SLOVENSKI STANDARD
SIST EN 12341:2014

01-julij-2014

Nadomešča:
SIST EN 12341:2000
SIST EN 14907:2005

Zunanji zrak - Standardna gravimetrijska metoda za določevanje masne koncentracije frakcije lebdečih delcev PM10 ali PM2,5

Ambient air - Standard gravimetric measurement method for the determination of the PM10 or PM2,5 mass concentration of suspended particulate matter

Außenluft - Gravimetrisches Standardmessverfahren für die Bestimmung der PM10- oder PM2,5-Massenkonzentration des Schwebstaubes

Air ambiant - Méthode normalisée de mesurage gravimétrique pour la détermination de la concentration massique MP10 ou MP2,5 de matière particulaire en suspension

Ta slovenski standard je istoveten z: EN 12341:2014

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This European Standard was approved by CEN on 10 April 2014.

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Foreword

This document (EN 12341:2014) has been prepared by Technical Committee CEN/TC 264 “Air quality”, 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of an identical text or by endorsement, at the latest by November 2014 and conflicting national standards shall be withdrawn at the latest by November 2014.

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 12341:1998 and EN 14907:2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports Essential Requirements of the Council Directive 2008/50/EC [1].

EN 12341:2014 includes the following significant technical changes with respect to EN 12341:1998 and EN 14907:2005:

— this document is adapted from EN 14907:2005 due to consideration of best available technology;

— the three different standard reference methods for PM_{10} described in EN 12341:1998 and the two different standard reference methods for $PM_{2,5}$ described in EN 14907:2005 are replaced in this document by only one possible standard reference method for each of PM_{10} or $PM_{2,5}$.

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom

Introduction

For air quality across the European Union to be assessed on a consistent basis, Member States need to employ standard measurement techniques and procedures. The aim of this European Standard is to present a harmonized methodology for monitoring the mass concentrations of suspended particulate matter (PM_{10} and $PM_{2,5}$ respectively) in ambient air, following Directive 2008/50/EC on ambient air quality and cleaner air for Europe [1] which sets the parameters specific to the assessment of ambient concentration levels of particulate matter.

NOTE In principle, the methodology described in this European Standard may also be used for measurement of mass concentrations of other PM fractions such as PM_1. However, this European Standard does not describe standardized sampling inlets for such fractions.

This European Standard merges the earlier European Standards EN 12341:1998 [2] and EN 14907:2005 [3] with the aim of harmonizing the very similar procedures that are used to measure mass concentrations of both fractions of particulate matter in ambient air.

The European Standard method described in this European Standard is focussed primarily on harmonization and improvement of the data quality of measurement methods used in monitoring networks, with regard to avoiding unnecessary discontinuities with historical data. It is a method that is suited for practical use in routine monitoring, but not necessarily the method with the highest metrological quality.

There are no traceable reference standards for PM_{10} or $PM_{2,5}$ measurements. Therefore, the standard method defines the measured quantity by convention, specifically by the sample inlet design and associated operational parameters covering the whole measurement process. This European Standard contains:

— a description of a manual gravimetric standard measurement method for PM_{10} or $PM_{2,5}$ using sequential samplers or single-filter samplers;

— a summary of performance requirements of the method;

— requirements for suitability testing of facilities and equipment on initial application of the method;

— requirements for ongoing quality assurance / quality control when applying the method in the field;

— the assessment of measurement uncertainty of the results of this European Standard method;

— (tentative) criteria and test methods for the evaluation of the suitability of filters for application using this method.

The performance characteristics and requirements described in this European Standard were partly determined in different comparative and validation trials. The trials were sponsored by the European Commission and the European Free Trade Association.

However, for lack of appropriate criteria and protocols to test filters for fitness for purpose, considerable differences may exist between results obtained when using different filter types, and even filters of the same type. For example, differences of up to 15 % have been found when applying different brands of quartz-fibre filters in parallel measurements of PM_{10} for concentrations around 50 % of the daily limit value [4]. This may have implications for results produced by automated measurement systems as these are calibrated by comparison of results with those obtained using reference samplers (CEN/TS 16450:2013 [5]).

In principle, the filters collected for the purpose of determining the mass concentrations of PM_{10} or $PM_{2,5}$ can be used for further speciation, e.g. for the determination of concentrations of:

— heavy metals and polycyclic aromatic hydrocarbons (see EN 14902 [6] and EN 15549 [7]) in conformity with Directive 2004/107/EC [8],

— constituents of $PM_{2,5}$ (see CEN/TR 16243 [9] and CEN/TR 16269 [10]) to be used for source apportionment as required by Directive 2008/50/EC.

Additional requirements might have to be considered for those purposes (e.g. blank values of chemical constituents).

However, the requirements of this European Standard are targeted firstly towards obtaining optimum results for the measurement of mass concentrations of PM_{10} or $PM_{2,5}$.

