SLOVENSKI STANDARD
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[Not translated]

Workplace exposure - Measurement of dustiness of bulk materials that contain or release nano-objects or submicrometer particles - Part 1: Requirements and choice of test methods

Exposition am Arbeitsplatz - Messung des Staubungsverhaltens von Nanoobjekte und deren Aggregate und Agglomerate enthaltenden Schüttgütern - Teil 1: Anforderungen und Auswahl des Prüfverfahrens

Exposition sur les lieux de travail - Mesurage du pouvoir de resuspension des matériaux en vrac contenant des nano-objets et leurs agrégats et agglomérats - Partie 1: Exigences et choix des méthodes d'essai

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Workplace exposure - Measurement of dustiness of bulk materials that contain or release nano-objects or submicrometer particles - Part 1: Requirements and choice of test methods

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If this draft becomes a European Standard, 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.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

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European foreword

This document (prEN 17199-1:2017) 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 document is currently submitted to the CEN Enquiry.

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

Introduction

The control of the emitted and released airborne nano-objects and particles during the handling and transportation of bulk materials is an important consideration for workers' exposure and the design and operation of many industrial or research processes. It is therefore important to obtain information about the propensity of bulk materials to release nano-objects and respirable particles and thus assist in assessing the risk for exposure to a hazardous material.

Dustiness data have been recommended for nanomaterials exposure assessment by the Organisation for Economic Co-operation and Development [1]; here are also already in use as an input parameter in some control banding tools for nanomaterials or to predict the likelihood of exposure by modelling. Finally, dustiness data can provide the manufacturers of nanomaterials with information that can help to improve their products (e.g. by selecting less dusty nanomaterials) or the users to improve their processes or their technical prevention approaches.

Dustiness depends on a number of factors including the physical state of the bulk material (e.g. powder, granules, pellets and moisture content), the physicochemical properties of the particles contained in the bulk material (e.g. size and shape, relevant density, type of coating, hydrophobicity and hydrophilicity properties, aggregation of particles), the environment (e.g. moisture, temperature), the condition of the bulk material, the type of aerosol generation (activation energy or energy input, time characteristics of the energy input),the interaction between particles during agitation (e.g. friction shearing, van der Wall forces) and the sampling and measurement configuration.

The aim of dustiness testing is to simulate typical powder processing and handling in order to enable a comparison of the relative dust release potential of different bulk materials. Data derived from dustiness testing can be used as input for qualitative or quantitative exposure assessment. Dustiness involves the application of a given type and amount of activation energy or energy input, to a stipulated amount of test material during a stipulated time, whereby particles are dispersed into the air and are described quantitatively. No single dustiness method is likely to represent and reproduce the various types of processing and handling used in the workplace. Therefore, there are a number of methods for the design of dustiness devices and different values will be obtained by different test methods. However, the test and the variables including the sampling and measurement configuration demand to be closely specified to ensure reproducibility.

Conventional dustiness methods for micrometre size particles estimate the airborne dust generated in terms of dustiness mass fraction (e.g. respirable, thoracic, inhalable), given in mg/kg. The current tripartite European Standard EN 15051 for conventional dustiness provides two methods: the rotating drum method and the continuous drop method. Although these methods are accepted standards for micrometer size particles, the biological behaviour of nano-objects, because of their small size and surface area, has raised the question whether the dustiness can be adequately characterised by their mass fraction only. Therefore, particle number concentration and size distribution are other important measurands for measuring and characterising the dustiness of bulk material containing nano-objects[1].

1) CEN ISO/TS 12025 [2] provides general methodology for the quantification of nano-object release from powders as a result of treatment, ranging from handling to high energy dispersion, by measuring aerosols liberated after a defined aerosolization procedure. However, it does not establish test methods.

This part of prEN 17199 together with prEN 17199-2:2017 to prEN 17199-5:2017 establishes test methods that measure the dustiness of bulk materials containing nano-objects in terms of health-related index mass fraction, index number and emission rate. In addition, it establishes test methods that characterize the aerosol from its particle size distribution and the morphology and chemical composition of its particles. It also gives guidance on the choice of a test method from four methods: the rotating drum, the continuous drop, the small rotating drum and the vortex shaker. These methods require different amount of test material and allow the application of a wide range of energy inputs to those materials. The rotating drum methods differ from the continuous drop and the vortex shaker methods. In the rotating drum, the bulk material is repeatedly dropped while in the continuous drop, it is dropped only once but continuously. In the vortex shaker, the bulk material is subjected to a much higher energy input. The principle of the rotating drum method is similar to that of the small rotating drum method.

