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Zračni filtri za delce pri splošnem prezračevanju - Ugotavljanje učinkovitosti filtracije

Particulate air filters for general ventilation - Determination of the filtration performance

Partikel-Luftfilter für die allgemeine Raumlufttechnik - Bestimmung der Filterleistung

Filtres à air de ventilation générale pour l'"élimination des particules - Exigences, essais, marquage

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Particulate air filters for general ventilation - Determination of the filtration performance

Filtres à air de ventilation générale pour l'élimination des particules - Détermination des performances de filtration

Partikel-Luftfilter für die allgemeine Raumlufttechnik - Bestimmung der Filterleistung

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Contents

Foreword

This document (EN 779:2012) has been prepared by Technical Committee CEN/TC 195 “Air filters for general air cleaning”, the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by October 2012, and conflicting national standards shall be withdrawn at the latest by October 2012.

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

This document supersedes EN 779:2002.

EN 779:2012 is based on the test method according to EN 779:2002. It contains extensive test rig qualification procedures together with procedures which give some information regarding the real life behaviour of particulate air filters (see ”Introduction”).

Annexes A to D are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

General

The procedures described in this standard have been developed from those given in EN 779:2002. The basic design of test rig given in EN 779:2002 is retained. A challenge aerosol of DEHS (or equivalent) is dispersed evenly across the duct upstream of the filter being tested. Representative upstream and downstream air samples are analysed by an optical particle counter (OPC) to provide filter particle size efficiency data.

Classification

The EN 779:2002 classification system (comprising groups F and G filters) has been changed to three groups (F-, M- and G-filters).

Filters found to have an average efficiency value of less then 40 % of 0,4 µm particles will be allocated to group G and the efficiency reported as "< 40 %". The classification of G filters (G1 - G4) is based on their average arrestance with the loading dust.

Filters found to have an average efficiency value from 40 % to less than 80 % of 0,4 µm particles will be allocated to group M (M5, M6) and the classification is based on their average efficiency (0,4 µm). The filter classes F5 and F6 have changed to M5 and M6, but with same requirements, as in the old classification system.

Filters found to have an average efficiency of 80 % or more of 0,4 µm particles will be allocated to group F (F7-F9) and the classification is based on their average efficiency (0,4 µm) as in the old system and the minimum efficiency during the test.

Test aerosol

A challenge aerosol of DEHS (or equivalent) was chosen for the efficiency test for the following reasons:

— Experience has already been gained by users of EN 779:2002 and Eurovent 4/9 test method so that much suitable equipment already exists.

— Liquid aerosols is easy to generate in the concentrations, size range and degree of consistency required.

— Undiluted DEHS is used to give a non charged aerosol.

— Spherical latex particles are used to calibrate particle counters. The determination of the particle size of spherical liquid particles using optical particle counters is more accurate than would be the case with solid particles of non-spherical salt and test dusts.

Filtration characteristics

Initiatives to address the potential problems of particle re-entrainment and shedding from filters have been included in Annex A.

In an ideal filtration process, each particle would be permanently arrested at the first contact with a filter fibre, but incoming particles may impact on a captured particle and dislodge it into the air stream. Fibres or particles from the filter itself could also be released, due to mechanical forces. From the user's point of view it might be important to know this, but such behaviour would probably not be detected by a particle counter system according to this standard.

Certain types of filter media rely on electrostatic effects to achieve high efficiencies at low resistance to air flow. Exposure to some types of challenge, such as combustion particles in normal atmospheric air or oil mist, may neutralise such charges with the result that filter performance suffers. It is important that the users are aware of the potential for performance degradation when loss of charge occurs. It is also important that means be available for identifying cases where the potential exists. The discharge test procedure described provides techniques for identifying this type of behaviour. This procedure is used to determine whether the filter efficiency is dependent on the electrostatic removal mechanism and to provide quantitative information about the importance of the electrostatic removal.

1 Scope

This European Standard refers to particulate air filters for general ventilation. These filters are classified according to their performance as measured in this test procedure.

This European Standard contains requirements to be met by particulate air filters. It describes testing methods and the test rig for measuring filter performance.

In order to obtain results for comparison and classification purposes, particulate air filters shall be tested against two synthetic aerosols, a fine aerosol for measurement of filtration efficiency as a function of particle size within a particle size range 0,2 µm to 3,0 µm, and a coarse one for obtaining information about test dust capacity and, in the case of coarse filters, filtration efficiency with respect to coarse loading dust (arrestance).

