SLOVENSKI STANDARD
SIST EN 1822-4:2001

01-junij-2001

High efficiency particulate air filters (HEPA and ULPA) - Part 4: Determining leakage of filter element (Scan method)

High efficiency particulate air filters (HEPA and ULPA) - Part 4: Determining leakage of filter element (Scan method)

Schwebstoffilter (HEPA und ULPA) - Teil 4: Leckprüfung des Filterelementes (Scan-Verfahren)

Filtres a air a tres haute efficacité et filtres a air a tres faible pénétration (HEPA et ULPA) - Partie 4: Essais d'étanchéité de l'élément filtrant (méthode d'exploration)

Ta slovenski standard je istoveten z: **EN 1822-4:2000**

ICS:

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

SIST EN 1822-4:2001 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1822-4

August 2000

ICS 23.120

English version

High efficiency particulate air filters (HEPA and ULPA) - Part 4: Determining leakage of filter element (Scan method)

Filtres à air à très haute efficacité et filtres à air à très faible pénétration (HEPA et ULPA) - Partie 4: Essais d'étanchéité de l'élément filtrant (méthode d'exploration)

Schwebstoffilter (HEPA und ULPA) - Teil 4: Leckprüfung des Filterelementes (Scan-Verfahren)

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
EUROPÄISCHES KOMITEE FÜR NORMUNG

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

Ref. No. EN 1822-4:2000 E

Contents

Page

Foreword 3

Introduction 3

1 Scope 4

2 Normative references 4

3 Terms and definitions 4
3.1 sampling volume flow rate 4
3.2 sampling duration 5
3.3 total particle count method 5
3.4 particle counting and sizing method 5
3.5 particle flow rate 5
3.6 particle flow distribution 5

4 Description of the procedure 5

5 Test filter 6

6 Test apparatus 7
6.1 Set-up of the test apparatus 7
6.2 Test duct 9
6.3 Scanning assembly 10
6.4 Aerosol generation and measurement techniques 11

7. Test air 13

8. Test procedure 13
8.1 General 13
8.2 Preparatory checks 14
8.3 Starting up the aerosol generator 14
8.4 Preparing the test filter 15
8.5 Testing 15

9 Evaluation 17
9.1 Calculating the penetration and the efficiency 17
9.2 Local penetration 19
9.3 Mean efficiency 19
9.4 Classification 19

10 Test report 19
10.1 Details of the test filter 19
10.2 General details of the test parameters 19
10.3 Test results 20

11 Maintenance and inspection of the test apparatus 20

Annex A (normative) Oil thread test 22

Annex B (normative) Determining the test parameters 23

Annex C (informative) Example of an application with evaluation 33

Bibliography 36

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 particultate 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 elements (Scan method)
- Part 5 Determining the efficiency of filter elements

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 air filters and ultra low penetration air filters (HEPA- and ULPA-filters) used in the field of ventilation and air conditioning and for technical processes, for example, for clean room technology or applications in the nuclear or 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 4 of this standard applies to the leak testing of filter elements. The scan method which is described in detail regarding procedure, apparatus and test conditions is valid for the complete range of HEPA- and ULPA-filters. The oil thread test according to annex A may be used alternatively only for HEPA-filters (see EN 1822-1).

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. The 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	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 1822-5: 2000	High efficiency particulate air filters (HEPA and ULPA) - Part 5: Determining the efficiency of filter element
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 are not included here but which are valid for the application of this part are listed in EN 1822-1 and EN 1822-2.

3.1

sampling volume flow rate

the proportion of the upstream or downstream volume flow rate which is led to the measuring cell of the particle counter used to determine the upstream or downstream particle count.

In the case of particle counters which only analyze a part of the flow led to the measuring call, then this analyzed portion is referred to as the sampling volume flow rate.

3.2

sampling duration
the time period during which the particles in the sample are counted upstream and downstream.
[EN 1822-5:2000]

3.3

total particle count method
a particle counting method in which the total number of particles in a certain sample volume is determined without classification according to size (for example using a condensation nucleus counter).
[EN 1822-5:2000]

3.4

particle counting and sizing method
a particle counting method which allows both the determination of the number of particles and also the classification of the particles according to size (for example using an optical particle counter).
[EN 1822-5:2000]

3.5

particle flow rate

the number of particles which are measured or which flow past a specified cross section in unit time.

3.6

particle flow distribution
the distribution of the particle flow over a plane at right angles to the direction of flow.

