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High efficiency particulate air filters (HEPA and ULPA) - Part 5: Determining the efficiency of filter element

High efficiency particulate air filters (HEPA and ULPA) - Part 5: Determining the efficiency of filter element

Schwebstofffilter (HEPA und ULPA) - Teil 5: Abscheidegradprüfung des Filterelementes

Filtres a air a tres haute efficacité et filtres a air a tres faible pénétration (HEPA et ULPA) - Partie 5: Mesure de l'efficacité de l'élément filtrant

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

SIST EN 1822-5:2001 **en**

EUROPEAN STANDARD
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English version

High efficiency particulate air filters (HEPA and ULPA) - Part 5: Determining the efficiency of filter element

Filtres à air à très haute efficacité et filtres à air à très faible pénétration (HEPA et ULPA) - Partie 5: Mesure de l'efficacité de l'élément filtrant

Schwebstoffilter (HEPA und ULPA) - Teil 5: Abscheidegradprüfung des Filterelementes

This European Standard was approved by CEN on 7 July 2000.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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
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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.

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 February 2001, and conflicting national standards shall be withdrawn at the latest by February 2001.

It contains requirements, fundamental principles of testing and the marking for high efficiency particulate air filters (HEPA) and ultra low penetration air filters (ULPA).

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

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

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.

Introduction

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: 0,15µm 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.

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.

Part 5 of the standard deals with measuring the efficiency of filter elements, specifying the conditions and procedures for carrying out tests, describing a specimen test apparatus and its components, and including the method for evaluating the test 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 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 1822-1:1998	High efficiency particulate air filters (HEPA and ULPA) - Part 1: Classification, performance testing, marking
EN 1822-2:1998	High efficiency particulate air filters (HEPA and ULPA) - Part 2: Aerosol production, measuring equipment, particle counting statistics
EN 1822-3	High efficiency particulate air filters (HEPA and ULPA) - Part 3: Testing flat sheet filter media
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 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply. Further terms and definitions which also apply for the application of this part of EN 1822 are to be found in EN 1822-1 and in EN 1822-2.

3.1

sampling volume flow rate
the volume flow rate of sample air passing to the measuring cell of the particle counter used to determine the upstream or downstream particle count.

3.2

sampling duration
the time during which the particles in the sampling volume flow are counted (upstream or downstream)

3.3

measuring procedure with fixed sampling probes
determination of the overall efficiency using fixed sampling probes upstream and downstream of the test filter.

3.4

total particle count method
a particle counting method in which the overall number of particles - without size classification - can be determined in a certain test volume (e.g. by using a condensation nucleus counter)

3.5

particle counting and sizing method
a particle counting method which can determine both the number of particles and also their size distribution (e.g. by using an optical particle counter).

4 Description of the method

In order to determine the efficiency of the test filter it is fixed in the test filter mounting assembly and subjected to a test air volume flow corresponding to the nominal volume flow rate. After measuring the pressure drop at the nominal volume flow rate, the filter is purged with clean air and the test aerosol produced by the aerosol generator is mixed with the prepared test air along a mixing section, so that it is spread homogeneously over the cross section of the duct.

The efficiency is always determined for the most penetrating particle size (MPPS) (see EN 1822-3). The size distribution of the aerosol particles can optionally be measured using a particle size analysis system (for example a differential mobility particle sizer, DMPS).

The testing can be carried out using either a monodisperse or polydisperse test aerosol. When testing with (quasi-) monodisperse aerosol the total particle counting method can be used with a condensation nucleus counter (CNC) or an optical particle counter (OPC; for example a laser particle counter). It shall be ensured that the number median particle diameter corresponds to the MPPS particle diameter at which the filter medium has its minimum efficiency.

When using a polydisperse aerosol, an optical particle counter shall be used, which in addition to counting the particles is also able to determine their size distribution. It shall be ensured that the median diameter of the test aerosol lies in the range between

$$\frac{\text{MPPS}}{2} \text{ and MPPS x 1,5.}$$

In order to determine the overall efficiency, representative partial flows are extracted on the upstream and downstream sides of the filter element and led to the attached particle counter to measure the number of particles.

