SLOVENSKI STANDARD

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Izpostavljenost na delovnem mestu - Postopki za merjenje plinov in par z difuzijskimi vzorčevalniki - Zahteve in preskusne metode

Workplace exposure - Procedures for measuring gases and vapours using diffusive samplers - Requirements and test methods

Exposition am Arbeitsplatz - Messung von Gasen und Dämpfen mit Diffusionssammlern - Anforderungen und Prüfverfahren

Exposition sur les lieux de travail - Procédures pour le mesurage des gaz et vapeurs à l'aide de dispositifs de prélèvement par diffusion - Exigences et méthodes d'essai

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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

Workplace exposure - Procedures for measuring gases and vapours using diffusive samplers - Requirements and test methods

Exposition sur les lieux de travail - Procédures pour le mesurage des gaz et vapeurs à l'aide de dispositifs de prélèvement par diffusion - Exigences et méthodes d'essai

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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 Management Centre has the same status as the official versions.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 838:2010) 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of an identical text or by endorsement, at the latest by July 2010, and conflicting national standards shall be withdrawn at the latest by July 2010.

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

This document supersedes EN 838:1995.

The major technical changes between this European Standard and the previous edition are as follows:

a) adaptation of the framework for assessing the performance of procedures for measuring gases and vapours against the general requirements for the performance of procedures for measuring chemical agents in workplace atmospheres as specified in EN 482;

b) revision of the calculation model for the uncertainty of measurement to comply with EN 482 and ENV 13005;

c) modification of the classification scheme for sampler types;

d) deletion of the informative annexes on the evaluation of diffusive samplers by means of field tests.

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

Introduction

This European Standard provides a framework for assessing the performance of procedures for measuring gases and vapours against the general requirements for the performance of procedures for measuring chemical agents in workplace atmospheres as specified in EN 482. These performance criteria include maximum values of expanded uncertainty achievable under prescribed laboratory conditions for the methods to be used. In addition, the performance criteria should also be met under a wider variety of environmental influences, representative of workplace conditions.

This European Standard enables manufacturers and users of diffusive samplers and developers and users of procedures for measuring gases and vapours to adopt a consistent approach to method validation.

1 Scope

This European Standard specifies performance requirements and test methods under prescribed laboratory conditions for the evaluation of diffusive samplers and of procedures using these samplers for the determination of gases and vapours in workplace atmospheres.

This European Standard is applicable to diffusive samplers and measuring procedures using these samplers in which sampling and analysis are carried out in separate stages.

This European Standard is not applicable to:

- diffusive samplers which are used for the direct determination of concentrations;
- diffusive samplers which rely on sorption into a liquid.

2 Normative references

The following referenced documents are indispensable for the application 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 482:2006, *Workplace atmospheres — General requirements for the performance of procedures for the measurement of chemical agents*

EN 1076, *Workplace exposure — Procedures for measuring gases and vapours using pumped samplers — Requirements and test methods*

EN 1540, *Workplace atmospheres — Terminology*

EN ISO 8655-2, *Piston-operated volumetric apparatus — Part 2: Piston pipettes (ISO 8655-2:2002)*

EN ISO 8655-6, *Piston-operated volumetric apparatus — Part 6: Gravimetric methods for the determination of measurement error (ISO 8655-6:2002)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 482:2006 and EN 1540 1) apply.

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

NOTE See 8.4 and Annex C for symbols used in conjunction with uncertainty of measurement only.

A	cross-sectional area of sorption surface, in square centimetres (cm²)
CRM	certified reference material

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1) EN 1540:1998 is currently subject to revision. Until the revised EN is published the definitions given in EN 482:2006 take precedence.

