SLOVENSKI STANDARD
SIST EN 17199-3:2019

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 - 3. del: Metoda trajnega padanja

Workplace exposure - Measurement of dustiness of bulk materials that contain or release respirable NOAA or other respirable particles - Part 3: Continuous drop method

Exposition am Arbeitsplatz - Messung des Staubungsverhaltens von Schüttgütern, die Nanoobjekte oder Submikrometerpartikel enthalten oder freisetzen - Teil 3: Verfahren mit kontinuierlichem Fall

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 3: Méthode de la chute continue

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ICS:

13.040.30	Kakovost zraka na delovnem mestu	Workplace atmospheres

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EUROPEAN STANDARD

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English Version

Workplace exposure - Measurement of dustiness of bulk materials that contain or release respirable NOAA or other respirable particles - Part 3: Continuous drop method

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 3: Méthode de la chute continue

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

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European foreword

This document (EN 17199-3:2019) 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of an identical text or by endorsement, at the latest by September 2019 and conflicting national standards shall be withdrawn at the latest by September 2019.

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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 manufactures 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 continuous drop 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 and emission rate using on-line methods and collects samples for off-line analysis (as required) for their morphology and chemical composition. This test uses the same dust generation methods and the same set-up including dimensions of the apparatus specified in EN 15051-3. The determination of the inhalable and respirable dustiness mass fractions (see EN 481 [1]) of the released dust from a bulk material containing NOAA is carried out separately according to EN 15051-1 and EN 15051-3.

The continuous drop 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 continuous drop 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 mechanical or by hand.

The continuous drop method presented here differs from the rotating drum, the small rotating drum and the vortex shaker method presented in EN 17199-2 [2], EN 17199-4 [3] and EN 17199-5 [4] respectively. The rotating drum and small rotating drum methods perform, both, repeated pouring or agitation of the same sample 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 [5]. 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 continuous drop 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 and, optionally, the inhalable dustiness mass fractions,

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

c) the measurement of the number-based emission rate of 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 dustiness mass fraction for subsequent observations and analysis by analytical electron microscopy.

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 1 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 2 The methods specified in this document have not been evaluated for nanofibers and nanoplates.

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 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 15051-3, *Workplace exposure - Measurement of the dustiness of bulk materials - Part 3: Continuous drop 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*

EN ISO 13137, *Workplace atmospheres - Pumps for personal sampling of chemical and biological agents - Requirements and test methods (ISO 13137)*

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

APS®[1)]	Aerodynamic Particle Sizer
BET	Brunauer–Emmett–Teller
CDD	Continuous Drop Device
CPC	Condensation Particle Counter
d_{50}	A lower particle size at which the counting or sampling efficiency is 50 %
DEMC	Differential Electrical Mobility Classifier
DMAS	Differential Mobility Analysing system
NOAA	Nano-objects, and their aggregates and agglomerates > 100 nm
RH	Relative Humidity
SEM	Scanning Electron Microscopy
TEM	Transmission Electron Microscopy

5 Principle

The continuous drop method (see Annex A) described in this document measures the dustiness of bulk materials containing or releasing respirable NOAA or other respirable particles in terms of

— the respirable and inhalable dustiness mass fractions,

— the number-based dustiness index, and

— the number-based emission rate.

1) APS® is the trade name or trademark of a product supplied by TSI Instruments Ltd. 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.

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 real-time 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 — Measurands, aerosol instruments/sampling devices and associated recommendations for the continuous drop method

Measurand (unit)	**Method / device specific to measurand**	**Mandatory / optional**
Respirable dustiness mass fraction (mg/kg)	Filters according to EN 15051-1 and EN 15051-3	Mandatory
Inhalable dustiness mass fraction (mg/kg)		Optional
Number-based dustiness index of particles in the particle size range from about 10 nm to about 1 µm (1/mg)	Condensation Particle Counter (CPC)[a] covering the particle size range from about 10 nm to about 1 µm	Mandatory
Number-based average emission rate of particles in the particle size range from about 10 nm to about 1 µm (1/mg·s)		Mandatory
Number of modes of the time-averaged number-based particle size distribution as $dN/d\log D_i$ (-)	DMAS/APS® combination covering the particle size particle from about 10nm 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
Morphological and chemical characterization of the particles including NOAA	Sampling device, e.g. filters, according to EN 15051-1 and EN 15051-3	Optional
NOTE The particle size range described above is based on the equipment used during the prenormative research.		
[a] However, see 6.2.8 for possible alternate solutions.		

The determination of the inhalable and respirable dustiness mass fractions of the released dust from a bulk material containing NOAA can be carried out within the same test run according to EN 15051-1 and EN 15051-3.

