SLOVENSKI STANDARD
SIST EN 16966:2019

01-januar-2019

Izpostavljenost na delovnem mestu - Merjenje izpostavljenosti pri vdihavanju nanopredmetov ter njihovih agregatov in aglomeratov - Uporaba metrik, kot so številčna koncentracija, masna koncentracija in koncentracija površine

Workplace exposure - Measurement of exposure by inhalation of nano-objects and their aggregates and agglomerates - Metrics to be used such as number concentration, surface area concentration and mass concentration

Exposition am Arbeitsplatz - Messung der inhalativen Exposition gegenüber Nanoobjekten und deren Aggregaten und Agglomeraten - Zu verwendende Metriken wie Anzahlkonzentration, Oberflächenkonzentration und Massenkonzentration

Exposition sur les lieux de travail - Mesurage de l'exposition par inhalation de nano-objets et de leurs agrégats et agglomérats - Métriques à utiliser telles que concentration en nombre, concentration en surface et concentration en masse

Ta slovenski standard je istoveten z: EN 16966:2018

ICS:

13.040.30	Kakovost zraka na delovnem mestu	Workplace atmospheres

SIST EN 16966:2019 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16966

November 2018

ICS 13.040.30

English Version

Workplace exposure - Measurement of exposure by inhalation of nano-objects and their aggregates and agglomerates - Metrics to be used such as number concentration, surface area concentration and mass concentration

Exposition sur les lieux de travail - Mesurage de l'exposition par inhalation de nano-objets et de leurs agrégats et agglomérats - Métriques à utiliser telles que concentration en nombre, concentration en surface et concentration en masse

Exposition am Arbeitsplatz - Messung der inhalativen Exposition gegenüber Nanoobjekten und deren Aggregaten und Agglomeraten - Zu verwendende Metriken wie Anzahlkonzentration, Oberflächenkonzentration und Massenkonzentration

This European Standard was approved by CEN on 27 August 2018.

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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 16966:2018 E

Contents

Page

European foreword

This document (EN 16966:2018) has been prepared by Technical Committee CEN/TC 137 “Assessment of workplace exposure to chemical and biological agents”, 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 May 2019, and conflicting national standards shall be withdrawn at the latest by May 2019.

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

This document has been prepared under a standardization request given to CEN by the European Commission and the European Free Trade Association.

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

Introduction

Historically, workers' occupational exposure to airborne non-radioactive particles has been expressed as mass concentrations. The main exception has been fibres of various compositions that have been given as a number concentration for fibres within specified diameter and length limits. Other exceptions are units of glycine per cubic metre for enzymes and number of colony-forming units for airborne microbiological organisms.

Engineered/manufactured nanomaterials are now being used on a wide scale. Only for a few nanomaterials is there currently large enough knowledge of which parameters of the exposure are critical for specific health end-points. Scientific documents for the elaboration of OELs for airborne nano-objects and their aggregates and agglomerates (NOAA) greater than 100 nm are limited, and nano-object specific legally binding Occupational Exposure Limits (OELs) have not been established. However, for some NOAA recommended OELs have been published. Currently, there is no overall agreement on the metric of occupational exposure to airborne NOAA. Nevertheless, all existing legally binding OELs are respected, as substances in their non-nanoscale or microscale form may have recognised OELs. Concentrations of airborne particles can be expressed as a number, surface area or mass concentrations. For spherical particles these are mathematically related to the integral over all particle sizes of the number of particles (per size) times the corresponding particle size raised to zero, two and three, respectively. The different expressions of particle concentrations are generally referred to as different metrics.

Instruments used for the determination of concentrations of airborne particles are generally based on a specific measurement principle that measures the particles in only one of the metrics. Particle concentrations given by these metrics are related to each other via the particle size distribution. In general it is difficult, not to say impossible, to recalculate a concentration given in one metric into another if the complete size distribution is not known and the particles are not spherical or of varying/unknown effective density. It is therefore important that the user of measurement data on occupational exposure to NOAA understands the concepts of particle metrics.

For comprehensive exposure assessments of NOAA, it is recommended that the occupational exposure is determined in parallel for more than one metric, as it is presently unknown which metric later will be considered as most relevant for the critical health effect.

