SLOVENSKI STANDARD
SIST EN 17199-2:2019

01-september-2019

Izpostavljenost na delovnem mestu - Meritve prašnosti razsutih materialov, ki vsebujejo ali sproščajo respirabilne nanopredmete ter njihove agregate in aglomerate (NOAA) in druge respirabilne delce - 2. del: Metoda z vrtečim bobnom

Workplace exposure - Measurement of dustiness of bulk materials that contain or release respirable NOAA or other respirable particles - Part 2: Rotating drum method

Exposition am Arbeitsplatz - Messung des Staubungsverhaltens von Schüttgütern, die Nanoobjekte oder Submikrometerpartikel enthalten oder freisetzen - Teil 2: Verfahren mit großer rotierender Trommel

Exposition sur les lieux de travail - Mesurage du pouvoir de resuspension des matériaux en vrac contenant ou émettant des nano-objets et leurs agrégats et agglomérats (NOAA) ou autres particules en fraction alvéolaire - Partie 2: Méthode du tambour rotatif

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13.040.30	Kakovost zraka na delovnem mestu	Workplace atmospheres

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EUROPEAN STANDARD

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English Version

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

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

Contents

Page

European foreword

This document (EN 17199-2:2019) 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of an identical text or by endorsement, at the latest by September 2019 and conflicting national standards shall be withdrawn at the latest by September 2019.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.

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Introduction

Dustiness measurement and characterization provide users (e.g. manufacturers, producers, occupational hygienists and workers) with information on the potential for dust emissions when the bulk material is handled or processed in workplaces. They provide the manufacturers of bulk materials containing NOAA with information that can help to improve their products and reduce their dustiness. It allows the users of the bulk materials containing NOAA to assess the controls and precautions required for handling and working with the material and the effects of pre-treatment (e.g. modify surface properties or chemistry). It also allows the users to select less dusty products, if available. The particle size distribution of the aerosol and the morphology and chemical composition of its particles can be used by occupational hygienists, scientists and regulators to further characterize the aerosol in terms of particle size distribution and chemical composition and to thus aid users to evaluate and control the health risk of airborne dust.

This document gives details on the design and operation of the rotating drum method that measures the dustiness of bulk materials that contain or release respirable NOAA or other respirable particles in terms of dustiness indices or emission rates. Dustiness indices as well as emission rates can be number-based or mass-based. In addition, the test method characterizes the released aerosol by measuring the particle size distribution using direct-reading aerosol instruments and collects samples for off-line analysis (as required) for their morphology and chemical composition. This test uses the same dust generation method as EN 15051-2. The determination of the health-related dustiness mass fractions of the released dust from a bulk material containing NOAA is carried out according to EN 15051-1 and EN 15051-2, an experimental set-up different from the one used to determine the number-based dustiness index and the number-based emission rate.

The rotating drum method is useful for addressing the ability of bulk materials including nanomaterials (in powder form), to release airborne particles (aerosol) during agitation, the so-called dustiness.

The rotating drum method has been designed to simulate workplace scenarios and to represent general bulk material handling processes, including processes where bulk material is tipped, poured, mixed, scooped, dropped or similar, either mechanically or by hand.

The rotating drum method presented here differs from the continuous drop, the small rotating drum and the vortex shaker methods presented in EN 17199-3 [1], EN 17199-4 [2] and EN 17199-5 [3] respectively. The rotating drum and small rotating drum methods perform, both, repeated pouring or agitation of a bulk material. The continuous drop method simulates continuous feed of a bulk material while the vortex shaker method simulates vigorous agitation of a bulk material.

This document was developed based on the results of pre-normative research [4]. This project investigated the dustiness of ten bulk materials (including nine bulk nanomaterials) with the intention to test as wide a range of bulk materials as possible in terms of magnitude of dustiness, chemical composition and primary particle size distribution as indicated by a large range in specific surface area.

1 Scope

This document provides the methodology for measuring the dustiness of bulk materials that contain or release respirable NOAA or other respirable particles, under standard and reproducible conditions and specifies for that purpose the rotating drum method.

This document specifies the selection of instruments and devices and the procedures for calculating and presenting the results. It also gives guidelines on the evaluation and reporting of the data.

The methodology described in this document enables

a) the measurement of the respirable, thoracic and inhalable dustiness mass fractions,

b) the measurement of the number-based dustiness index of respirable particles in the particle size range from about 10 nm to about 1 µm,

c) the measurement of the number-based emission rate of respirable particles in the particle size range from about 10 nm to about 1 µm,

d) the measurement of the number-based particle size distribution of the released aerosol in the particle size range from about 10 nm to about 10 µm, and

e) the collection of released airborne particles in the respirable fraction for subsequent observations and analysis by analytical electron microscopy.

NOTE 1 The particle size range described above is based on the equipment used during the pre-normative research [4].

This document is applicable to the testing of a wide range of bulk materials including powders, granules or pellets containing or releasing respirable NOAA or other respirable particles in either unbound, bound uncoated and coated forms.

NOTE 2 Currently no number-based classification scheme in terms of dustiness indices or emission rates have been established. Eventually, when a large number of measurement data has been obtained, the intention is to revise this document and to introduce such a classification scheme, if applicable.

NOTE 3 The method specified in this document has not been investigated for the measurement of the dustiness of bulk materials containing nanofibres and nanoplates in terms of number-based dustiness indices or emission rates. However, there is no reason to believe that the number-based dustiness indices or emission rates could not be measured with the rotating drum method using the set-up described in this document.