This European Standard was originally developed based on the results of pre-normative research [3]. This project investigated the dustiness of ten bulk materials including nine bulk nanomaterials with the intention to test as wide a range of bulk nanomaterials as possible in terms of magnitude of dustiness, chemical composition and primary particle size-distribution as indicated by a high range in specific surface area.

1 Scope

This European Standard provides the methodology for measuring and characterizing the dustiness of a bulk material that contains or releases nano-objects or submicrometer particles. In addition, it specifies the environmental conditions, the sample handling procedure and the method of calculating and presenting the results. Guidance is given on the choice of method to be used.

The methodology described in this European Standard enables

a) the quantification of dustiness in terms of health-related index mass fractions,

b) the quantification of dustiness in terms of an index number and an emission rate, and

c) the characterization of the aerosol from its particle size distribution and the morphology and chemical composition of its particles.

NOTE 1 Currently, no number-based classification scheme in terms of particle number has been established for particle dustiness release. Eventually, when a large enough number of measurement data has been obtained, the intention is to revise this European Standard and to introduce a number-based classification scheme.

This European Standard is applicable to all bulk materials, including powders, granules or pellets, containing or releasing nano-objects or submicrometer particles.

NOTE 2 The vortex shaker method specified in part 5 of this European Standard has not yet been evaluated for pellets and granules.

NOTE 3 The rotating drum and continuous drop methods have not yet been evaluated for nanofibres and nanoplates.

This European Standard does not provide methods for assessing the release of particles during handling or mechanical reduction of machining (e.g. crushing, cutting, sanding, sawing) of solid nanomaterials (e.g. nanocomposites).

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*

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 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*

prEN 17199-2:2017, *Workplace exposure - Measurement of dustiness of bulk materials that contain or release nano-objects or submicrometer particles - Part 2: Rotating drum method* prEN 17199-3:2017, *Workplace exposure - Measurement of dustiness of bulk materials that contain or release nano-objects or submicrometer particles - Part 3: Continuous drop method*

prEN 17199-4:2017, *Workplace exposure - Measurement of dustiness of bulk materials that contain or release nano-objects or submicrometer particles - Part 4: Small rotating drum method*

prEN 17199-5:2017, *Workplace exposure - Measurement of dustiness of bulk materials that contain or release nano-objects or submicrometer particles - Part 5: Vortex shaker 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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1540, EN 15051-1 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.

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

[SOURCE: CEN ISO/TS 27687:2009, definition 3.2 [4]]

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 27687:2009, definition 3.3 [4]]

3.3
background particle
particle infiltrated from the laboratory

3.5
equivalent diameter
diameter of a sphere that produces a response by a given particle-sizing instrument, that 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 (ISO 9276-1:1998 [5]).

Note 2 to entry: For discrete-particle-counting, light-scattering instruments, the equivalent optical diameter is used.

Note 3 to entry: For inertial instruments, the aerodynamic diameter is used. Aerodynamic diameter is the diameter of a sphere of density 1 000 kg m^{-3} that has the same settling velocity as the irregular particle.

[SOURCE: CEN ISO/TS 27687:2009, definition A.3.3 [4]]

3.6
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, definition 2.4 [6]]

3.7
nano-object
material with one, two or three external dimensions in the nanoscale

Note 1 to entry: Generic term for all discrete **nanoscale** objects.

[SOURCE CEN ISO/TS 27687:2009, definition 2.2 [4]]

3.8
nanoscale
size range from approximately 1 nm to 100 nm

Note 1 to entry: Properties that are not extrapolations from a larger size will typically, but not exclusively, be exhibited in this size range. For such properties the size limits are considered approximate.

Note 2 to entry: The lower limit in this definition (approximately 1 nm) is introduced to avoid single and small groups of atoms from being designated as nano-objects or elements of nanostructures, which might be implied by the absence of a lower limit.

[SOURCE: CEN ISO/TS 27687:2009, definition 2.1 [4]]

3.9
nanoparticle
nano-object with all three external dimensions in the nanoscale

Note 1 to entry: If the lengths of the longest to the shortest axes of the nano-object differ significantly (typically by more than three times), the terms nanofibre or nanoplate are intended to be used instead of the term nanoparticle.

[SOURCE: CEN ISO/TS 27687:2009, definition 4.1 [4]]

3.10
number-based dustiness index
ratio of the number of particles released over the duration of the test, to the test mass for the respective test dustiness