1 Scope

This European Standard specifies the use of different metrics for the measurement of exposure by inhalation of NOAA during a basic assessment and a comprehensive assessment, respectively, as described in EN 17058 [1].

This document demonstrates the implications of choice of particle metric to express the exposure by inhalation to airborne NOAA, e.g. released from nanomaterials[1] and present the principles of operation, advantages and disadvantages of various techniques that measure the different aerosol metrics.

Potential problems and limitations are described and need to be addressed when occupational exposure limit values might be adopted in the future and compliance measurements will be carried out.

Specific information is mainly given for the following metrics/measurement techniques:

— Number/Condensation Particle Counters by optical detection;

— Number size distribution/differential mobility analysing systems by electrical mobility;

— Surface area/electrical charge on available particle surface;

— Mass/chemical analyses (e.g. Inductively Coupled Plasma atomic Mass Spectrometry (ICP-MS), X-Ray Fluorescence (XRF)) on size-selective samples (e.g. by impaction or diffusion).

This document is intended for those responsible for selecting measurement methods for occupational exposure to airborne NOAA.

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.

EN 1540, *Workplace exposure — Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1540 and the following apply.

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

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

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

3.1
agglomerate
collection of weakly bound particles or aggregates or mixtures of the two where the resulting external surface area is similar to the sum of the surface areas of the individual components

Note 1 to entry: The forces holding an agglomerate together are weak forces, for example van der Waals forces, or simple physical entanglement.

[1] Currently, the EU has a recommendation for a definition of nanomaterial [SOURCE: *Official Journal of the European Union* L275/38, 20 October 2011]. In this document the ISO definition on nanomaterial is used.

Note 2 to entry: Agglomerates are also termed secondary particles and the original source particles are termed primary particles.

[SOURCE: CEN ISO/TS 80004-2:2017, 3.4] [2]

3.2
aggregate
particle comprising strongly bonded or fused particles where the resulting external surface area can be significantly smaller than the sum of calculated surface areas of the individual components

Note 1 to entry: The forces holding an aggregate together are strong forces, for example covalent bonds, or those resulting from sintering or complex physical entanglement.

Note 2 to entry: Aggregates are also termed secondary particles and the original source particles are termed primary particles.

[SOURCE: CEN ISO/TS 80004-2:2017, 3.5]

3.3
background airborne particles
particles which occur at the time and position where samples are taken or measurements are carried out using different metrics of NOAA but which have another origin or source than the NOAA under investigation

Note 1 to entry: Ultrafine particles are a subset of the background airborne particles.

3.4
BET method
method for the determination of the total specific external and internal surface area of disperse powders and/or porous solids per unit of mass by measuring the amount of physically adsorbed gas utilizing the model developed by Brunauer, Emmett and Teller for interpreting gas adsorption isotherms

Note 1 to entry: Method originates from Brunauer, Emmett and Teller [3].

Note 2 to entry: Inaccessible pores are not detected. The BET method cannot reliably be applied to solids that absorb the measuring gas.

[SOURCE ISO 9277:2010] [4]

3.5
coagulation
process caused by relative motion between particles which causes particles to collide with each other and thereafter adhering to one another

Note 1 to entry: For nanoscale particles, Brownian diffusion is the dominant source of relative motion between particles, whereas for particles of significantly different sizes, the corresponding settling velocities can be the dominant source. Coagulation leads to a reduction in the number concentration of airborne particles and a simultaneous increase in particle size. The mass concentration remain unaffected by coagulation, and for solid particles, the surface area concentration also remain unaffected by coagulation.

3.6
coincidence
simultaneous occurance of two particles in the sensing zone of an instrument which are registered as one (possibly larger) particle

3.7
equivalent density
effective density
ratio of mass of an agglomerate/aggregate to the volume of a sphere defined by an equivalent diameter of the same agglomerate/aggregate

Note 1 to entry: The effective density generally decreases as the size of an agglomerate/aggregate increases.

3.8
equivalent spherical diameter
diameter of a sphere that produces a response by a given particle-sizing method, which is equivalent to the response produced by the particle being measured

Note 1 to entry: The physical property to which the equivalent diameter refers is indicated using a suitable subscript (see ISO 9276-1).