6 Equipment

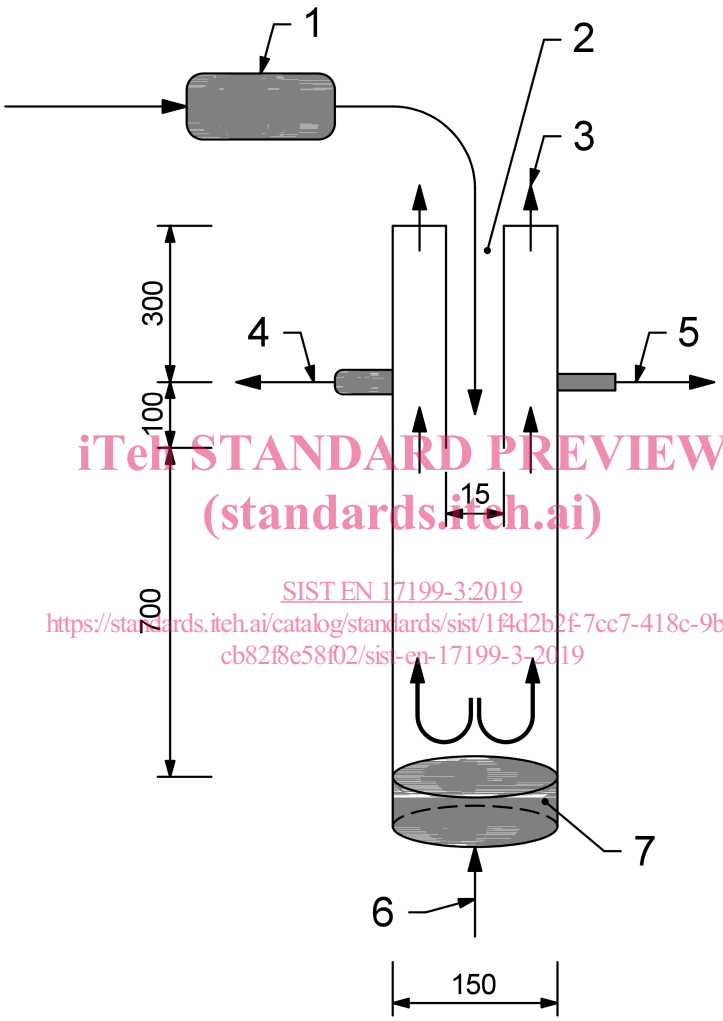
6.1 General

The test set-up used shall comply with all requirements of EN 15051-3.

The test apparatus required in order to determine the dustiness by the continuous drop test method is shown in Figure 1.

An illustration for an experimental test set-up example is given in Annex B.

Dimensions in millimetres



Key

1 feeder (6.2.2)
2 drop pipe (6.2.3)
3 main pump
4 sampler for gravimetric analysis (6.2.7), e.g. cyclone for the respirable dustiness mass fraction
5 online monitors
6 conditioned air, 53 l/min
7 collector tank (6.2.6) for fallen powder/ feed rate check

Figure 1 — Test apparatus

6.2 Test apparatus

The usual laboratory apparatus and, in particular, the following:

6.2.1 Continuous drop device, with characteristics as described in EN 15051-3.

6.2.2 Feeder, comprising of

a) a **sample tank**, large enough to hold the entire volume of the test substance for an entire test run;

b) a **metering device** for the powder mass flow, which does not change the composition and properties of the test material, e.g. by compacting or other mechanical processes, or, if some influence cannot be prevented, it should be minimized.

The metering device shall be suited at least for mass flows in the intended range from 3 g/min to 30 g/min, and should be suited for smaller mass flows as well.

The whole feeder shall be made from inert material, e.g. stainless steel. It shall be closed off during the experiments and no air leakage may enter the system via the feeder during the experiments.

NOTE A vibrating chute with adjustable feed rate has been shown to work well.

6.2.3 Drop pipe, with an inner diameter of 15 mm and a length of 400 mm.

The drop pipe shall be made from inert and electrically conducting material, e.g. stainless steel.

The drop pipe is a thin-walled tube.

6.2.4 Backflow pipe, round with an inner diameter of 150 mm.

The backflow pipe shall be manufactured from an inert and electrically conducting material, e.g. stainless steel. Within the backflow pipe a vertical air speed of 0,053 m/s, measured below the end of the drop pipe (6.2.3) shall be generated. It is critically important that a constant vertical air speed of 0,053 m/s is maintained as the sum of the main pump's flow rate and those of all sampling/measuring devices employed in the tests. For this purpose, a suitable instrument (e.g. a mass-flow controller (6.2.5)) to control the air flow generated by the main pump shall be in place.

The backflow pipe needs to be equipped with suitable openings/probes to connect the sampling devices. All openings shall be situated in one measurement plane (i.e. in an identical distance from the metering device 100 mm above the end of the drop pipe. They shall be situated in a symmetrical way around the drop pipe (i.e. for example if two openings are needed, they shall be opposite one another, if three are needed they shall be situated in a 120° orientation). Additionally, in the case of different sampling flow rates of the applied devices, they shall be oriented in such a way as to generate as homogenous distributions of sampling flows (out of the backflow pipe) as possible, in order to avoid inhomogeneous air flows in the vicinity of the end of the drop pipe.

6.2.5 Mass-flow controller, or another suitable instrument to control the air flow generated by the main pump.

6.2.6 Collector tank, made from inert material, e.g. stainless steel.

The collector tank for the fallen powder shall be mounted to the backflow pipe (6.2.4). It is used to collect the dropped powder and shall be suited for weighing.

In addition, the external air which generates the upstream air flow within the backflow pipe (6.2.4), shall be cleaned of environmental particles by use of a suitable filter (a target particle number concentration of less than 20 particles/cm^3 shall be guaranteed) and pass through the collector tank.