D_a	diffusion coefficient of an analyte, in square centimetres per minute (cm²/min)
D_{a1}	diffusion coefficient of analyte 1, in square centimetres per minute (cm²/min)
D_{a2}	diffusion coefficient of analyte 2, in square centimetres per minute (cm²/min)
l	length of static air layer in sampler (or equivalent for permeation types), in centimetres (cm)
LV	limit value
m_b	mass of analyte desorbed from blank sampler, in nanograms (ng)
m_d	mass of analyte desorbed, in nanograms (ng)
m_s	mass of the analyte which can diffuse to a suitable sorbent within a certain time, i.e. the mass uptake of a diffusive sampler, in nanograms (ng)
$\dot{m}_1$	mass loss from permeation tube, in micrograms per minute (µg/min)
M_a	molar mass of analyte, in grams per mole (g/mol)
n	number of replicate samples
p_{at}	actual pressure of the test atmosphere sampled, in kilopascals (kPa)
R	recovery
R_{an}	analytical recovery
RH	relative humidity of the test atmosphere sampled, in percent (%)
t_e	exposure time, in minutes (min)
T_{at}	temperature of the test atmosphere sampled, in Kelvin (K)
$\dot{U}_d$	uptake rate, in cubic centimetres per minute (cm³/min)
$(\dot{U}_d)'$	uptake rate, in nanograms per parts per million (volume fraction) per minute (ng ppm^{-1} min^{-1})
$\dot{U}_{d1}$	uptake rate of analyte 1, in cubic centimetres per minute (cm³/min)
$\dot{U}_{d2}$	uptake rate of analyte 2, in cubic centimetres per minute (cm³/min)
$\dot{v}$	flow rate into the exposure chamber, for example, in litres per minute (l/min)
β_a	mass concentration of the analyte in the calibration gas mixture, in milligrams per cubic metre (mg/m³)
$(\beta_a)'$	mass concentration in parts per million (ppm);
β_{a1}	mass concentration of the given analyte at the beginning of the diffusion layer (i.e. at the distance l from the surface of the sorbent), in milligrams per cubic metre (mg/m³)

β_{a2} mass concentration of the given analyte at the end of the diffusion layer (i.e. at the surface of the sorbent), in milligrams per cubic metre (mg/m³)

$\overline{\beta}_{a,R}$ mean mass concentration of the analyte recovered from the test gas atmosphere, in milligrams per cubic metre (mg/m³);

β_{cg} mass concentration of the calibration gas mixture, in milligrams per cubic metre (mg/m³)

ϑ_{at} temperature of the test atmosphere sampled, in degree Celsius (°C)

K_v coefficient of variation (CV)[2]

ϕ_a volume fraction of the analyte, in microlitres per litre (μl/l)

5 Types of samplers

Samplers for gases and vapours can be divided into type A samplers and type B samplers:

Type A samplers rely on sorption onto a solid or onto a support impregnated with a reagent, desorption with solvent, and subsequent analysis of the desorbate. They are usually made of glass and consist of two beds of sorbent in series, i.e. with a back-up section, and contain an active sorbent (e.g. activated carbon) or a support impregnated with reagent.

Type B samplers rely on sorption onto a solid or onto a support impregnated with a reagent, thermal desorption, and analysis of the desorbate. They are usually made of glass or metal, are sealed with removable fittings and consist of one or more beds of sorbent (e.g. porous polymer resin).

6 Requirements

NOTE If there is no procedure for measuring a particular chemical agent which meets the requirements of this European Standard, a procedure whose performance is nearest to the specified requirements should be used.

6.1 General

Some requirements (see 6.2) shall be verified once for each type of sampler. Other requirements (see 6.3) shall be verified for each combination sampler/chemical agent.

It is the responsibility of the manufacturer to meet the requirements specified in 6.2. It is also the responsibility of the manufacturer or the developer of the measuring procedure to meet the requirements specified in 6.3 when use of a sampler for measurement of a particular gas or vapour is claimed.

NOTE 1 No useful performance requirements can be given for the effect of interferents (with the exception of water vapour). The effect of interferents is difficult to predict for a non ideal sorbent without adsorption isotherm data on mixed systems which is normally unavailable. However the user of diffusive samplers should be cautioned that the adsorption of water vapour on certain sorbents, e.g. activated carbon and silica gel, can have a large effect on sampler capacity and analytical recovery.

