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Zrak na delovnem mestu - Protokol za vrednotenje lastnosti difuzijskih vzorčevalnikov

Workplace atmospheres - Protocol for evaluating the performance of diffusive samplers

Air des lieux de travail - Protocole pour l'évaluation de la performance des dispositifs de prélèvement par diffusion

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Workplace atmospheres — Protocol for evaluating the performance of diffusive samplers

Air des lieux de travail — Protocole pour l'évaluation de la performance des dispositifs de prélèvement par diffusion

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 16107 was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 2, *Workplace atmospheres*.

This second edition cancels and replaces the first edition (ISO 16107:1999), which has been technically revised.

Introduction

Gas or vapor sampling is often accomplished by actively pumping air through a collection medium such as activated charcoal. Problems associated with a pump, such as inconvenience, inaccuracy and expense, are inextricable from this type of sampling. The alternative covered by this International Standard is to use diffusion for moving the compound of interest onto the collection medium. This approach to sampling is attractive because of the convenience of use and low total monitoring cost.

However, previous studies have found significant problems with the accuracy of some samplers. Therefore, although diffusive samplers may provide a plethora of data, inaccuracies and misuse of diffusive samplers may yet affect research studies. Furthermore, worker protection may be based on faulty assumptions. The aim of this International Standard is to counter the uncertainties in diffusive sampling through achieving a broadly accepted set of performance tests and acceptance criteria for proving the efficacy of any given diffusive sampler intended for use.

This International Standard is intended specifically for the large-scale evaluation of many diffusive sampler/analyte pairs of practical application and is complementary to EN 838. An affordable, experimental evaluation determines a single performance value indicating how a sampler performs in a typical situation. A sampler can thereby be quickly judged as to acceptability. Additionally, sufficient data are obtained to predict performance in many atypical situations. For example, although sampling may normally be done at room temperature, a particular need may call for use in extreme cold. In such a case, the single performance value would be superseded by the particular needs.

Workplace atmospheres — Protocol for evaluating the performance of diffusive samplers

1 Scope

This International Standard specifies methods for evaluation of sampler performance in terms of workplace conditions: wind speed, humidity, temperature, atmospheric pressure, and analyte variation. The concise set of experiments specified aims to minimize cost to the user. The evaluation is limited to conditions commonly encountered in personal sampling in the indoor workplace setting, namely wind speeds of up to 0,5 m/s and for sampling periods typically from 2 h to 8 h.

Static or area sampling, unlike personal sampling where movement of the subject is significant, may sometimes be subject to sampling-rate reduction due to stagnation at very low wind speeds. This International Standard therefore does not apply to wind speeds of less than 0,1 m/s relative to static samplers. Samplers are also tested for compliance with the manufacturer's stated limits on capacity, possibly in the presence of interfering compounds. Given a suitable exposure chamber, the sampler evaluation protocol can be extended to cover sampler use for other sampling periods and conditions.

This International Standard indicates how to measure diffusive sampler uncertainty for characterizing concentration estimates obtained subsequent to the evaluation. It is impractical continually to re-evaluate diffusive sampler performance under various environmental conditions prevailing during application.

NOTE 1 In this International Standard, the confidence level for the initial method evaluation becomes an integral part of the measurement uncertainty. This approach slightly broadens the statistical protocols given in ISO Guide 98:1995. Furthermore, the possibility of sampler errors related to correctible sampler bias is addressed.

NOTE 2 This International Standard is an extension of previous research on diffusive samplers (References [1] to [17] inclusive and EN 838).

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 838, *Workplace atmospheres — Diffusive samplers for the determination of gases and vapours — Requirements and test methods*

ISO Guide 98:1995, *Guide to the expression of uncertainty in measurement*. BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 838 and ISO Guide 98:1995 and the following apply.

3.1
symmetric accuracy range
A
fractional range about the measurand concentration, c, within which 95 % of sampler measurements are found

NOTE See References [18] to [21] inclusive.

If the modulus of the bias is small, i.e. $|\Delta| < R/1{,}645$, the symmetric accuracy range, A, can be shown to be closely approximated (Reference [21]) by Equation (1):

$$A = 1{,}960 \times \sqrt{\Delta^2 + R^2} \quad (1)$$

where

Δ is the bias, expressed relative to true concentrations;

R is the overall true relative standard deviation, expressed relative to true concentrations.

Otherwise

$$A = |\Delta| + 1{,}645 \times R \quad (2)$$

If the bias is corrected, the expected value of Δ^2 in Equation (1) becomes equal to the variance of the bias correction, reflecting an uncorrectable residual bias due to uncertainty in the correction. Then if the bias uncertainty is under control, the low bias modulus model of Equation (1) indicates the proportionality of A to the root mean squared combined uncertainty components.

4 Symbols and abbreviated terms

A symmetric accuracy range (3.1) in terms of bias and precision

A_{est} estimated symmetric accuracy range, A

$A_{95\,\%}$ 95 % confidence level on the symmetric accuracy range, A

c true or reference analyte concentration, in milligrams per cubic metre, or parts per million as a ratio of analyte to air molecules, per instructions of the sampler manufacturer

c_{est} mean of (four) concentration estimates (including pressure and temperature corrections), in milligrams per cubic metre or parts per million as a ratio of analyte to air molecules, per instructions of the sampler manufacturer

h humidity, partial pressure of water vapor, in kilopascals

n number of diffusive samplers tested for measuring sampler capacity

p (atmospheric) pressure

R overall true relative standard deviation of concentration estimates (dependent on assumed environmental variability), expressed as a percentage relative to a “true” concentration as estimated by reference sampling

R_{est} estimated true relative standard deviation, expressed as a percentage

R_{run} true relative standard deviation characterizing inter-run chamber variability, expressed as a percentage

R_{s} intersampler component of the true relative standard deviation, expressed as a percentage

$R_{\text{s est}}$ estimated intersampler true relative standard deviation, R_{s}, expressed as a percentage

R_t pulse-induced true relative standard deviation, expressed as a percentage

$R_{95\ \%}$ 95 % confidence limit on the true relative standard deviation, expressed as a percentage

s estimated standard deviation characterizing intersampler variation

$t_{0,95}(v)$ value which, at the 95 % probability level, exceeds random variables distributed according to the Student t-distribution with v degrees of freedom

T temperature, in degrees Celsius

u ambient wind speed, in metres per second

α_x concentration estimate dependence on environmental variable, x (T, h, u, or c)

Δ bias relative to concentration, c

Δ_{est} estimated bias, Δ

Δ_t bias associated with concentration pulse

$\Delta_{95\ \%}$ 95 % confidence limit on the bias, Δ

v degrees of freedom in determining R_{s}

v_{eff} effective number of degrees of freedom in determining R

σ_c assumed concentration variability

σ_h assumed humidity variability

σ_T assumed temperature variability

σ_u assumed ambient wind speed variability

5 Summary of test protocol

5.1 Factors affecting performance

5.1.1 Diffusive sampling may first of all suffer from error in the sampling rate as stated by the manufacturer of the sampler. As diffusive samplers are usually used without recalibration, this error implies a bias or systematic error in all concentration estimates made. As the bias may be in one direction, such error cannot be minimized by averaging several measurements. If the error is correctible it is not strictly part of the sampler uncertainty.