
Preskusna metoda za merjenje učinkovitosti sredstev za filtriranje zraka, ki vsebuje kroglaste nanomateriale - 1. del: Velikost od 20 nm do 500 nm (ISO 21083-1:2018)

Test method to measure the efficiency of air filtration media against spherical nanomaterials - Part 1: Size range from 20 nm to 500 nm (ISO 21083-1:2018)

Prüfverfahren zur Messung der Effizienz von Luftfiltrationsmedien gegen sphärische Nanomaterialien - Teil 1: Partikelgrößenbereich von 20 nm bis 500 nm (ISO 21083-1:2018)

Méthode d'essai pour mesurer l'efficacité des médias de filtration d'air par rapport aux nanomatériaux sphériques - Partie 1: Spectre granulométrique de 20 nm à 500 nm (ISO 21083-1:2018)

Ta slovenski standard je istoveten z: EN ISO 21083-1:2018

ICS:

91.140.30	Prezračevalni in klimatski sistemi	Ventilation and air-conditioning systems
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SIST EN ISO 21083-1:2019

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EUROPEAN STANDARD

EN ISO 21083-1

NORME EUROPÉENNE

EUROPÄISCHE NORM

December 2018

ICS 91.140.30

English Version

Test method to measure the efficiency of air filtration media against spherical nanomaterials - Part 1: Size range from 20 nm to 500 nm (ISO 21083-1:2018)

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European foreword

This document (EN ISO 21083-1:2018) 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.

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of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

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INTERNATIONAL
STANDARD

ISO
21083-1

First edition
2018-11

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

**Part 1:
Size range from 20 nm to 500 nm**

iTeh STANDARD PREVIEW
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*Méthode d'essai pour mesurer l'efficacité des médias de filtration
d'air par rapport aux nanomatériaux sphériques —
Partie 1: Spectre granulométrique de 20 nm à 500 nm*

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Reference number
ISO 21083-1:2018(E)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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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.

ISO 21083-1:2018(E)

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 [17]).

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 nanoparticle 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.

A large number of standards for testing air filters exist such as the ISO 29463 series and the 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.

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

Part 1: Size range from 20 nm to 500 nm

1 Scope

This document specifies the testing instruments and procedure for determining the fractional filtration efficiencies of flat sheet filter medium against airborne nanoparticles in the range of 20 nm to 500 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 5725-2, *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 29463-1, *High efficiency filters and filter media for removing particles from air — Part 1: Classification, performance, testing and marking*

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 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 <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

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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 user-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
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

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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, defined as:

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

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} :

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