SLOVENSKI STANDARD
SIST EN 1822-3:2000

01-december-2000

High efficiency air filters (HEPA and ULPA) - Part 3: Testing flat sheet filter media

High efficiency air filters (HEPA and ULPA) - Part 3: Testing flat sheet filter media

Schwebstofffilter (HEPA und ULPA) - Teil 3: Prüfung des planen Filtermediums

Filtres a air a tres haute efficacité et filtres a air a tres faible pénétration (HEPA et ULPA) - Partie 3: Essais de medias filtrants plans

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ICS:

23.120	Zraļ niki. Vetrniki. Klimatske naprave	Ventilators. Fans. Air-conditioners

SIST EN 1822-3:2000 **en**

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1822-3

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ICS 23.120

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English version

High efficiency air filters (HEPA and ULPA) - Part 3: Testing flat sheet filter media

Filtres à air à très haute efficacité et filtres à air à très faible pénétration (HEPA et ULPA) - Partie 3: Essais de medias filtrants plans

Schwebstoffilter (HEPA und ULPA) - Teil 3: Prüfung des planen Filtermediums

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.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

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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)" consists 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 November 1998, and conflicting national standards shall be withdrawn at the latest by November 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 air filters 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.

This European Standard applies to testing sheet filter media used in high efficiency air filters. The procedure includes methods, test assemblies and conditions for carrying out the test, and the basis for calculating results.

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.

EN 1822-1:1998 High efficiency air filters (HEPA and ULPA) - Part 1: Classification, general principles of testing, marking;

EN 1822-2:1998 High efficiency air filters (HEPA and ULPA) - Part 2: Aerosol production, measuring equipment, particle counting statistics;

3 Definitions and quantities

3.1 Definitions

For the purposes of this standard, the definitions according to EN 1822-1 and EN 1822-2 apply.

3.2 Quantities

Table 1 contains the quantities (terms and symbols) used in this standard to represent measurement variables and calculated values. The values inserted in the equation given for these calculations should be in the units specified.

Table 1: Quantities

Term	Symbol	Unit	Equation for the calculation
Measured variables			
Exposed area	A	cm²	
Test volume flow rate	$\dot{V}$	cm³/s	
Pressure drop	Δp	Pa	
Mean particle diameter	$\tilde{d}_p$	µm	
Particle number	N	-	
Sampling volume flow rate	$\dot{V}_S$	cm³/s	
Sampling duration	t	s	
Calculated quantities			
Filter medium velocity	u	cm/s	$u = \frac{\dot{V}}{A}$
Mean pressure difference	$\overline{\Delta p}$	Pa	$\overline{\Delta p} = \frac{1}{n} \sum_{i=1}^{n} \Delta p_i$
Particle number concentration	c_N	cm⁻³	$c_N = \frac{N}{\dot{V}_S \cdot t}$
Penetration for particles in size range i	P_i	1)	$P_i = \frac{c_{N,d,i}}{c_{N,u,i}}$ 2)
Mean penetration	$\overline{P}$	1)	$\overline{P} = \frac{1}{n} \sum_{i=1}^{n} P_i$
Mean efficiency	$\overline{E}$	1)	$\overline{E} = 1 - \overline{P}$
Number of particles for the upper or lower limit of the 95% level of confidence	$N_{95\%}$	-	see clause 7 of EN 1822-2:1998
Penetration as upper limit value for the 95% level of confidence	$P_{95\%,i}$	1)	$P_{95\%,i} = \frac{c_{N,d,95\%,i}}{c_{N,u,95\%,i}}$ 2)
Mean penetration as upper limit value for the 95% level of confidence	$\overline{P}_{95\%}$	1)	$\overline{P}_{95\%} = \frac{1}{n} \sum_{i=1}^{n} P_{95\%,i}$
Mean efficiency as lower limit value for the 95% level of confidence	$\overline{E}_{95\%}$	1)	$\overline{E}_{95\%} = 1 - \overline{P}_{95\%}$

1) These quantities are usually given as a percentage
2) The index 'u' refers to up-stream particle counts, and the index 'd' refers to down-stream particle counts

4 Description of the test method

When testing the sheet filter medium the particle size efficiency is determined using a particle counting method. The testing can use a monodisperse or a polydisperse test aerosol. The methods differ in terms of both the production of the aerosol and the particle counter used. Furthermore the measurement of the pressure drop is made at the prescribed filter medium velocity.

