SLOVENSKI STANDARD
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High efficiency air filters (HEPA and ULPA) - Part 1: Classification, performance testing, marking

High efficiency air filters (HEPA and ULPA) - Part 1: Classification, performance testing, marking

Schwebstofffilter (HEPA und ULPA) - Teil 1: Klassifikation, Leistungsprüfung, Kennzeichnung

Filtres a air a tres haute efficacité et filtres a air a tres faible pénétration (HEPA et ULPA) - Partie 1: Classification, essais de performance et marquage

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Descriptors: air filters, cleaning equipment for gases, ventilation, air conditioning, definitions, classifications, specifications, tests, aerosols, test conditions, effectiveness

English version

High efficiency air filters (HEPA and ULPA) - Part 1: Classification, performance testing, marking

Filtres à air à très haute efficacité et filtres à air à très faible pénétration (HEPA et ULPA) - Partie 1: Classification, essais de performance et marquage

Schwebstoffilter (HEPA und ULPA) - Teil 1: Klassifikation, Leistungsprüfung, Kennzeichnung

This European Standard was approved by CEN on 6 March 1998.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 195 "Air filters for general air cleaning", the secretariat of which is held by DIN.

It is dealing with the performance testing of high efficiency particulate air filters (HEPA) and ultra low penetration air filters (ULPA).

The complete European Standard "High efficiency air filters (HEPA and ULPA) will consist of the following parts:

Part 1	Classification, general principles of testing, marking
Part 2	Aerosol production, measuring equipment, particle counting statistics
Part 3	Testing flat sheet filter media
Part 4	Determining leakage of filter elements (Scan method)
Part 5	Determining the efficiency of filter elements

As decided by CEN/TC 195, this European Standard is based on particle counting methods which actually cover most needs of different applications. The difference between this European Standard and previous national standards lies in the technique used for the determination of the overall efficiency. Instead of mass relationships, this new technique is based on particle counting at the most penetrating particle size (MPPS; range: 0,15 to 0,30 µm). It also allows ultra low penetration air filters to be tested, which is not possible with the previous test methods because of their inadequate sensitivity.

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 October 1998, and conflicting national standards shall be withdrawn at the latest by October 1998.

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 applies to high efficiency particulate and ultra low penetration air filters (HEPA and ULPA) used in the field of ventilation and air conditioning and for technical processes,e.g. for clean room technology or applications in the nuclear and pharmaceutical industry.

It establishes a procedure for the determination of the efficiency on the basis of a particle counting method using a liquid test aerosol, and allows a standardized classification of these filters in terms of their efficiency.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. Theses 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.

EN 1822-2	High efficiency air filters (HEPA and ULPA) - Part 2: Aerosol production, measuring equipment, particle counting statistics
EN 1882-3	High efficiency air filters (HEPA and ULPA) - Part 3: Testing flat sheet filter media
prEN 1882-4	High efficiency air filters (HEPA and ULPA) - Part 4: Determining leakage of filter elements (Scan method)
prEN 1882-5	High efficiency air filters (HEPA and ULPA) - Part 5: Determining the efficiency of filter elements
EN ISO 5167-1	Measurement of fluid flow by means of pressure differential device - Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full (ISO 5167-1:1991)

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of this standard, the following definitions apply:

3.1.1 Filter medium

Flat sheet filter material, unfolded.

3.1.2 Folded pack

A pack of the filter medium formed by uniform individual folds.

3.1.3 Filter element (filter)

A folded pack enclosed by a frame.

3.1.4 Penetration

The ratio of the particle number concentration downstream of the filter to the concentration upstream.

3.1.5 Efficiency
The ratio of the number of particles held back by the filter to the number of the particles impinging on the filter.

3.1.6 Particle size efficiency
The efficiency for a specific particle diameter. The efficiency plotted as a function of the particle diameter gives the efficiency curve.

3.1.7 Minimum filter efficiency
The minimum of the efficiency curve under given operating conditions of the filter (see 3.1.24).

3.1.8 Overall efficiency
The efficiency, averaged over the whole superficial face area of a filter element under given operating conditions of the filter.

3.1.9 Local efficiency
The efficiency at a specific point of the filter element under given operating conditions of the filter.

