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Zrak na delovnem mestu - Ocenjevanje lastnosti merilnikov za merjenje koncentracij lebdečih delcev - 6. del: Transport in ravnanje

Workplace exposure - Assessment of sampler performance for measurement of airborne particle concentrations - Part 6: Transport and handling tests

Exposition am Arbeitsplatz - Bewertung der Leistungsfähigkeit von Sammlern für die Messsung der Konzentration luftgetragener Partikel - Teil 6: Prüfungen zum Transport und zur Handhabung

Exposition sur les lieux de travail - Évaluation des performances des dispositifs de prélèvement pour la mesure des concentrations de particules en suspension dans l'air - Partie 6: Essais de manipulation et de transport

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Workplace exposure - Assessment of sampler performance for measurement of airborne particle concentrations - Part 6: Transport and handling tests

Exposition sur les lieux de travail - Évaluation des performances des dispositifs de prélèvement pour la mesure des concentrations de particules en suspension dans l'air - Partie 6: Essais de manipulation et de transport

Exposition am Arbeitsplatz - Beurteilung der Leistungsfähigkeit von Sammlern für die Messung der Konzentration luftgetragener Partikel - Teil 6: Prüfungen zum Transport und zur Handhabung

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 137.

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Foreword

This document (prEN 13205-6:2012) 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 together with prEN 13205-1, prEN 13205-2, FprCEN/TR 13205-3, prEN 13205-4 and prEN 13205-5 supersedes prEN 13205:2010 and will supersede EN 13205:2001.

EN 13205 *Workplace exposure – Assessment of sampler performance for measurement of airborne particle concentrations* consists of the following parts:

— *Part 1: General requirements;*

— *Part 2: Laboratory performance test based on determination of sampling efficiency;*

— *Part 3: Analysis of sampling efficiency data;*

— *Part 4: Laboratory performance test based on comparison of concentrations;*

— *Part 5: Aerosol sampler performance test and sampler comparison carried out at workplaces;*

— *Part 6: Transport and handling tests.*

Introduction

EN 481 defines sampling conventions for the particle size fractions to be collected from workplace atmospheres in order to assess their impact on human health. Conventions are defined for the inhalable, thoracic and respirable aerosol fractions. These conventions represent target specifications for aerosol samplers, giving the ideal sampling efficiency as a function of particle aerodynamic diameter.

In general, the sampling efficiency of real aerosol samplers will deviate from the target specification, and the aerosol mass collected will therefore differ from that which an ideal sampler would collect. In addition, the behaviour of real samplers is influenced by many factors such as external wind speed. In many cases there is an interaction between the influence factors and fraction of the airborne size distribution of the environment in which the sampler is used.

This part of EN 13205 describes two test methods for determining the uncertainties due to transport errors. The values calculated can directly be compared to the requirements of prEN 13205-1:2012. The first method is based on loading collection substrates with particles from a workplace aerosol and delivery by ordinary mail. The second method is based on loading collection substrates with particles from a specified laboratory test aerosol and subsequent exposure of the collection substrates to vibrations using either a laboratory shaker table or a vertical shaker.

EN 13205 enables manufacturers and users of aerosol sampling instruments to adopt a consistent approach to sampler validation, and provide a framework for the assessment of sampler performance with respect to EN 481 and EN 482.

It is the responsibility of the manufacturer of aerosol samplers to inform the user of the sampler performance under the laboratory conditions[1)] specified in this part of EN 13205. It is the responsibility of the user to ensure that the actual conditions of intended use are within what the manufacturers specifies as acceptable conditions according to the performance test.

1) The inhalable convention is undefined for particle sizes in excess of 100 µm or for wind speeds greater than 4 m/s. The tests required to assess performance are therefore limited to these conditions. Should such large particle sizes or wind speeds actually exist at the time of sampling, it is possible that different samplers meeting this standard give different results.

1 Scope

This European Standard specifies a performance test of loaded collection substrates for samplers for the inhalable, thoracic or respirable aerosol fractions and, as alternative, a handling test, both for testing transport losses of aerosol sampler substrates under prescribed conditions in order to calculate the expanded uncertainty of a measuring procedure according to prEN 13205-1:2012, Annex A. The transport test involves shipping loaded substrates with ordinary mail, whereas the handling test uses a shaker.

This part of EN 13025 applies to all samplers used for the health-related sampling of particles in workplace air.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 481:1993, *Workplace atmospheres — Size fraction definitions for measurement of airborne particles*

EN 482:2012, *Workplace exposure — General requirements for the performance of procedures for the measurement of chemical agents*

EN 1540, *Workplace exposure — Terminology*

prEN 13205-1:2012, *Workplace exposure — Assessment of sampler performance for measurement of airborne particle concentrations — Part 1: General requirements*

prEN 13205-2:2012, *Workplace exposure — Assessment of sampler performance for measurement of airborne particle concentrations — Part 2: Laboratory performance test based on determination of sampling efficiency*

ISO 15767:2009, *Workplace atmospheres — Controlling and characterising uncertainty in weighing collected aerosols*

3 Terms and definitions

For the purpose of this document, the term and definitions given in EN 1540, prEN 13205-1:2012, prEN 13205-2:2012 apply.