4 Description of the procedure

The leakage test serves to test the filter element for local penetration values which exceed permissible levels (see EN 1822-1).

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

The particle flow rate on the downstream side of the test filter is smaller than the particle flow rate reaching the filter on the upstream side by the factor mean penetration.

The manufacturing irregularities of the filter material or leaks lead to a variation of the particle flow rate over the filter face area. In addition, leaks at the boundary areas and within the components of the test filter (sealant, filter frame, seal of the filter mounting assembly) can lead locally to an increase in the particle flow rate on the downstream side of the test filter.

For the leakage test, the particle flow distribution shall be determined on the downstream side of the filter in order to check where the limit values are exceeded. The coordinates of these positions shall be recorded.

In order to measure the particle flow distribution, a probe with defined geometry shall be used on the downstream side to take a specified partial flow as sample. From this partial flow, a sample volume flow rate shall be led to a particle counter which counts the particles and displays the results as a function of time. During the testing, the probe moves at a defined speed in touching or overlapping tracks without gaps close to the downstream side of the filter element. The measuring period for the particle flow distribution can be shortened by using several measuring systems (partial flow extractors/particle counters) operating in parallel.

The measurement of the coordinates of the probe, a defined probe speed, and measurement of the particle flow rate at sufficiently short intervals allow the localisation of leaks. In a further test step, the local penetration shall be measured at this position using a stationary probe.

The leakage tests shall always be conducted using particles of the most penetrating particle size (MPPS) (see EN 1822-3). The size distribution of the aerosol particles can be checked using a particle size analysis system (for example a differential mobility particle sizer, DMPS).

The leakage testing can be carried out using either a monodisperse or polydisperse test aerosol. It shall be ensured that the median particle diameter corresponds to the MPPS particle diameter, at which the filter medium has its minimum efficiency.

When testing with a monodisperse aerosol, the total particle counting method can be used with a condensation nucleus counter (CNC) or an optical particle counter (OPC; e.g. a laser particle counter).

When using a polydisperse aerosol, an optical particle counter shall be used which counts the particles and measures their size distribution.

If scan testing is carried out as an automatic procedure it also allows to determine the mean efficiency of the test filter from the measurement of the particle concentration. The mean particle concentration on the downstream side is calculated from the total particle number counted while the probe traverses the passage area. The reference volume is the volume of air analyzed by the particle counter over this period of time. The particle concentration on the upstream side of the test filter shall be measured at a representative position on the duct cross-section. This method for determining the integral efficiency is equivalent to the method with fixed probes specified in EN 1822-5.

5 Test filter

A test filter shall be used for the leak testing which does not show any visible signs of damage or other irregularities, and which can be sealed in position and subjected to flow in accordance with requirements. The temperature of the test filter during the tests shall corresponds to the temperature of the test air. The filter element shall be handled with care, and shall be clearly and permanently marked with the following details:

