aerosol is measured before and after the filter under test by means of a light scattering aerosol photometer. Determinations shall be possible in the range < 0,001 % to 100 % filter penetration.

7.2 Test equipment

The apparatus is shown schematically in Figure 2. The test apparatus consists of four modules:

1) paraffin oil mist aerosol generator;
2) flow control;
3) filter test chamber;
4) scattered light aerosol detector.

The paraffin oil characteristics at 20 °C shall be:

— CAS number: 8012-95-1;
— density: 0,818 g/cm^3 to 0,875 g/cm^3;
— dynamic viscosity: 0,025 Pa·s to 0,080 Pa·s; [kinematic viscosity: < 35 mm^2/s (at 40 °C: 13,5 mm^2/s to 16,5 mm^2/s)].

Laboratories shall consider the following:

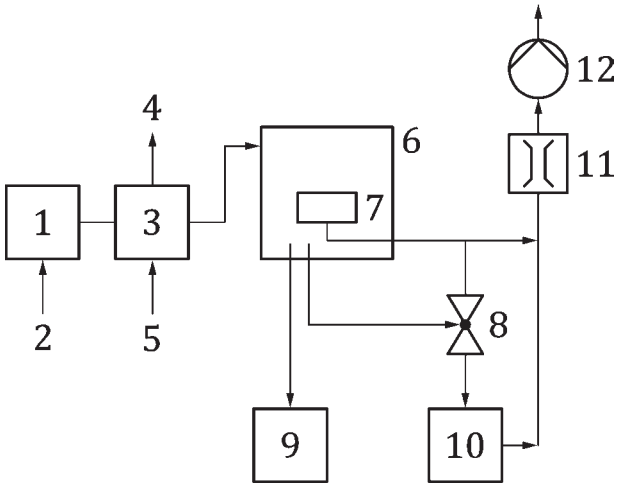
— paraffin oil in the test rig shall be replaced with fresh oil every three months irrespective of use, or more frequently if exposed continuously to heating and compressed air; or
— where the generator requires the oil to be heated, it is recommended not to heat the oil above 60 °C.

The test aerosol produced by the generator is polydisperse and shall have the following properties:

— the number median of particle size distribution is between 0,29 µm and 0,45 µm diameter, with a geometric standard deviation between 1,6 and 2,2;
— the aerosol concentration is within the range 15 mg/m^3 to 25 mg/m^3;
— the variation of the concentration over a period of 5 min is not greater than ±3 % and is not greater than ±10 % during the exposure test;

The aerosol mass concentration and particle size distribution shall be measured within the filter test chamber.

It is recommended that an electrical mobility method be used to determine the particle size distribution. Additional information on electrical mobility measurements can be found in ISO 15900.



Key

1 paraffin oil mist aerosol generator
2 compressed air supply
3 flow control module
4 air bleed (test flows less than the output of the generator)
5 make-up air (test flows greater than the output of the generator)
6 filter test chamber
7 filter under test
8 two-way sample selection valve
9 second aerosol flame photometer (optional)
10 scattered light aerosol photometer
11 flow meter
12 suction pump

Figure 2 — Schematic example of paraffin oil mist test apparatus

7.3 Procedure

The test aerosol is fed into the test chamber, where the filter under test is fixed.

Where the specified test flow through the filter is less than the output of the generator, the aerosol is passed through the filter at the specified volume flow rate, by means of a suitable pump. The aerosol concentration is measured immediately before and after the filter by the aerosol photometer at each determination of filter penetration.

Where the specified test flow through the filter is greater than that supplied by the generator, a supply of clean air shall be added prior to the test chamber so as to obtain in excess of the required flow rate. The air shall be added prior to the test chamber so as to ensure a homogeneous aerosol concentration within the test chamber. Care shall be taken that the addition of extra air does not significantly change the aerosol particle size distribution.

This procedure will also have the effect of reducing the aerosol concentration before the filter which shall be taken into account when calculating the filter penetration in accordance with 7.4, [Formula (2)].

7.4 Calculation of the penetration

$$P(\%) = \frac{I_2 - I_0}{I_1 - I_0} \times 100 \quad (2)$$

Where

P is the penetration;
I_1 is the photometer reading in front of the filter;
I_2 is the photometer reading behind the filter;
I_0 is the photometer zero reading for clean air.

Bibliography

[1] JCGM 100[1)], *Evaluation of measurement data — Guide to the expression of uncertainty in measurement*

[2] ISO 15900, *Determination of particle size distribution — Differential electrical mobility analysis for aerosol particles.*

1) available at: http://www.bipm.org/en/publications/guides/gum.html

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