NOTE 2 Because of the known effect of pressure on diffusion coefficients, a pressure test is not necessary.

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[2] The predecessor term "relative standard deviation" is deprecated by the term "coefficient of variation". See also ISO 3534-1:2006, 2.38, Note 2.

6.2 Sampler requirements

6.2.1 Nominal uptake rate

The nominal uptake rate and the coefficient of variation[3] shall be provided by the manufacturer. If it is possible to calculate the ideal steady-state value in accordance with 8.2.1.1, the nominal uptake rate, determined in accordance with 8.2.1.2, shall be within ± 25 % of the steady-state value.

6.2.2 Air velocity/sampler orientation

The manufacturer shall test the working range of air velocity and the influence of sampler orientation in accordance with 8.2.2.

6.2.3 Sampler leak test

When tested in accordance with 8.2.3, any additional analyte determined above the blank value (see 6.3.2.3) shall be less the one-third of the calculated mass uptake by the sampler for 30 min exposure to a concentration of 0,1 LV.

6.2.4 Shelf life (for impregnated supports)

The manufacturer shall specify the shelf life of the diffusive sampler when stored in its original package. During this period the sampler shall fulfil all requirements.

6.2.5 Sample identification (for commercially available diffusive samplers)

The diffusive sampler shall have a suitable area for sample identification by the user.

6.2.6 Marking

Diffusive samplers shall be marked with at least the following:

- manufacturer's name;
- product identification;
- batch identification;
- shelf life (if applicable);
- number of this European Standard.

If required due to limited space, the marking may be placed on the packaging of the diffusive sampler. However, the manufacturer's name and product identification shall be indicated on the diffusive sampler.

6.2.7 Instructions for use

The instructions for use supplied with the diffusive sampler shall be in the language(s) of the country where the diffusive sampler is to placed on the market. They shall contain at least the following information:

a) designated use (general purpose for a number of gases and vapours or, specific, for a particular gas or vapour, see 6.1);

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[3] The predecessor term "relative standard deviation" is deprecated by the term "coefficient of variation". See also ISO 3534-1:2006, 2.38, Note 2.

b) blank value (only when used for a particular gas or vapour, see 6.1;

c) nominal uptake rate for the substances for which the diffusive sampler is intended to use;

d) directions for proper handling of the diffusive sampler, including opening and closing;

e) general information on the principle of use, for example, sorbent type, reaction of the reagent impregnated solid, desorption method;

f) information on storage and transport;

g) working range of air velocity;

h) orientation;

i) information on health or environmental hazards and method of disposal.

The general information on the principle of use can be given in additional literature.

6.3 Measuring procedure requirements

6.3.1 Sampling procedure requirements

6.3.1.1 Sampling time

Sampling time shall be established according to concentration range of the compounds of interest over which measurements are to be made, i.e. up to two times the limit value (see EN 482), and taking into account the nominal or theoretical uptake rate.

6.3.1.2 Bias due to the selection of a non ideal sorbent (back diffusion)

When tested in accordance with 8.3.1.1, the bias shall be ≤ 10 %.

6.3.1.3 Uptake rate

If it is possible to calculate the ideal steady-state value in accordance with 8.2.1.1, the nominal uptake rate, determined in accordance with 8.2.1.2, shall be within ± 25 % of the steady-state value.

6.3.1.4 Storage conditions after sampling

The storage conditions after sampling shall be specified. When tested in accordance with 8.3.1.3, the mean value of the recovery after storage shall not differ by more than 10 % from the value before storage.

6.3.2 Analytical procedure requirements

6.3.2.1 Analytical quantification limit

The quantification limit shall be lower than or equal to one-third of the calculated mass uptake by the sampler for 30 min exposure to a concentration of 0,1 LV.