3.1.10 Nominal air volume flow rate
The air volume flow rate for which the filter element to be tested is specified.

3.1.11 Filter face area
The cross-sectional area of the filter element including the frame.

3.1.12 Superficial face area
The cross-sectional area of the filter element which is passed by the air flow.

3.1.13 Effective filter medium area
The effective cross-sectional area of the filter medium in the filter element (without adhesive areas, struts etc) which is passed by the air flow.

3.1.14 Nominal filter medium face velocity
The nominal air volume flow rate divided by the effective filter medium area.

3.1.15 Leak
A point in the filter element at which the local efficiency falls below a given limit value.

3.1.16 Particle number concentration
The number of particles per unit volume of the carrier gas (air).

3.1.17 Counting rate
The number of counting events per unit time.

3.1.18 Particle size
The geometrical diameter of the particles of the test aerosol.

3.1.19 Mean particle diameter
Median value of the particle number distribution of the test aerosol.

3.1.20 Monodisperse

An aerosol is referred to as monodisperse when the width of its distribution function, described by the geometric standard deviation, is less than σ_g = 1,15. Aerosols whose distribution has a geometric standard deviation between σ_g = 1,15 and σ_g = 1,5 are referred to as quasi - monodisperse.

3.1.21 Polydisperse

An aerosol is referred to as polydisperse if its distribution shows a geometric standard deviation of $\sigma_g > 1,5$.

3.1.22 HEPA filter

High efficiency particulate air filter, classes H 10 to H 14 (see table 1).

3.1.23 ULPA filter

Ultra low penetration air filter, classes U 15 to U 17 (see table 1).

3.1.24 Most penetrating particle size (MPPS)

The particle size at which the minimum of the particle size efficiency curve occurs (see 3.1.7).

3.2 Symbols and abbreviations

For the purposes of this standard, the following sybols and abbreviations apply:

d_p	Particle diameter
E	Efficiency
P	Penetration
p	Pressure
RH	Relative humidity
T	Temperature
σ_g	Geometric standard deviation
CNC	Condensation nucleus counter
DEHS	Sebacic acid-bis (2 ethyl hexyl-) ester (trivial name: di-ethyl-hexyl-sebacate)
DMA	Differential electric mobility analyser
DMPS	Differential mobility particle sizer
DOP	Phthalic acid-bis (2-ethyl hexyl-) ester (trivial name: di-octyl-phthalate)
MPPS	Most penetrating particle size
OPC	Optical particle counter

4 Classification

Filter elements are classified in groups and classes according to their filtration performance (efficiency or penetration).

4.1 Groups of filters

According to this standard, filter elements fall into one of the following groups :

- group H : HEPA filters;
- group U : ULPA filters.

4.2 Classes of filters

Filter elements of group H and U are classified according to their performance (see 5.5).

Group H filters are subdivided in five classes:

- H 10

- H 11
- H 12
- H 13
- H 14

Group U filters are subdivided in three classes :

- U 15
- U 16
- U 17

5 Requirements

5.1 General

The filter element shall be designed or marked so as to prevent incorrect mounting.

The filter element shall be designed so that when correctly mounted in the ventilation duct, no leak occurs at the sealing edge.

If, for any reason, dimensions do not allow testing of a filter under standard test conditions, assembly of two or more filters of the same type or model is permitted, provided no leaks occur in the resulting filter.

5.2 Material

The filter element shall be made of suitable material to withstand normal usage and exposures to those temperatures, humidities and corrosive environments that are likely to be encountered.

The filter element shall be designed so that it will withstand mechanical constraints that are likely to be encountered during normal use.

Dust or fibres released from the filter media by the air flow through the filter element shall not constitute a hazard or nuisance for the people (or devices) exposed to filtered air.

5.3 Nominal air volume flow rate

The filter element shall be tested at its nominal air volume flow rate for which the filter has been designed by the manufacturer.

5.4 Pressure difference

The pressure difference across the filter element is recorded at the nominal air volume flow rate.

5.5 Filtration performance

The filtration performance is expressed by the efficiency or penetration.

After testing in accordance with clause 6, filter elements are classified according to table 1.