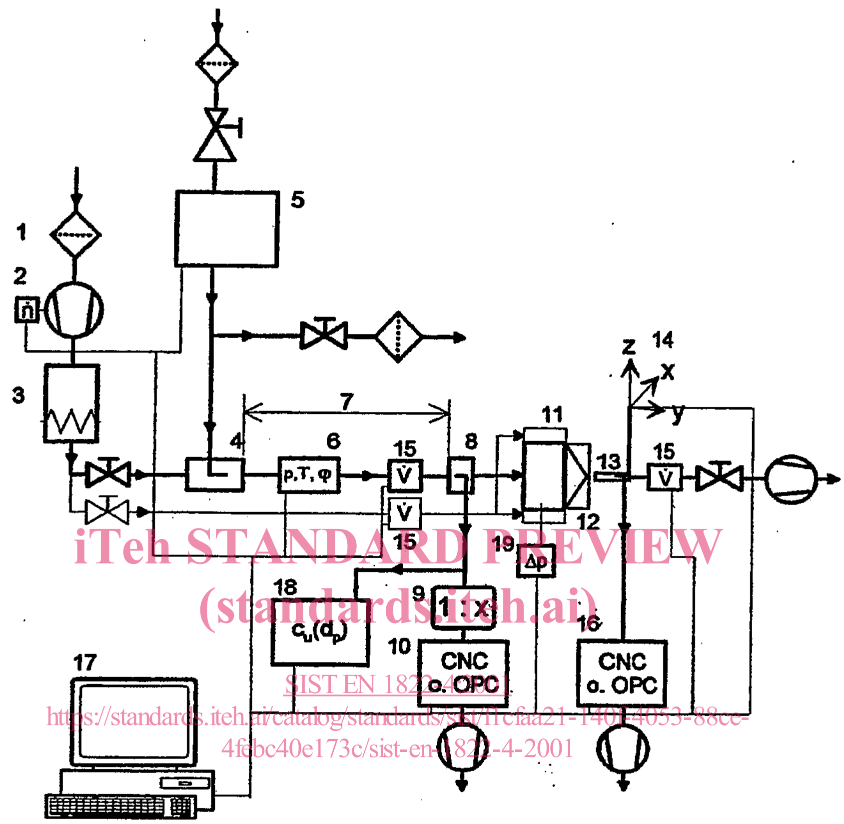
a) Designation of the filter element,

b) The upstream side of the filter element.

6 Test apparatus

6.1 Set-up of the test apparatus

Figure 1 shows the set-up of the test apparatus. This layout is valid for tests with a monodisperse or with a polydisperse aerosol. The only differences between these lie in the technique used to measure the particles and the way the aerosol is generated.

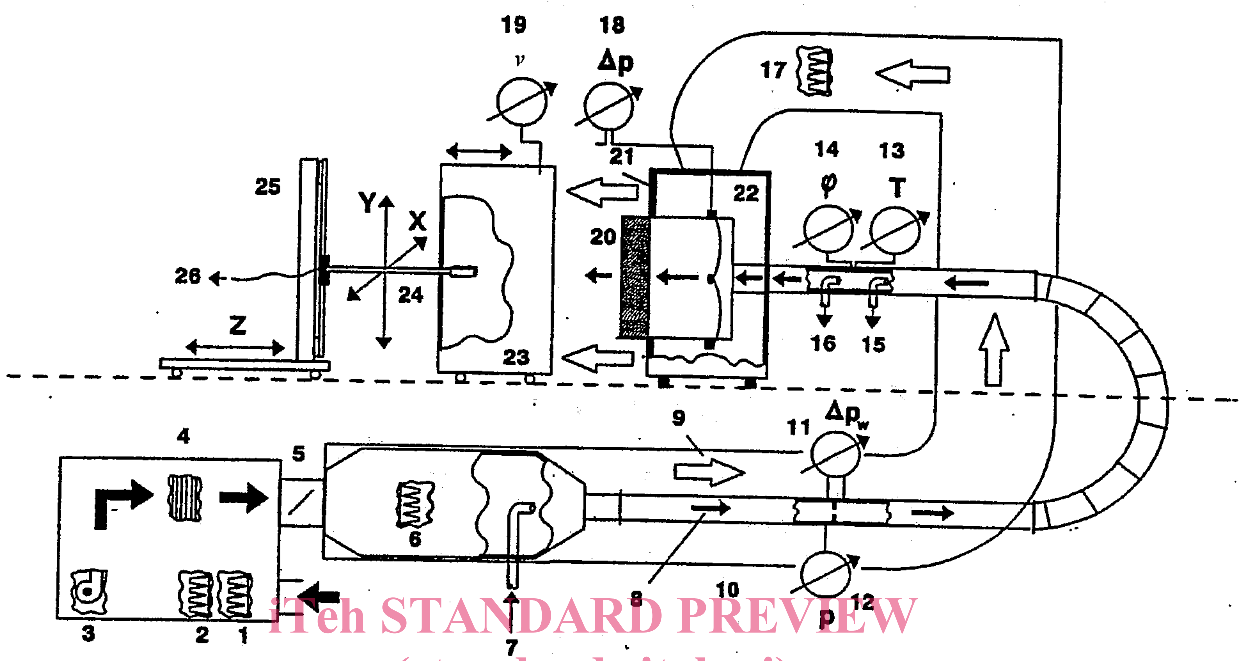


Key

1 Pre-filter for the test air
2 Fan with speed regulator
3 Air heater
4 Aerosol inlet in the duct
5 Aerosol generator with conditioning of supply air and aerosol flow regulator
6 Measurement of atmospheric pressure, temperature and relative humidity
7 Upstream side mixing section
8 Sampling point for upstream particle counting
9 Dilution system (optional)
10 Particle counter, upstream
11 Sheath flow (optional)
12 Test filter
13 Sampling point and partial flow extraction, downstream
14 Traversing system for probe
15 Volume flow rate measurement
16 Particle counter, downstream
17 Computer for control and data storage
18 Measuring system to check the test aerosol
19 Measurement of differential pressure

Figure 1 - A diagram of test apparatus

An example of a testrig is shown in Figure 2 (without particle measuring equipment).