NOTE With regard to EN 1540, in particular, the following terms are used in this document: total airborne particles, respirable fraction, sampling efficiency, static sampler, thoracic fraction, measuring procedure, non-random uncertainty, random uncertainty, expanded uncertainty, standard uncertainty, combined standard uncertainty, expanded uncertainty, uncertainty (of measurement), coverage factor, precision and analysis.

4 Symbols and abbreviations

4.1 Symbols

4.1.1 Latin

C_n calculated concentration corresponding to the mass load n, selected sampling period T and nominal flow rate Q^0, [mg/m^3]

C_{OEL}	relevant occupational exposure limit (OEL) value, [mg/m^3]
$m_{0,1}$, $m_{0,5}$ and m_2	nominal masses to be loaded onto collection substrates for selected sampling time T and nominal flow rate Q^0 at concentrations corresponding to 10 %, 50 % and 200 % of the occupational exposure limit, [mg]
m_{Load}	mass loaded onto collection substrate, in the range $\min\left(m_{Load_n}\right)$ to $\max\left(m_{Load_n}\right)$, [mg]
$m_{Load_{bn}}$	mass loaded onto collection substrate n of subset b , [mg] – Clause 5
m_{Handl_n}	mass loaded onto collection substrate n, [mg] – Clause 6
$m_{Load_{bn}}$	mass loaded onto collection substrate n of subset b, [mg] – Clause 5
m_{Load_n}	mass loaded onto collection substrate n, [mg] – Clause 6
$m_{Transp_{bn}}$	mass remaining on collection substrate n of subset b after the transport, [mg] – Clause 5
N_{ML}	number of mass loaded collection substrates – Clause 6
N_{ML_b}	number of mass loaded collection substrates in subset b – Clause 5
Q^0	nominal flow rate of sampler, [l/min]
s_{Handl}	standard deviation of transport losses of loaded collection substrates, [mg] – Clause 6
s_{Transp}	standard deviation of transport losses of loaded collection substrates, [mg] – Clause 5
s_{Transp_b}	standard deviation of transport losses of loaded collection substrates for subset b, [mg] – Clause 5
T	selected sampling time in the range from the minimum to the maximum sampling time according to the measurement procedure, [min]
$T_{0,1}$, $T_{0,5}$ and T_2	estimated sampling times for obtaining nominal mass loadings of collection substrates, $m_{0,1}$, $m_{0,5}$ and m_2, respectively, with nominal flow rate Q^0 at actual workplace concentration, [min]
T_χ	minimum sampling period at the concentration equal to χC_{OEL} mg/m^3, [min]
$u_{t\text{-}nR}$	non-random measurement error due to transport losses, [-]
$u_{t\text{-}R}$	random measurement error due to transport losses, [-]

4.1.2 Greek

$\Delta m_{\text{Handl}_n}$	mass loss due to the transport test for collection substrate n, [mg] – Clause 6
$\Delta m_{\text{Transp}_{bn}}$	mass loss due to the transport test for collection substrate n of subset b, [mg] – Clause 5
$^{\text{aver}}\Delta m_{\text{Handl}}$	average transport losses of loaded collection substrates, [mg] – Clause 6
$^{\text{aver}}\Delta m_{\text{Transp}_b}$	average transport losses of loaded collection substrates of subset b, [mg] – Clause 5
$\Delta m^*_{\text{Handl}_n}$	relative weight change due to the transport test for collection substrate n, [mg] – Clause 6
λ_χ	requirement for the transport loss (see Clause 5.1) at the concentration equal to χC_{OEL} mg/m^3, [-] – Clause 6
χ	proportionality constant that takes the values 0,1, 0,5 and 2,0, respectively, for the concentrations corresponding to 10 %, 50 % and 200 %, respectively, of C_{OEL} , [-]
χ_n	ratio of the calculated concentration from mass load n and the limit value, [-]

4.2 Enumerating subscripts

b	for subset of collection substrate mass loads – Clause 5
n	for collection substrate mass load

5 Transport test based on weighing samples before and after shipping by mail

5.1 Principle

The transport test is carried out as laboratory test to simulate rough handling that collection substrates, either mounted or unmounted in their aerosol samplers, can be subjected to while transported by mail. Rough handling can result in the movement of collected particles between collection substrate and the internal walls of the sampler or between collection substrate and a special container for transport of the collection substrate to the laboratory. This can be important for all samples being transported from the sampling site to a laboratory

5.2 Test procedure

5.2.1 General

The purpose of this test is estimate mass measurement errors due to either material loss or substrate contamination during the transport of samples between field and laboratory. This test is relevant to both complete samplers (i.e. with mounted collection substrates) and collection substrates removed from the samplers and placed in special containers for transport to a laboratory.

It is expected that the errors increase with median particle geometric size of the test aerosols, and that the errors for inhalable aerosol samplers would be larger than those for respirable aerosol samplers. This test can

be performed for several different aerosols, differentiated by their size distribution, stickiness, etc. For a test that is intended to be representative of a range of aerosols possibly encountered by the sampler, it is necessary to perform the test with a test aerosol consisting of as large particles as relevant.

