SLOVENSKI STANDARD
SIST-TS CEN ISO/TS 21083-2:2019

01-junij-2019

Preskusna metoda za merjenje učinkovitosti sredstev za filtriranje zraka, ki vsebuje kroglaste nanomateriale - 2. del: Velikost delcev od 3 nm do 30 nm (ISO/TS 21083-2:2019)

Test method to measure the efficiency of air filtration media against spherical nanomaterials - Part 2: Particle size range from 3 nm to 30 nm (ISO/TS 21083-2:2019)

Méthode d'essai pour mesurer l'efficacité des médias de filtration d'air par rapport aux nanomatériaux sphériques - Partie 2: Spectre granulométrique de 3 nm à 30 nm (ISO/TS 21083-2:2019)

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TECHNICAL SPECIFICATION

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English Version

Test method to measure the efficiency of air filtration media against spherical nanomaterials - Part 2: Size range from 3 nm to 30 nm (ISO/TS 21083-2:2019)

Méthode d'essai pour mesurer l'efficacité des médias de filtration d'air par rapport aux nanomatériaux sphériques - Partie 2: Spectre granulométrique de 3 nm à 30 nm (ISO/TS 21083-2:2019)

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European foreword

This document (CEN ISO/TS 21083-2:2019) has been prepared by Technical Committee ISO/TC 142 "Cleaning equipment for air and other gases" in collaboration with Technical Committee CEN/TC 195 “Air filters for general air cleaning” the secretariat of which is held by UNI.

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Endorsement notice

The text of ISO/TS 21083-2:2019 has been approved by CEN as CEN ISO/TS 21083-2:2019 without any modification.

TECHNICAL SPECIFICATION

ISO/TS 21083-2

First edition
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Test method to measure the efficiency of air filtration media against spherical nanomaterials —

Part 2: Size range from 3 nm to 30 nm

Méthode d'essai pour mesurer l'efficacité des médias de filtration d'air par rapport aux nanomatériaux sphériques —

Partie 2: Spectre granulométrique de 3 nm à 30 nm

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 195, *Air filters for general cleaning*, in collaboration with ISO Technical Committee TC 142, *Cleaning equipment for air and other gases*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 21083 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Nano-objects are discrete piece of material with one, two or three external dimensions in the nanoscale (see ISO/TS 80004-2) and are building blocks of nanomaterials. Nanoparticles, referring to particles with at least one dimension below 100 nm, generally have a higher mobility than larger particles. Because of their higher mobility and larger specific surface area, available for surface chemical reactions, they can pose a more serious health risk than larger particles. Thus, particulate air pollution with large concentrations of nanoparticles can result in an increased adverse effect on human health and an increased mortality (see Reference [15]).

With the increased focus on nanomaterials and nanoparticles, the filtration of airborne nanoparticles is also subject to growing attention. Aerosol filtration can be used in diverse applications, such as air pollution control, emission reduction, respiratory protection for human and processing of hazardous materials. The filter efficiency can be determined by measuring the testing particle concentrations upstream and downstream of the filter. The particle concentration may be based on mass, surface area or number. Among these, the number concentration is the most sensitive parameter for nanoparticles measurement. State-of-the-art instruments enable accurate measurement of the particle number concentration in air and therefore precise fractional filtration efficiency. Understanding filtration efficiency for nanoparticles is crucial in schemes to remove nanoparticles, and thus, in a wider context, improve the general quality of the environment, including the working environment.

Filtration testing for nanoparticles, especially those down to single-digit nanometres, is a challenging task which necessitates generation of a large amount of extremely small particles, and accurate sizing and quantification of such particles. The thermal rebound remains a question for particles down to 1 nm to 2 nm (see Reference [11]). The accuracy of particle size classification is complicated by very strong diffusion of particles below 10 nm (see References [7] and [8]). The state-of-the-art commercial condensation particle counters for general purposes can detect particles down to 1 nm to 2 nm.

A large number of standards for testing air filters exist such as the ISO 29463 and ISO 16890 series. The test particle range in the ISO 29463 series is between 0,04 µm and 0,8 µm, and the focus is on measurement of the minimum efficiency at the most penetrating particle size (MPPS). The test particle range in the ISO 16890 series is between 0,3 µm and 10 µm. The ISO 21083 series aims to standardize the methods of determining the efficiencies of filter media, of all classes, used in most common air filtration products and it focuses on filtration efficiency of airborne nanoparticles, especially for particle size down to single-digit nanometres.

Advances in aerosol instruments and studies on nanoparticle filtration in the recent years provide a solid base for development of a test method to determine effectiveness of filtration media against airborne nanoparticles down to 3 nm range.