The overall efficiency can be determined using one of two methods, either

- with fixed test sampling probes (see 4.1)

or

- with one or several movable sampling probes downstream (scan method) (see 4.2)

In both methods the sample upstream is taken using a fixed sampling probe. The upstream and downstream number concentrations and the overall efficiency are calculated from the particle count, the duration of the sampling and the sampling volume flow rate.

4.1 Measurement method using fixed sampling probe

Using this method, the downstream sample used to determine the overall efficiency is taken using a fixed sampling probe. It is necessary to have a mixing section behind the test filter to mix the aerosol homogeneously with the test air over the duct cross section (see 6.1.4).

4.2 Scan method

This overall efficiency can be determined by averaging the readings from the result of the leak test (scan method). The test rig for the scan method is described in Part 4 of this standard.

In the scan method the downstream sampling is carried out directly behind the test filter using one or several moveable sampling probes, which can traverse the entire cross sectional area of the filter and its frame in overlapping tracks without any gaps.

The test apparatus corresponds largely with that used with stationary sampling probes. The difference for the scanning method is that the downstream mixing section is not included and that a 3-dimensional tracking system is included downstream to move the probe(s). Since the test duct is usually open for this reason, provisions shall be made to prevent the inleakage of contaminated outside air into the test air flow. The arrangement of this test apparatus is described in Part 4 of this standard.

In the scan method all the particles counted during the entire downstream scan in the course of the leak testing are added together. The duration of the sampling is derived from the data of the scanning and the number of probes.

The further clauses of this standard refer solely to the measuring method with fixed sampling probes where the overall efficiency is determined independently from the leak test procedure.

5 Test filter

The filter element to be tested shall show no signs of damage or any other irregularities. The filter element shall be handled carefully and shall be clearly and permanently marked with the following details:

a) Designation of the filter element

b) Upstream side of the filter element

The temperature of the test filter during the testing shall correspond with that of the test air.

6 Test apparatus

A flowsheet showing the arrangement of apparatus comprising a test rig is given at Figure 4 of EN 1822-1:1998. An outline diagram of a test rig is given at Figure 1 of this standard.

The fundamentals of aerosol generation and neutralisation with details of suitable types of equipment as well as detailed descriptions of the measuring instruments needed for the testing are contained in EN 1822-2.

6.1 Test duct

6.1.1 Test air conditioning

The test air conditioning equipment shall comprise the equipment needed to control the condition of the test air that it may be brought in compliance with the requirement of clause 7.

6.1.2 Adjustment of the volume flow rate

Filters shall always be tested at their nominal air flow rate. It shall be possible to adjust the volume flow rate by means of a suitable provision (e.g. by changing the speed of the fan, or with dampers) to a value ± 3 % of the nominal flow rate. It shall then remain constant in this range throughout each test.

6.1.3 Measurement of the volume flow rate

The volume flow (rate) shall be measured using a standardized or calibrated method (e.g. measurement of the differential pressure using standardized damper equipment such as orifice plates, nozzles, Venturi tubes in accordance with EN ISO 5167-1).

The limit error of measurement shall not exceed 5 % (of the measured value).

