SLOVENSKI STANDARD
SIST ISO 15767:2012

01-april-2012

Zrak na delovnem mestu - Pregled in opis napak pri tehtanju zbranih aerosolov

Workplace atmospheres - Controlling and characterizing uncertainty in weighing collected aerosols

Air des lieux de travail - Contrôle et caractérisation de l'incertitude de pesée des aérosols collectés

Ta slovenski standard je istoveten z: ISO 15767:2009

ICS:

13.040.30	Kakovost zraka na delovnem mestu	Workplace atmospheres

SIST ISO 15767:2012 **en,fr**

INTERNATIONAL STANDARD

ISO 15767

Second edition
2009-06-01

Workplace atmospheres — Controlling and characterizing uncertainty in weighing collected aerosols

Air des lieux de travail — Contrôle et caractérisation de l'incertitude de pesée des aérosols collectés

Reference number
ISO 15767:2009(E)

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Published in Switzerland

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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 15767 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 15767:2003), which has been technically revised.

Introduction

Assessment of airborne aerosol hazards in occupational settings entails sampling onto a collection substrate, followed by analysis of the collected material. The weight of the collection substrate is generally many times (10 to 20, or more) larger than the aerosol sample. Weighing the aerosol sample is therefore actually the differential weighing of the substrate, where the aerosol sample is essentially a disturbance of the substrate. The result is generally an estimated concentration of a hazardous material in the air. The uncertainty in such estimates depends on several factors, one of which relates to the specific type of analysis employed.

This International Standard deals with a specific type of analysis which finds the most general application in the sampling of aerosols, namely the weighing of sampled material. Gravimetric analysis, though apparently simple, is subject to uncertainty arising from instability in the mass of the sampling medium and other elements which must be weighed. An example is provided by aerosol samplers designed to collect particles so as to agree with the inhalable aerosol sampling convention. For some sampler types, the filter and cassette are weighed together to make estimates. Therefore, uncertainty may result if the cassette, for example, absorbs or loses water between the weighings required for a concentration estimation. This International Standard describes such uncertainty and provides solutions for minimization.

Workplace atmospheres — Controlling and characterizing uncertainty in weighing collected aerosols

1 Scope

This International Standard provides recommendations for controlling the analytical uncertainty associated with aerosol collection medium instability, where collection medium or collection substrate includes any article used to collect particles (e.g. filter or foam material) as well as those supporting elements which must be analysed by weighing.

This International Standard is applicable to results compiled both from the literature and, if necessary and feasible, through laboratory experiment. Expected uncertainty associated with given aerosol capture methods is quantified where possible. Recommendations as to materials to be used are given. Means of minimizing uncertainty arising from instability are provided. Recommendations for the weighing procedure are given. A procedure for estimating weighing uncertainty is described. Finally, recommendations are given for the reporting of measured mass, including an uncertainty component and limits of detection and quantification.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
aerosol sample
aerosol particles collected onto the collection substrate or sampling cassette

2.2
collection substrate
aerosol sampling filter, foam, impaction plate or other deposition plate designed for subsequent analysis, with whatever mounting, e.g. a sampling cassette, if used, analysed (weighed) as a single item together with the collected aerosol sample, if present

NOTE As an example of the converse, the 25 mm or 37 mm plastic filter holder often used for “total dust” sampling in either its closed-face or open-face version is not part of the collection substrate in the definition above, since it is not weighed.

2.3
substrate holder
cassette primarily designed to hold a collection substrate (of any kind) and for which only the deposit on the collection substrate is analysed (weighed)

2.4
filter holder
substrate holder designed to hold a filter and for which only the filter deposit is analysed (weighed)

2.5
sampling cassette
collection substrate together with whatever mounting that is used and analysed (weighed) as a single unit

2.6
equilibration time
time constant dependent on the type of collection substrate and characterizing an approximately exponentially damped approach of the mass of an aerosol collection medium to a constant value

NOTE 1 The constant can be defined as the mean difference of the mass from equilibrium per mean rate of mass loss or gain, averaging over any time interval.

NOTE 2 There may be important instances in which several independent time constants are required to describe the approach to equilibrium.

NOTE 3 Equilibration times range from seconds to weeks.

2.7
field blank
blank collection substrate that undergoes the same handling as the collection substrate plus aerosol sample, including conditioning and loading into the samplers or transport containers, as well as transportation between the lab and sampling site, but without being exposed to sampling

2.8
lab blank
blank collection substrate that never leaves the laboratory, but undergoes the same handling as the collection substrate plus aerosol sample, including conditioning and loading into the samplers or transport containers

2.9
blank collection substrate
collection medium or substrate taken from the same batch as the sampling medium, but unexposed to sampling

2.10
limit of detection
LOD
three times the estimated standard deviation of the mass of the aerosol sample, accounting for the double weighing (exposed vs. unexposed) and for the uncertainty associated with any correction blanks used

NOTE The value of LOD, as defined here, does not take into account sources of variability beyond weighing.