Table 1: Classification of HEPA and ULPA filters

Filter class	Overall value		Local value[1)2)]	
	Efficiency (%)	Penetration (%)	Efficiency (%)	Penetration (%)
H 10	85	15	---	---
H 11	95	5	---	---
H 12	99,5	0,5	---	---
H 13	99,95	0,05	99,75	0,25
H 14	99,995	0,005	99,975	0,025
U 15	99,999 5	0,000 5	99,997 5	0,002 5
U 16	99,999 95	0,000 05	99,999 75	0,000 25
U 17	99,999 995	0,000 005	99,999 9	0,000 1

1) see 6.5.2 and prEN 1822-4
2) local values lower than those given in the table may be agreed between supplier and purchaser

6 Test methods

6.1 Test rigs

The test rigs are described in detail in EN 1822-3, prEN 1822-4 and prEN 1822-5. The individual methods of measurement and the measuring instruments are described in EN 1822-2.

6.2 Test conditions

The air in the test channel used for testing shall comply with the following requirements :

Temperature: 23 °C ± 5 °C
Relative humidity < 75%

The temperature and relative humidity shall remain constant over a longer period of time.

The cleanliness of the test air shall be ensured by appropriate pre-filtering, so that in operation without addition of aerosol the particle number concentration measured with the particle counting method is less than 350 000 m^{-3}. The test specimen shall have the same temperature as the test air.

6.3 Test aerosols

For the testing of HEPA and ULPA filters in accordance with this standard, a liquid particle test aerosol shall be used. Possible substances include but are not limited to DEHS, DOP, Paraffin oil (low viscosity). For further details see 4.1 of EN 1822-2:1998.

> NOTE: The use of alternative materials for challenge aerosols may also be agreed between supplier and purchaser when the materials specified in this standard are unacceptable.

The concentration and the size distribution of the aerosol shall be constant over time. For the leakage testing and the efficiency test of the filter element the mean particle diameter of the test aerosol shall correspond to the most penetrating particle size (MPPS) for the filter medium.

6.4 Survey of test procedures

The complete testing procedure for HEPA and ULPA filters in accordance with this standard consists of three steps, each of which may be implemented as an independent test.

6.4.1 Step 1

Firstly the efficiency of test samples of the filter medium shall be determined for a range of particle sizes at the nominal filter medium velocity. From the efficiency vs particle size curve the most penetrating particle size (MPPS) shall be determined, for which the filtration efficiency of the filter medium is at a minimum.
See 6.5.1.

6.4.2 Step 2

The filter element is tested at nominal air volume flow rate for freedom from leaks using a test aerosol with a mean particle size which corresponds to the MPPS.
See 6.5.2.

6.4.3 Step 3

Using the same test aerosol, again at the nominal air volume flow rate, the overall efficiency of the filter element is determined.
See 6.5.3.

6.4.4 On the basis of the values determined for the local efficiency (leakage test) and the overall efficiency, the filter can be assigned to a filter class as specified in 5.5. This assignment is only valid if the fixed test conditions are met.

In all three procedural steps it is permissible to use either a monodisperse or a polydisperse test aerosol. The particle counting method used may be a total count method (CNC) or a method involving particle size analysis (OPC).

Since total count particle counting methods provide no information about the particle size, they may only be used to determine the efficiency in procedural step 1 with monodisperse test aerosols of a known particle size.

For the determination of the minimum efficiency of the sheet filter medium (see 6.4.1) the test method using a monodisperse test aerosol has to be considered as the reference test method. Care has to be taken for the correlation with the reference test method if using a polydisperse aerosol.

6.5 Test procedures

6.5.1 Testing sheet filter media

6.5.1.1 Test samples

The testing procedure requires at least 5 sheet samples of the filter material.
The test samples shall be free of folds, creases, holes and other irregularities. The test samples shall have a minimum size of 200 mm x 200 mm.

6.5.1.2 Test apparatus

The arrangement of the test apparatus is shown in figure 1. An aerosol is produced in the aerosol generator, then passed through a conditioner (for example to evaporate a solvent) and neutralised, before being brought together with the particle-free mixing air to the test filter mounting assembly.

Upstream and downstream from the test filter mounting assembly there are sampling points from which a part of the flow is led to the particle counter. The upstream sampling point is connected