[SOURCE: CEN ISO/TS 80004-2:2017, A.2.3]

3.9
Feret diameter
distance between two parallel tangents on opposite sides of the image of a particle

[SOURCE: ISO 26824, 8.6] [5]

3.10
incidental nano-object
nano-object generated as an unintentional by-product of a process

Note 1 to entry: The process includes manufacturing, biotechnological or other processes.

Note 2 to entry: The term ultrafine particles is often used to describe unintentionally produced nano-objects.

[SOURCE: CEN ISO/TS 80004-2:2017, 4.3, modified — Note 2 has been added]

3.11
material density
particle material density
ratio of particle mass to particle volume excluding all pores, voids and other gas containing compartments

3.12
median diameter
median particle diameter
particle size of a particle distribution for which one-half the total number of particles are larger and one-half are smaller

[SOURCE: ISO 16972:2010, 3.47] [6]

3.13
metric
airborne metric
NOAA metric
concentration metric
amount of a selected NOAA characteristic in which the particle concentration is expressed

3.14
monitor
real-time monitor
instrument that continuously measures an entity and for the purpose of the measurements instantaneously displays/ records the measured value

Note 1 to entry: The relevant instruments typically report a value every second or even faster. Instruments with a time resolution of 1 min up to several minutes are usually termed quasi-real-time.

3.15
nanomaterial
material with any external dimensions in the nanoscale or having internal structure or surface structure in the nanoscale

[SOURCE: CEN ISO/TS 80004-1:2015, 2.4] [7]

3.16
nano-object
discrete piece of material with one, two or three external dimensions in the nanoscale

Note 1 to entry: The second and third external dimensions are orthogonal to the first dimension and to each other.

[SOURCE: CEN ISO/TS 80004-1: 2015, 2.5]

3.17
nanoscale
length range approximately from 1 nm to 100 nm

Note 1 to entry: Properties that are not extrapolations from larger sizes are predominantly exhibited in this length range.

[SOURCE: CEN ISO/TS 80004-1: 2015, 2.1]

3.18
particle
minute piece of matter with defined physical boundaries

Note 1 to entry: A physical boundary can also be described as an interface.

Note 2 to entry: A particle can move as a unit.

Note 3 to entry: This general particle definition applies to nano-objects.

Note 4 to entry: The physical phase of the particle can be either solid or liquid.

[SOURCE: ISO 26824:2013, 1.1, modified — Note 4 has been added]

3.19
particle aerodynamic diameter
particle aerodynamic equivalent diameter
aerodynamic equivalent diameter
aerodynamic diameter
d_{ae}
diameter of a sphere of 1 g/cm^3 density with the same terminal settling velocity in calm air as the particle, under the prevailing conditions of temperature, pressure and relative humidity

Note 1 to entry: The particle aerodynamic diameter of a particle depends on the size, density and shape of the particle.

Note 2 to entry: In the human respiratory tract, the separation of particles with an aerodynamic diameter smaller than approximately 0,4 µm is better characterized by the particle diffusive equivalent diameter.

[SOURCE: EN 1540:2011, 2.3.2, modified — Further admitted terms, letter symbol and Note 2 have been added]

3.20
particle diffusive diameter
particle diffusive equivalent diameter
diffusive equivalent diameter
diffusive diameter
DEPRECATED: thermodynamic diameter
d_{de}
diameter of a sphere with the same diffusion coefficient as the particle under prevailing condition of temperature and pressure within the respiratory tract

Note 1 to entry: The weak dependence of the particle diffusive diameter on the relative humidity is neglected [2].

Note 2 to entry: The particle diffusive diameter is applicable to any particle, regardless of its shape and is independent of the density of the particle.

Note 3 to entry: For spherical particles, the particle diffusive diameter equals the geometric diameter.

Note 4 to entry: For particles with aerodynamic diameter above approximately 0,4 µm, the aerodynamic diameter becomes more significant in characterizing deposition than particle diffusive diameter.

[SOURCE: EN ISO 13138:2012, 3.2, modified — 'Particle diffusive diameter" introduced as new preferred term, further admitted terms added, term 'thermodynamic diameter' referred as deprecated] [8]

3.21
particle mobility diameter
particle mobility equivalent diameter
mobility equivalent diameter
mobility diameter
d_{me}
diameter of a sphere carrying a single elementary charge with the same drift speed in an electric field as the particle under prevailing condition of temperature and pressure