2.11
false positive rate
fraction of incorrect assertions of the presence of an aerosol sample on a substrate

NOTE Annex B describes how to estimate, on the basis of the method evaluation, the false positive rate in such assertions.

2.12
limit of quantification
LOQ
ten times the estimated standard deviation of the mass of the aerosol sample

NOTE The value of LOQ can be used as a threshold value to assure accurate measurement of a substance. For details, see Annex B.

2.13
uncertainty component
u_w
estimated standard deviation of the mass of the aerosol sample

NOTE See Annex A and ISO/IEC Guide 98-3 for details.

3 Weight instability — Causes and minimization

3.1 General

Weight instability of collection substrates can be attributed to several causes (see References [1] to [14]). The following subclauses address the more important of these.

3.2 Moisture sorption

3.2.1 Moisture sorption is the most common cause of weight instability. Water can be directly collected by the filter or foam or other collection substrate material that is weighed. Water sorption by any part of the sampling system which is weighed must be suspected as well. For example, the sampling cassette itself, if weighed, can be the cause of significant uncertainty [1].

3.2.2 The effects of water sorption can be reduced by using non-sorptive materials. However, there may exist specific sampling needs for which a hydrophobic material is not feasible. Table 1 presents a list of common aerosol collection substrates with different water sorption features.

Table 1 — Water sorption characteristics of some aerosol sampling media

Collection substrate or cassette type	Water sorption			
	Very low	Low	High	Very high
Cellulose fibre filter			*	
Glass fibre filter		*		
Quartz fibre filter		*		
Cellulose ester membrane filter			*	
Polytetrafluoroethylene filter	*			
PVC membrane filter		*		
Polycarbonate filter	*			
Silver membrane filter	*			
Polyurethane foam				*
Greased Mylar impaction collection substrate		*		
Greased aluminium foil impaction collection substrate		*		
Carbon-filled resin				*
Aluminium cassette		*		
Stainless steel cassette	*			

NOTE 1 References [2] to [4] provide further details. Also, Reference [5] reports that filters of evidently the same material, but originating from different manufacturers, can have widely differing variabilities.

NOTE 2 There is generally a trade-off between hydrophobicity and conductivity in many materials [9]. Therefore, one must be aware of the possibility of creating sampling problems when reducing hygroscopicity.

NOTE 3 Pre-treatments of collection substrates, such as greasing, can also affect water sorption.

3.3 Electrostatic effects

Electrostatic effects are a common source of weighing problems. These effects can usually be minimized by discharging the collection substrate through the use of a plasma ion source or a radioactive source immediately before weighing or during weighing. Using conductive materials may reduce such problems. (See also Reference [7].)

3.4 Effects of volatile compounds (other than water)

3.4.1 Volatile compounds can be present in unused collection media [3], or can be adsorbed onto media during sampling.

3.4.2 Desorption of volatiles from unused media can be controlled, for example, by heating or oxygen plasma treatment prior to conditioning and weighing. Alternatively, losses may be compensated by the use of blanks (see Clause 4).

3.4.3 When volatile materials collected during sampling constitute part of the intended aerosol sample, standardized written procedures are required to ensure that any losses are minimized or at least controlled, for example by conditioning under tightly specified conditions.

3.4.4 When volatile materials collected during sampling are not part of the intended aerosol sample, it may be difficult to eliminate them if weighing is the only form of analysis. Non-sorptive media should preferably be used.

3.5 Handling damage

3.5.1 If friable collection substrates such as quartz filters are used, procedures are needed to control mechanical damage.

3.5.2 The air-sampling equipment should be designed so that the collection substrate is not damaged during assembly and disassembly.

3.5.3 Flat-tipped forceps are recommended for handling filters. Non-oxidizing metal tins may be used to weigh delicate collection substrates without direct handling.

3.5.4 Parts to be weighed shall not be touched with the hands, unless gloved.

3.5.5 Gloves, if used, shall leave no residue on what is weighed.

3.5.6 Handling shall take place in a clean environment, to avoid contamination.

3.6 Buoyancy changes

Corrections for air buoyancy [8], equal to the density of air multiplied by the air volume displaced, are not necessary for small objects, such as a 37 mm diameter membrane filter. However, there may exist circumstances (e.g. if an entire sampling cassette was weighed without the use of correcting blanks) in which the object to be weighed is so large that buoyancy must be corrected. For example, if the volume weighed exceeds 0,1 cm^3, then correction would be required in order to weigh down to 0,01 mg, if pressure changes in the order of 10 % between weighings are expected (e.g. at different altitudes). If such a correction is necessary, the atmospheric pressure and temperature at the time of weighing should be recorded.