6.3.2.2 Analytical recovery

When tested in accordance with 8.3.2.2 the analytical recovery R_{an} shall be:

- For type A samplers: $R_{\text{an}} \geq 75$ % with $K_{\text{v}} \leq 10$ % at each loading;

- For type B samplers: $R_{an} \geq 95$ % with $K_v \leq 10$ % at each loading.

6.3.2.3 Blank value

When tested in accordance with 8.3.2.3 the blank value shall be less than one-tenth of the calculated mass uptake by the sampler for 30 min exposure to a concentration of 0,1 LV.

Where it is known that the blank value is significant and varies between batches of samplers, it shall be checked regularly.

Type B samplers which are not thermally sealed should be cleaned before sampling to eliminate any contamination which could occur during storage before use.

NOTE 1 In order to eliminate any contamination which could occur during storage before use, Type B samplers should be cleaned by taking them through the thermal desorption procedure. This cleaning process should be carried out as close as possible to the time when the samplers will be used.

NOTE 2 In order to obtain acceptable values for the quantification limit of the method, the blank value of the sampling media should be as low as technically possible.

6.3.3 Expanded uncertainty

When tested in accordance with 8.3 the expanded uncertainty calculated in accordance with 8.4 shall meet the requirements given in EN 482.

The expanded uncertainty requirement shall be met from 10 ºC to 40 ºC and at relative humidities from 20 % to 80 %. Above 30 ºC the use of correction factors is permitted to meet this requirement.

6.3.4 Method description

6.3.4.1 Scope of the measurement procedure

The scope of the measuring procedure shall give information about the following:

- principle of the method;
- chemical agents covered by the measuring procedure;
- analytical technique used;
- working ranges;
- chemical agents for which the measuring procedure is known to be adequate but not completely validated according to this European Standard, especially in case of compounds of the same chemical family or homologous series;
- chemical agents for which the measuring procedure is known to be inadequate;
- any known interferences.

6.3.4.2 Method performance

The measuring procedure shall give information about method performance, including the following:

- the chemical agents for which measurement method has been shown to be effective;

- the range of concentrations of chemical agents in air, sample volume, uptake rates, exposure time and range of environmental conditions over which the measurement method has been shown to meet the performance criteria for expanded uncertainty prescribed in EN 482;
- the quantification limit of the analytical method for chemical agents of interest;
- full details of any known interferences, including suitable and sufficient information on how to minimise their effects.

6.3.4.3 Apparatus

The measuring procedure shall:

- specify that the diffusive sampler complies with the provisions of this European Standard;
- define the required characteristics of analytical instruments to be used;
- specify the quality of the reagents to be used.

6.3.4.4 Safety information

The measuring procedure shall provide suitable and sufficient information on the safety hazards associated with the reagents and equipment used in the procedure.

7 General test conditions

7.1 Reagents

Use reagents of analytical grade, where possible.

7.2 Apparatus

Usual laboratory apparatus and the following:

7.2.1 A dynamic system for generating, pre-mixing and delivering a known concentration of a test gas or vapour in air (see EN ISO 6145-1, EN ISO 6145-4 and EN ISO 6145-6), including at least:

- an exposure chamber constructed of inert materials such as glass or polytetrafluorethylene (PTFE), through which the generated test atmosphere is passed, of sufficient capacity to accommodate simultaneously at least six test samplers and six samplers of one independent method (see 7.3) positioned in such a manner that there is no interference between each sampler;
- provisions for measuring, controlling and varying the air flow rate through the chamber and the concentration, temperature and relative humidity of the calibration gas mixture.

NOTE It is also possible to use a smaller exposure chamber and to carry out repeat experiments to obtain at least six pairs of data.

7.2.2 Micropipettes or syringes, for applying known volumes of standard solutions, complying with the requirements of EN ISO 8655-2 and with a calibration checked in accordance with EN ISO 8655-6.

7.2.3 Instruments for analysing the gas, vapour or a characteristic reaction product collected by either the test sampler or an independent sampling method.