This European Standard applies to air filters having an initial efficiency of less than 98 % with respect to 0,4 µm particles. Filters shall be tested at an air flow rate between 0,24 m^3/s (850 m^3/h) and 1,5 m^3/s (5400 m^3/h).

The performance results obtained in accordance with this standard cannot by themselves be quantitatively applied to predict performance in service with regard to efficiency and lifetime. Other factors influencing performance to be taken into account are described in Annex A (informative).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 5167-1:2003, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1:General principles and requirements (ISO 5167-1:2003)*

ISO 2854:1976, *Statistical interpretation of data — Techniques of estimation and tests relating to means and variances*

ISO 12103-1:1997, *Road vehicles — Test dust for filter evaluation — Part 1: Arizona test dust*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
arrestance
weighed (mass) removal of loading dust

3.2
average arrestance - A_m
ratio of the total amount of loading dust retained by the filter to the total amount of dust fed up to final test pressure drop

Note 1 to entry: Average arrestance is used for classification of G-filters.

3.3
average efficiency - E_m
weighted average of the efficiencies of 0,4 µm particles for the different specified dust loading levels up to final test pressure drop

Note 1 to entry: Average efficiency is used for classification of M and F-filters.

3.4
average efficiency - $E_{i,j}$
average efficiency for a size range ”i” at different dust loading intervals ”j”

3.5
average discharged efficiency - $\overline{E}_{D,i}$
average efficiency for a size range ”i” after discharging filter samples

3.6
average untreated efficiency - $\overline{E}_{U,i}$
average efficiency for a size range ”i” of untreated filter samples

3.7
charged filter
filter which is electrostatically charged or polarised

3.8
coarse filter
filter classified in one of the classes G1 to G4

3.9
counting rate
number of counting events per unit of time

3.10
DEHS
liquid (DiEthylHexylSebacate) for generating the test aerosol

3.11
discharged efficiency
efficiency of filter media after having been discharged by isopropanol

3.12
test dust capacity
amount of loading dust retained by the filter up to final test pressure drop

3.13
efficiency
see initial efficiency, discharged efficiency, minimum efficiency and average efficiencies

3.14
face area
area of the inside section of the test duct immediately upstream of the filter under test

Note 1 to entry: Nominal values 0,61 m × 0,61 m = 0,372 m^2.

3.15
face velocity
air flow rate divided by the face area

3.16
final filter
air filter used to collect the loading dust passing the filter under test

3.17
final pressure drop - recommended
maximum operating pressure drop of the filter as recommended by the manufacturer at rated air flow

3.18
final test pressure drop
pressure drop up to which the filtration performance is measured for classification purposes

3.19
fine filter
filter classified in one of the classes F7 to F9

3.20
HEPA filter
High Efficiency Particulate Air filter, classes H13 to H14 according to EN 1822-1

3.21
initial arrestance
arrestance of the first 30 g loading dust increment

3.22
initial efficiency
efficiency of the clean filter operating at the test air flow rate

Note 1 to entry: For each size range of selected particles.

3.23
initial pressure drop
pressure drop of the clean filter operating at its test air flow rate

3.24
isokinetic sampling
sampling of the air within a duct such the probe inlet air velocity is the same as the velocity in the duct at the sampling point

3.25
loading dust
same as synthetic dust

3.26
mean diameter
geometric average of the size range diameter

3.27
media velocity
air flow rate divided by the net effective filtering area

Note 1 to entry: Expressed in m/s to an accuracy of three significant figures.

3.28
medium filter
filter classified in one of the classes M5 or M6

3.29
minimum efficiency
lowest efficiency among the discharged efficiency, initial efficiency and the lowest efficiency throughout the loading procedure of the test

Note 1 to entry: Minimum efficiency is used for classification of F-filters.

3.30
net effective filtering area
area of filter medium in the filter which collects dust

3.31
particle bounce
describes the behaviour of particles that impinge on the filter without being retained

3.32
particle size
equivalent optical diameter of a particle

3.33
particle number concentration
number of particles per unit of volume of the test air

3.34
penetration
ratio of the particle concentration downstream to upstream of the filter

3.35
re-entrainment
releasing to the air flow of particles previously collected on the filter

3.36
shedding
releasing to the air flow of particles due to particle bounce and re-entrainment effects, and to the release of fibres or particulate matter from the filter or filtering material

3.37
synthetic dust
dust specifically formulated for determining the test dust capacity and arrestance of the filter

3.38
test aerosol
aerosol used for determining the efficiency of the filter

3.39
test air flow rate
volumetric air flow rate through the filter under test

Note 1 to entry: Expressed in m^3/s for a reference air density of 1,20 kg/m^3.