This test is applicable to any suitable analytical method. Gravimetric determination (weighing) is used throughout this part of EN 13205 as a surrogate term for any suitable analytical method. If the test described in this clause is to be used with a different analytical method, the procedure needs to be modified accordingly.

If the normal mode of transport is to place the dust-laden collection media in special tins or containers, the transport test shall be carried out in this manner.

This test applies to both personal and static samplers.

5.2.2 Test equipment

At least five (but preferably seven) samplers, with collection substrates, shall be used in the test. The samplers need not be exposed to identical concentrations.

Twenty-one (21) collection substrates, plus blanks. Divide the collection substrates into three sets of seven substrates.

This test is preferentially carried out at workplaces, using workplace aerosols.

An analytical balance reading to 0,01 mg is required for weighing the collection substrates.

5.2.3 Test aerosol and method of loading collection media

The test shall be performed with a polydisperse test aerosol of suitable composition.

There are several requirements on the test aerosol when possible transport errors for unspecified aerosols are investigated: The test aerosol shall consist of non-volatile, non-reactive, non-sticky and non-hygroscopic particles; For samplers of the respirable or thoracic aerosol fraction, the ratio of the sampled fraction to the total airborne particle concentration shall be less than 40 %; For sampler of the inhalable aerosol fraction, the mass median of the test aerosol shall exceed 20 µm.

Unless the relevant measuring procedure states an upper (and/or lower) mass loading of the collection substrates, the range of masses loaded onto the collection substrates shall approximately correspond to that sampled from concentrations in the range one tenth to twice the occupational exposure limit value of a relevant substance, with one sampling time, T, in the range from the minimum to the maximum sampling time according to the measuring procedure and using the nominal flow rate. Determine the three nominal collection substrate mass loads, $m_{0,1}$, $m_{0,5}$ and m_2, respectively, that for the selected sampling time, T, and nominal flow rate, Q^0, corresponds to concentrations equal to 0,1, 0.5 and 2 times the relevant occupational exposure limit.

5.2.4 Test method

The procedure involves the following steps:

a) condition the collection media (including at least three blanks) in a balance room atmosphere until the weight is stable;

b) weigh the collection substrates according to the relevant measuring procedure;

c) clean the samplers before each new sampling period;

d) at the workplace, determine the approximate concentration, and from it estimate the approximate sampling times, $T_{0,1}$, $T_{0,5}$ and T_2, respectively, for loading the collection substrates with nominal masses $m_{0,1}$, $m_{0,5}$ and m_2, respectively

NOTE These sampling times can be longer than 8 h due to the actual workplace concentration being considerably lower than the OEL.

e) mount collection substrates into the samplers and run the samplers during the estimated sampling time(s) in order to load the collection substrates with the calculated nominal mass, $m_{0,1}$, $m_{0,5}$ or m_2;

f) after each run the loaded collection substrates are either placed in their transportation containers, or, if the collection substrates are transported mounted in the used samplers, the collection substrates are left in the samplers;

g) repeat from c) until a subset of seven collection substrates has been obtained per nominal load mass, $m_{0,1}$, $m_{0,5}$ or m_2;

h) transport the loaded collection substrates back to the laboratory, taking great care to avoid that the sample particles which are most easily lost have already been lost when the samples arrive at the laboratory;

i) weigh the loaded substrates and blanks according to the relevant measurement procedure;

j) pack the loaded substrates (or uncleaned samplers with loaded substrates, whichever is relevant) according to the relevant measurement procedure, and dispatch the transport containers by mail, consigned delivery system or by the end-user's own vehicle (whatever is most common/ appropriate) to a trusted addressee/consignee at a remote location; ask the addressee/ consignee to return the package containing the test substrates, with the same transport system without opening it;

k) upon return of the collection substrates (incl. blanks) weigh them according to the relevant measurement procedure.

5.3 Calculations

For each of the three sets $(b = 1,2,3)$ of nominal collection substrate mass loads, $m_{0,1}$, $m_{0,5}$ or m_2, calculate the loaded mass on each $(n = 1,2,..,N_{ML_b})$ collection substrate, before and after the transport test, respectively. Calculate the mass loss due to the transport test for each collection substrate

$$\Delta m_{\text{Transp}_{bn}} = m_{\text{Load}_{bn}} - m_{\text{Transp}_{bn}} \quad (1)$$

where

$m_{\text{Load}_{bn}}$ is the mass loaded onto collection substrate n of subset b, [mg];

$m_{\text{Transp}_{bn}}$ is the mass remaining on collection substrate n of subset b after the transport, [mg]; and

$\Delta m_{\text{Transp}_{bn}}$ is the mass loss due to the transport test for collection substrate n of subset b, [mg].

Plot the mass loss versus the initially loaded substrate mass, $m_{\text{Load}_{bn}}$.

NOTE It is expected that the relative transport losses in many cases will be less than 0,05, except for very small sample masses. However, in the latter circumstances it might be considerably larger than the analytical uncertainty.