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.

CEN ISO/TS 80004-2, *Nanotechnologies - Vocabulary - Part 2: Nano-objects (ISO/TS 80004-2)*

EN 481, *Workplace atmospheres - Size fraction definitions for measurement of airborne particles*

EN 1540, *Workplace exposure - Terminology*

EN 13205-2, *Workplace exposure - Assessment of sampler performance for measurement of airborne particle concentrations - Part 2: Laboratory performance test based on determination of sampling efficiency*

EN 15051-1, *Workplace exposure - Measurement of the dustiness of bulk materials - Part 1: Requirements and choice of test methods*

EN 15051-2, *Workplace exposure - Measurement of the dustiness of bulk materials - Part 2: Rotating drum method*

EN 16897, *Workplace exposure - Characterization of ultrafine aerosols/nanoaerosols - Determination of number concentration using condensation particle counters*

EN 17199-1, *Workplace exposure - Measurement of dustiness of bulk materials that contain or release respirable NOAA or other respirable particles - Part 1: Requirements and choice of test methods*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1540, EN 15051-1, CEN ISO/TS 80004-2 and EN 17199-1 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

4 Symbols and abbreviations

AES	Atomic Emission Spectroscopy
CPC	Condensation Particle Counter
d_{50}	A lower particle size at which the counting or sampling efficiency is 50 %
DEMC	Differential Electrical Mobility Classifier
ELPI® [1)]	Electrical Low Pressure Impactor
EM	Electron Microscopy
HEPA	High Efficienty Particulate Arrestance
ICP	Inductively Coupled Plasma
MS	Mass Spectrometry
NOAA	Nano-objects, and their aggregates and agglomerates > 100 nm
RD	Rotating Drum
RH	Relative Humidity
TEM	Transmission Electron Microscopy
XRF	X-ray fluorescence

1) ELPI® is the trade name or trademark of a product supplied by Dekati. This information is given for the convenience of users of this European Standard and does not constitute an endorsement by CEN of the product named. Equivalent products may be used if they can be shown to lead to the same results.

5 Principle

The rotating drum method described in this document measures the dustiness of bulk materials in terms of

— the respirable, thoracic and inhalable dustiness mass fractions,

— the number-based dustiness index, and

— the number-based emission rate.

In addition, this document describes the procedures by which the aerosols can be further characterized in terms of their particle size distributions and the morphology and chemical composition of their airborne particles.

The sampling for the purpose of and the execution of qualitative or quantitative analysis of the morphology and chemical composition of the collected airborne particles are described. Performing these analyses is optional but can provide confirmation of the sizes of the particles generated and complementary information to the time-resolving instruments.

Table 1 provides

— an overview of the different measurands,

— information on whether determining these measurands is mandatory or not, and

— the aerosol instruments and sampling devices needed to determine a measurand.

Table 1 — Measurand, aerosol instrument/sampling device and associated recommendations for the rotating drum method

Measurand (unit)	Method/device specific to measurand	Mandatory/optional
Respirable, thoracic and inhalable dustiness mass fraction (mg/kg)	Set of metal foams and a filter (separate testing according to EN 15051-1 and EN 15051-2)	Mandatory
Number-based dustiness index of respirable particles in the particle size range from about 10 nm to about 1 µm (1/mg)	Condensation Particle Counter (CPC)	Mandatory
Number-based average emission rate of respirable particles in the particle size range from about 10 nm to about 1 µm (1/mg·s)		Mandatory

Measurand (unit)	Method/device specific to measurand	Mandatory/optional
Number of modes of the time-averaged number-based particle size distribution as $dN/d\log D_i$ (-)	Time- and size-resolving instrument covering the particle size range from about 10 nm up to about 10 µm	Mandatory
Modal aerodynamic equivalent diameters corresponding to the highest mode ($M1_N$) and to the second highest mode ($M2_N$) of the time-averaged number-based particle size distribution as $dN/d\log D_i$ (µm)		Mandatory
Number of modes of the time-averaged mass-based particle size distribution as $dM/d\log D_i$ (-)	Cascade impactor covering the particle size range from about 10 nm up to about 10 µm	Optional
Modal aerodynamic equivalent diameters corresponding to the highest mode ($M1_M$) and to the second highest mode ($M2_M$) of the time-averaged mass-based particle size distribution as $dM/d\log D_i$ (µm)		Optional
Morphological and chemical characterization of the particles including NOAA	TEM-grid holder equipped with porous carbon film TEM-grid	Optional Carbon film can be analysed by TEM
	A set of metal foams followed by a filter according to EN 15051-2	Optional Filter can be quantitatively analysed by XRF, ICP-AES or ICP-MS.
NOTE The particle size range described above is based on the equipment used during the pre-normative research.		

The determination of the inhalable, thoracic and respirable dustiness mass fractions of the released dust from a bulk material shall be carried out according to EN 15051-1 and EN 15051-2. The experimental set-up of that method is different from the one used to determinate the number-based dustiness index and the emission rate.

6 Equipment

6.1 Test apparatus for the determination of the inhalable, thoracic and respirable dustiness mass fractions

The test apparatus and test methods specified in EN 15051-1 and EN 15051-2 shall be used to determine the inhalable, thoracic and respirable dustiness mass fractions.