3.40
test air
air to be used for testing purposes

3.41
test dust capacity
amount of loading test dust kept by filter up to final test pressure drop

3.42
ULPA-Filter
Ultra Low Penetration Air Filter, classes U15 to U17 according to EN 1822-1

3.43
untreated efficiency
efficiency of untreated filter samples

4 Symbols and abbreviated terms

For the application of this European Standard, the following symbols and abbreviated terms apply.

A	Arrestance
A_j	Arrestance in loading phase "j", %
A_m	Average arrestance during test to final test pressure drop, %
CL	Concentration limits of particle counter
CV	Coefficient of variation
CV_i	Coefficient of variation in size range "i"
DHC	Dust holding capacity (deprecated). see TDC
d_i	Size range diameter or mean diameter in a size range "i", µm
d_l	Lower border diameter in a size range, µm
d_u	Upper border diameter in a size range, µm
E_i	Average initial efficiency of size range "i", %
$E_{i,j}$	The average efficiency for size range "i" after dust loading phase "j", %
$E_{m,i}$	Average efficiency of size range "i" during test up to final test pressure drop, %
E_m	Average efficiency of 0,4 µm particles during test up to final test pressure drop (used for classification), %
$\overline{E}$	Average efficiency, %
$\overline{E}_{D,i}$	Average efficiency of conditioned (discharged) media samples for size range "i"
$\overline{E}_{D,s,i}$	Average efficiency of conditioned (discharged) media sample "s" and for size range "i"
$\overline{E}_{U,i}$	Average efficiency of untreated media samples for size range "i"
$\overline{E}_{U,s,i}$	Average efficiency of untreated media sample "s" and for size range "i"
F7 to F9	Fine filter classes
G1 to G4	Coarse filter classes
M5, M6	Medium filter classes
M_j	Mass of dust fed to the filter during loading phase "j", g
$mean$	Mean value
$mean_i$	Mean value in size range "i"
m_d	Dust in duct after filter, g
m_j	Mass of dust passing the filter at the dust loading phase "j", g
m_{tot}	Cumulative mass of dust fed to filter, g
m_1	Mass of final filter before dust increment, g
m_2	Mass of final filter after dust increment, g
N_i	Number of particles in size range "i" upstream of the filter
n	Number of points
n_i	Number of particles in size range "i" downstream of the filter
OPC	Optical particle counter

p	Pressure, Pa
p_a	Absolute air pressure upstream of filter, kPa
$p_{D,s}$	Pressure drop of conditioned (discharged) sample “s”
p_{sf}	Air flow meter static pressure, kPa
$p_{U,s}$	Pressure drop of untreated sample “s”
q_m	Mass flow rate at air flow meter, kg/s
q_V	Air flow rate at filter, m^3/s
q_{Vf}	Air flow rate at air flow meter, m^3/s
s	Subscript indicating sample number (1, 2, 3, …)
t	Temperature upstream of filter, °C
t_f	Temperature at air flow meter, °C
$t_{(1-\frac{\alpha}{2})}$	Distribution variable
TDC	Test dust capacity, g
U	Uncertainty, % units
δ	Standard deviation
δ_i	Standard deviation for size range "i"
ν	Number of degrees of freedom
ρ	Air density of air, kg/m^3
φ	Relative humidity upstream of filter, %
Δm	Dust increment, g
Δm_{ff}	Mass gain of final filter, g
Δp	Filter pressure drop, Pa
Δp_f	Air flow meter differential pressure, Pa
$\Delta p_{1,20}$	Filter pressure drop at air density 1,20 kg/m^3, Pa

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASTM	American Society for Testing and Materials
CAS	Chemical Abstracts Service
CEN	European Committee for Standardization
EN	European Norm
EUROVENT	European Committee of Air Handling and Refrigeration Equipment Manufacturers
ISO	International Organization for Standardization

5 Requirements

The filter shall be designed or marked so as to prevent incorrect mounting. The filter shall be designed so that when correctly mounted in the ventilation duct, no leak occurs at the sealing edge.

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

The complete filter 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 air flow through the filter shall not constitute a hazard or nuisance for the people (or devices) exposed to filtered air.