Key

1 Coarse dust filter
2 Fine dust filter
3 Fan
4 Air heater
5 Dampers to adjust test and sheath air
6 High efficiency air filter for the test air
7 Aerosol inlet in the duct
8 Test air flow
9 Sheath air flow
10 Effective pressure measuring device
11 Differential pressure
12 Atmospheric pressure
13 Temperature measurement
14 Hygrometer
15 Sampling point for particle size analysis
16 Sampling point, upstream
17 High efficiency air filter for the sheath air
18 Measurement of pressure drop
19 Measurement of sheath air speed
20 Test filter
21 Flow equalizer for the sheath air flow
22 Filter mounting assembly
23 Screening (linked to the filter mounting assembly during the testing)
24 Traversing probe arm with downstream sampling probe
25 Probe traversing system
26 Downstream sampling point

Figure 2 - A test duct for scan testing

The basic details for the generation and neutralization of the aerosol, together with the details of suitable types of equipment and detailed descriptions of measuring instruments needed for the testing are contained in EN 1822-2.

6.2 Test duct

6.2.1 Test air conditioning

The test air conditioning unit contains the equipment needed to condition the test air flow (see clause 7).

The test air flow shall be so prepared that it complies with the specifications in clause 7 and does not exceed the limit values specified there during the course of the efficiency testing.

6.2.2 Adjustment of the volume flow rate

It shall be possible by means of a suitable provision (e.g. changes to the speed of the fan, or by dampers) to produce the volume flow rate with a reproducibility of ± 3%. The nominal volume flow rate shall then remain in this range throughout the testing.

6.2.3 Measurement of the volume flow rate

The volume flow rate shall be measured using a standardized or calibrated method (e.g. measurement of the pressure drop 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).

6.2.4 Aerosol mixing duct

The aerosol input and the mixing duct (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 obtained from at least 9 measuring points spread evenly over the duct cross section.

6.2.5 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 passage area of the filter.

6.2.6 Measuring points for the pressure difference

The measuring points for pressure shall be so arranged that the mean value of the difference between static pressure in the upstream flow and the pressure of the surrounding air can be measured. The plane of the pressure measurements shall be positioned in a region of uniform flow.

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 duct walls, normal to the direction of flow. The four measurement holes shall be interconnected with a circular pipe.

6.2.7 Sampling, upstream

Samples are taken upstream by means of one or more sampling probes in front of the test filter. The probe diameter shall be chosen so that, at an average flow velocity, isokinetic conditions pertain at the given volume flow rate for the sample. Sampling errors which arise due to other flow velocities in the duct 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.

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 6.2.4.

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

6.2.8 Screening

The downstream side of the test filter shall be screened from impurities in the surrounding air. Furthermore, it is necessary for the localisation of leaks at the edges of the filter that the flow of particles from leaks in the seal, the filter frame or the sealant should be lead away directly in the direction of flow. This can be achieved, for example, if the outer sides of the filter frame are enclosed by particle-free air flowing in the downstream direction.

6.3 Scanning assembly

In addition to the automated testing for leaks, manual scanning is also permitted, provided that the most important parameters for the test procedure are adhered to.

However, when the probe is moved manually it is not possible to avoid irregularities, since the movement over the filter surface cannot be smooth and even. As a result, quantitative assessments are usually only possible to a limited extent if at all. Furthermore, it is extremely time-consuming to keep a record of the coordinates of leaks and particularly to evaluate the particle counts.

In the following, an automatic scanning apparatus is described.

6.3.1 Sampling, downstream

The sampling conditions determine the local resolution for the determination of the particle flow distribution on the downstream side. In order to ensure the comparability of the measurements for the local value of the penetration, the sampling shall be carried out under standardized conditions.

The geometry of the probe aperture may be rectangular or circular. The relationship between the sides of a rectangular probe shall not exceed 15 to 1. The area of the probe shall be 9 cm² ± 1 cm². The volume flow rate in the probe shall be chosen so that the speed at the probe aperture does not differ by more than 25% from the face velocity of the filter (see B.5).

If the probes have a rectangular aperture, then the measuring time can be shortened by using several probes next to each other (for several particle counters).

The probe shall be led at a distance of 10 mm to 50 mm from the downstream face of the filter element.