Specimens of the sheet filter medium are fixed in a test filter assembly and subjected to the test air flow corresponding to the prescribed filter medium velocity. The test aerosol from the aerosol generator shall be conditioned (e.g. vapourisation of a solvent) then neutralised, mixed homogeneously with filtered test air and led to the test filter assembly.

In order to determine the efficiency, partial flows of the test aerosol are sampled upstream and downstream of the filter medium. Using a particle counting instrument the number concentration of the particles contained is determined for various particle sizes. The results of these measurements are used to draw a graph of efficiency against particle size for the filter medium, and to determine the particle size for which the efficiency is a minimum. This particle size is known as the Most Penetrating Particle Size (MPPS).

When measuring the particles on the upstream side of the filter medium it may be necessary to use a dilution system in order to reduce the concentration of particles down to the measuring range of the particle counter used.

Additional equipment is required to measure the absolute pressure, temperature and relative humidity of the test aerosol and to measure and control the test volume flow rate.

5 Scampling of sheet filter media

The testing of the sheet filter medium shall be carried out on at least 5 samples.

The samples shall be handled with care; the area to be tested shall be free from all folds, kinks, holes or other irregularities.

All samples shall be clearly and permanently marked with the following details:
a) The designation of the filter medium,
b) The upstream side of the filter medium.

6 Test apparatus

The test apparatus to be used and the arrangement of the components and measuring equipment are shown in figure 1 of EN 1822-1:1998.

The basic details for the aerosol generation and the aerosol neutralisation, together with the details of suitable types of apparatus are contained in EN 1822-2.

6.1 Test arrangements for testing with monodisperse test aerosol

When testing sheet filter media with a monodisperse test aerosol the particle number concentration is determined using a total count method with a condensation nucleus counter. The arrangement of the test apparatus is shown in figure 1.

The monodisperse test aerosol is created in a number of steps. Firstly a polydisperse primary aerosol is produced using a jet nebulizer with, for example, a DEHS/iso-propanol solution. The particles are reduced to a convenient size for the following process by evaporation of the solvent. The aerosol is then neutralised and passed to a differential mobility analyser. The quasi-monodisperse test aerosol available at the output of the differential mobility analyser is once again neutralised, and then mixed homogeneously with filtered test air in order to achieve at the test volume flow rate required for the filter medium velocity.