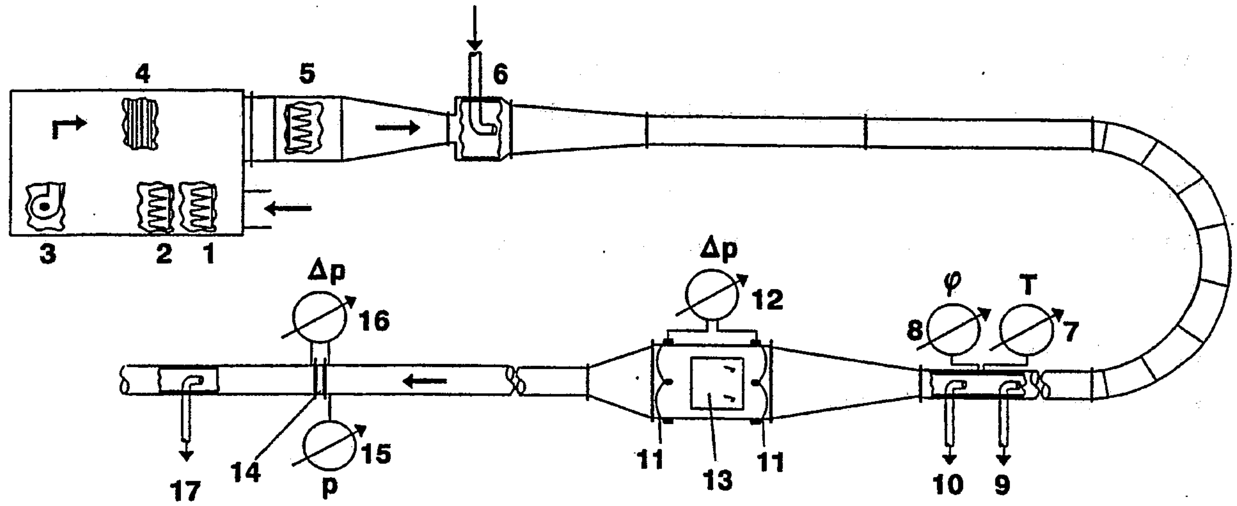
6.1.4 Aerosol mixing section

The aerosol input and the mixing section (see example in Figure 1) shall be so constructed that the aerosol concentration measured at individual points of the duct cross section, directly in front of the test filter, shall not deviate by more than 10% from the mean value of at least 9 measuring points over the channel cross section.

6.1.5 Test filter mounting assembly

The test filter mounting assembly shall ensure that the test filter can be sealed and subjected to flow in accordance with requirements.

It shall not obstruct any part of the filter cross sectional area.



Key

1	Coarse dust filter	11	Ring pipe for differential pressure measurement
2	Fine dust filter	12	Manometer
3	Fan	13	Test filter mounting assembly
4	Air heating	14	Measuring damper in accordance with EN ISO 5167-1
5	High efficiency air filter	15	Measurement of absolute pressure
6	Aerosol inlet to the test duct	16	Manometer measuring differential pressure
7	Temperature measurement	17	Sampler, downstream
8	Hygrometer		
9	Sampler, particle size analysis		
10	Sampler, upstream		

Figure 1 - Example of a test rig

6.1.6 Measuring points for the pressure drop

The measuring points for pressure drop shall be so arranged that the mean value of the static pressure in the flow upstream and downstream of the filter can be measured. The planes of the pressure measurements upstream and downstream shall be positioned in regions of an even flow with a uniform flow profile.

In rectangular or square test ducts, smooth holes with a diameter of 1 mm to 2 mm for the pressure measurements shall be bored in the middle of the channel walls, normal to the direction of flow. The four holes shall be interconnected with a circular pipe.

6.1.7 Sampling

In order to determine the efficiency, partial flows are extracted from the test volume flow by sampling probes and led to the particle counters. The diameter of the probes shall be chosen so that isokinetic conditions pertain in the duct at the given volume flow rate for the sample. Sampling errors can be neglected due to the small size of the particles in the test aerosol. The connections to the particle counter shall be as short as possible. Samples on the upstream side are taken by a fixed sampling probe in front of the test filter. The sampling shall be representative, which is taken to be the case when the aerosol concentration measured from the sample does not deviate by more than ± 10% from the mean value determined in accordance with 6.1.4.

A fixed sampling probe is also installed downstream, preceded by a mixing section which ensures a representative measurement of the downstream aerosol concentration. This is taken to be the case when in event of a leak in the test filter according to clause 5 of EN 1822-1:1998 the aerosol concentration measured does at no point deviate by more than ± 10% from the mean value of at least nine measuring points over the duct cross section.

The mean aerosol concentrations determined at the upstream and downstream sampling points without the filter in position shall not differ from each other by more than 5%.

6.2 Aerosol generation and measuring instruments

The operating parameters of the aerosol generator shall be adjusted to produce a test aerosol whose number median diameter is in the range of the Most Penetrating Particle Size (MPPS) for the sheet filter medium.

The median size of the monodisperse test aerosol may not deviate from the MPPS by more than ± 10 %. A deviation of ± 50 % is allowed when using a polydisperse aerosol.

The particle output of the aerosol generator shall be adjusted according to the test volume flow rate and the filter efficiency so that the counting rates on the upstream and downstream sides lie under the coincidence limits of the counter (coincidence error max. 5 %), and significantly above the zero count rate of the instruments.