Test method to measure the efficiency of air filtration media against spherical nanomaterials —

Part 2: Size range from 3 nm to 30 nm

1 Scope

This document specifies the testing instruments and procedure for determining the filtration efficiencies of flat sheet filter media against airborne nanoparticles in the range of 3 nm to 30 nm. The testing methods in this document are limited to spherical or nearly-spherical particles to avoid uncertainties due to the particle shape.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5167 (all parts), *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full*

ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

ISO 15900, *Determination of particle size distribution — Differential electrical mobility analysis for aerosol particles*

ISO 27891, *Aerosol particle number concentration — Calibration of condensation particle counters*

ISO 29464, *Cleaning of air and other gases — Terminology*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5167-1, ISO 5725-1, ISO 5725-2, ISO 15900, ISO 27891, and ISO 29464 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.2 Symbols and abbreviated terms

3.2.1 Symbols

Symbol	Definition
A	Source strength of the radioactive source
A_0	Original source strength of the radioactive source
A_f	Effective filtration surface area
C_{up}	Particle concentration upstream of the filter medium
$C_{up,i}$	Concentration of particles with the i_{th} monodisperse size upstream of the filter medium
C_{down}	Particle concentration downstream of the filter medium
$C_{down,i}$	Concentration of particles with the i_{th} monodisperse size downstream of the filter medium
C_{ni}	Concentration of particles after the second DEMC for the particles with i charge(s)
d_d	Diameter of the initial droplet including the solvent
d_p	Diameter of the testing particle after complete evaporation of the solvent
E	Filtration efficiency of the test filter medium
E_i	Filtration efficiency of the test filter medium against the particles with the i_{th} monodisperse size
e	Charge of an electron
φ_v	Volume fraction of DEHS in the solution
$t_{0,5}$	Half-life of the radioactive source
N_{up}	Total count of particles upstream of the filter medium in a certain user-defined time interval
$N_{up,i}$	Counts of particles with the i_{th} monodisperse size upstream of the filter medium in a certain user-defined time interval
N_{down}	Total count of particles downstream of the filter medium in a certain user-defined time interval
$N_{down,i}$	Counts of particles with the i_{th} monodisperse size downstream of the filter medium in a certain used-defined time interval
N_{ni}	Total count of particles after the second DEMC for the particles with i charge(s)
n_p	Number of elementary charges
P	Fractional penetration of the test filter medium
P_i	Fractional penetration of particles with the i_{th} monodisperse size for the test filter medium
P_m	Penetration with the filter medium, before applying the correlation ratio
$P_{m,i}$	Measured penetration against particles with the i_{th} monodisperse size when the filter medium is installed in the filter medium holder, before applying the correlation ratio
q	Flow rate through the filter medium
q_e	Air flow rate through the electrometer
R	Correlation ratio
R_i	Correlation ratio for the i_{th} monodisperse particle size, obtained as the penetration without the filter media
R_{es}	Resistance of resistor
t	Time
v_f	Filter medium velocity
V	Voltage
x	Volume of the sampled air
α	Angle for the transition section in the filter medium holder
Δp	Pressure drop across the filter medium
E_0	Initial particulate efficiency of media sample
ΔE_c	Difference in particulate efficiency between E_0 and conditioned efficiency of the media sample
λ	Radioactive decay constant equal to 0,693/ $t_{0,5}$

3.2.2 Abbreviated terms

AC	Alternating current
CAS	Chemical abstracts service
CL	Concentration limit
CMD	Count median diameter
CPC	Condensation particle counter
DEHS	Di(2-ethylhexyl) sebacate
DEMC	Differential electrical mobility classifier
DMAS	Differential mobility analysing system
HEPA	High efficiency particulate air
Kr	Krypton
IPA	Isopropyl alcohol
MPPS	Most penetrating particle size
Po	Polonium
PSL	Polystyrene latex
RH	Relative humidity
SRM	Standard reference material

4 Principle

The filtration efficiency of the filter medium is determined by measuring the particle number concentrations upstream and downstream of the filter medium. The fractional penetration, P, represents the fraction of aerosol particles which can go through the filter medium, as shown in Formula (1):

$$P = C_{\text{down}} / C_{\text{up}} \quad (1)$$

where C_{down} and C_{up} are the particle concentrations downstream and upstream of the filter medium, respectively. Another way is to measure the particle counts upstream and downstream of the filter medium for a certain same user-defined time interval and sampling volume rate. Then, the penetration is the ratio between the downstream count, N_{down}, and upstream count, N_{up}, as shown in Formula (2):

$$P = N_{\text{down}} / N_{\text{up}} \quad (2)$$

The filter medium efficiency, E, is the fraction of aerosols particles removed by the filter medium, as shown in Formula (3):

$$E = 1 - P \quad (3)$$

The filter medium efficiency is dependent on the challenge particle size. If the test is performed with a number of monodisperse particles with different sizes, the expression for the penetration of particles with the i_{th} monodisperse size, P_i, can be written as shown in Formula (4):

$$P_i = C_{\text{down},i} / C_{\text{up},i} \quad (4)$$

where $C_{\text{up},i}$ and $C_{\text{down},i}$ are the concentration of particles with the i_{th} monodisperse size upstream and downstream of the filter medium, respectively. If the test is performed with a number of monodisperse