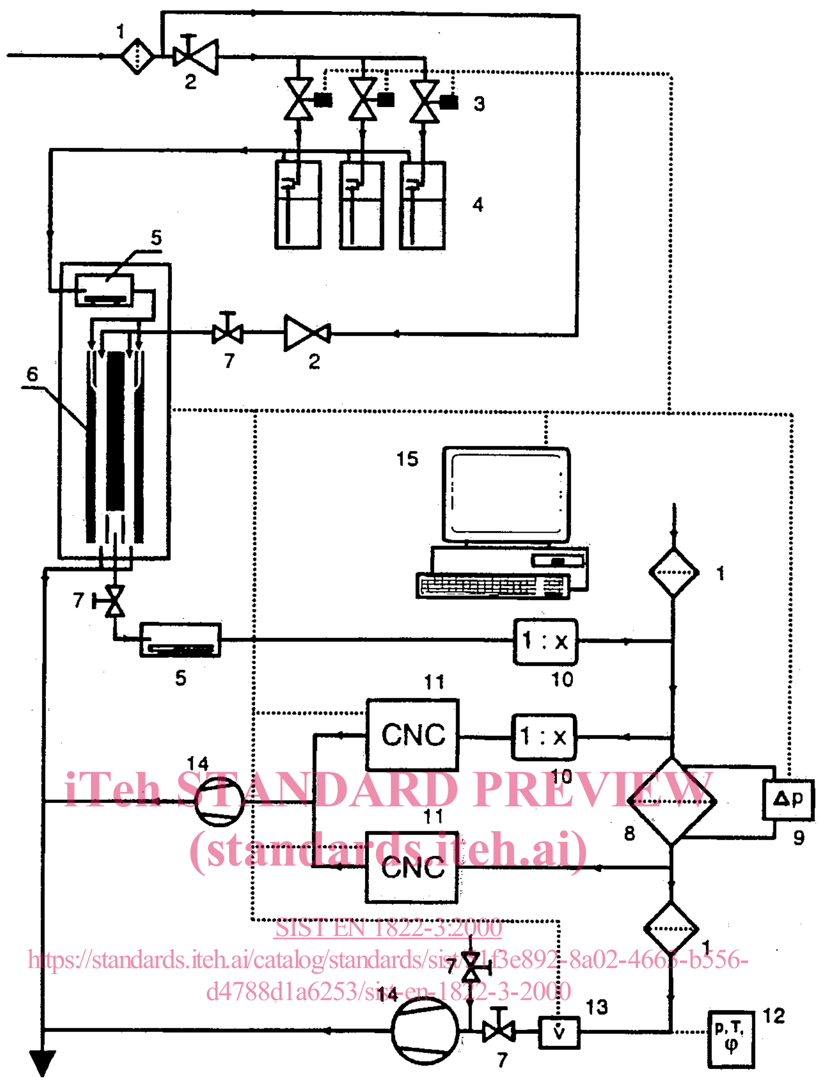
The mean particle diameter of the number distribution is varied by adjusting the voltage between the electrodes of the differential mobility analyzer[1)]

In order to achieve a sufficiently high particle number concentration over the entire test range from 0,04 µm to 0,8 µm it may prove necessary to use several jet nebulizers with differing concentrations of the aerosol substances in the solvent. Numerical concentrations which are too high can be adjusted by diluting the test aerosol before the test filter mounting assembly. The number concentration in the test aerosol shall be selected so that no dilution is necessary for the measurements made downstream from the filter.

A pump positioned downstream draws the test aerosol through the test filter mounting assembly. This ensures that the differential mobility analyser can always operate under nearly the same conditions, independent of the pressure drop across the tested filter medium. In contrast, where the testing system operates with an overpressure this ensures that leaks in the system do not falsify the test measurements.

Particles are counted upstream and downstream from the filter using either two condensation nucleus counters in parallel, or using only one such counter to measure the upstream and downstream concentrations alternately. If the level of the upstream number concentration exceeds the measuring range of the counter then a dilution system shall be included between the sampling point and the counter.

[1)] Actually, the adjustment gives the mode of number distribution. This can be taken as equal to the median value with sufficient accuracy.



1 Filter
2 Pressure valve
3 Solenoid valve
4 Jet nebulizer
5 Neutraliser
6 Differential mobility analyser
7 Needle valve
8 Test filter mounting assembly
9 Differential pressure gauge
10 Dilution system
11 Condensation nucleus counter
12 Measuring equipment for absolute pressure, temperature and relative humidity
13 Volume flow rate meter
14 Vacuum pump
15 Computer for control and data storage

Figure 1: Setup for testing with monodisperse test aerosols

6.2 Test arrangements for testing with a polydisperse test aerosol

When testing sheet filter media with a polydisperse test aerosol optical particle counters are used, which determine the number distribution and the number concentration of the test aerosol.

The tests can be carried out directly with the polydisperse, neutralised primary aerosol. In order to cover the test range it may be necessary to use several jet nebulizers with different concentrations of the aerosol substance in the solvent. The mean particle diameter of the number distribution shall not lie outside the test range of 0,04 µm to 0,8 µm.

The arrangement of the test apparatus is shown in figure 2. Instead of the single or two parallel condensation nucleus counters, optical particle counters are used to determine the number distribution and the number concentration of the polydisperse test aerosol on the upstream and downstream sides of the filter medium.

When testing with a polydisperse test aerosol and particle counting and sizing equipment it is also necessary to ensure that the number concentration of the test aerosol is adjusted to suit the measuring range of the particle counter - if necessary by the inclusion of a dilution system.