1 Scope

This European Standard describes a standard method for determining the PM_{10} or $PM_{2,5}$ mass concentrations of suspended particulate matter in ambient air by sampling the particulate matter on filters and weighing them by means of a balance.

Measurements are performed with samplers with inlet designs as specified in Annex A, operating at a nominal flow rate of 2,3 m^3/h, over a nominal sampling period of 24 h. Measurement results are expressed in µg/m^3, where the volume of air is the volume at ambient conditions near the inlet at the time of sampling.

The range of application of this European Standard is from approximately 1 µg/m^3 (i.e. the limit of detection of the standard measurement method expressed as its uncertainty) up to 150 µg/m^3 for PM_{10} and 120 µg/m^3 for $PM_{2,5}$.

NOTE 1 Although the European Standard is not validated for higher concentrations, its range of application could well be extended to ambient air concentrations up to circa 200 µg/m^3 when using suitable filter materials (see 5.1.4).

This European Standard describes procedures and gives requirements for the use of so-called sequential samplers, equipped with a filter changer, suitable for extended stand-alone operation. Sequential samplers are commonly used throughout the European Union for the measurement of concentrations in ambient air of PM_{10} or $PM_{2,5}$. However, this European Standard does not exclude the use of single-filter samplers.

This European Standard does not give procedures for the demonstration of equivalence of other sampler types, e.g. equipped with a different aerosol classifier and/or operating at different flow rates. Such procedures and requirements are given in detail in the *Guide to the Demonstration of Equivalence of Ambient Air Monitoring Methods* [11] and for automated continuous PM monitors (see CEN/TS 16450:2013).

The present European Standard represents an evolution of earlier European Standards (EN 12341:1998 and EN 14907:2005) through the development of the 2,3 m^3/h sampler to include constraints on the filter temperature during and after sampling and the ability to monitor temperatures at critical points in the sampling system. It is recommended that when equipment is procured it complies fully with the present European Standard. However, older versions of these 2,3 m^3/h samplers that do not employ sheath air cooling, the ability to cool filters after sampling, or the ability to monitor temperatures at critical points in the sampling system have a special status in terms of their use as reference samplers. Historical results obtained using these samplers will remain valid. These samplers can still be used for monitoring purposes and for equivalence trials, provided that a well justified additional allowance is made to their uncertainties (see Annex B).

In addition, three specific sampling systems – the “long nozzle” 2,3 m^3/h sampler and the 68 m^3/h sampler for PM_{10} in EN 12341:1998, and the 30 m^3/h $PM_{2,5}$ inlet in EN 14907:2005 – also have a special status in terms of their use as reference samplers. Historical results obtained using these samplers will remain valid. These samplers can still be used for monitoring purposes and for equivalence trials, provided that a well-justified additional allowance is made to their uncertainties (see Annex B).

Other sampling systems, as described in Annex B of this European Standard, can be used provided that a well justified additional allowance is made to their uncertainties as derived from equivalence tests.

NOTE 2 By evaluating existing data it has been shown that these samplers give results for PM_{10} and $PM_{2,5}$ that are equivalent to those obtained by application of this European Standard. Results are shown in Annex B.

This European Standard also provides guidance for the selection and testing of filters with the aim of reducing the measurement uncertainty of the results obtained when applying this European Standard.

2 Normative references

The following document, in whole or in part, is normatively referenced in this document and is 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.

JCGM 100, *Evaluation of measurement data — Guide to the expression of uncertainty in measurement*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

3.1.1
ambient air
outdoor air in the troposphere, excluding workplaces as defined by Directive 89/654/EEC [12] where provisions concerning health and safety at work apply and to which members of the public do not have regular access

[SOURCE: Directive 2008/50/EC]

3.1.2
calibration
operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

[SOURCE: JCGM 200 [13]]

3.1.3
combined standard uncertainty
standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root of a sum of terms, the terms being the variances or covariances of these other quantities weighted according to how the measurement result varies with changes in these quantities

[SOURCE: JCGM 100]

3.1.4
coverage factor
numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

[SOURCE: JCGM 100]

3.1.5
expanded uncertainty
quantity defining an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand

Note 1 to entry: The fraction may be viewed as the coverage probability or level of confidence of the interval.

Note 2 to entry: To associate a specific level of confidence with the interval defined by the expanded uncertainty requires explicit or implicit assumptions regarding the probability distribution characterized by the measurement result and its combined standard uncertainty. The level of confidence that may be attributed to this interval can be known only to the extent to which such assumptions may be justified.

[SOURCE: JCGM 100]

3.1.6
field blank
filter that undergoes the same procedures of conditioning and weighing as a sample filter, including transport to and from, and storage in the field, but is not used for sampling air

Note 1 to entry: A field blank is sometimes also called a procedure blank.

3.1.7
weighing room blank
filter that undergoes the same procedures of conditioning and weighing as a sample filter, but is stored in the weighing room

3.1.8
limit value
level fixed on the basis of scientific knowledge, with the aim of avoiding, preventing or reducing harmful effects on human health and/or the environment as a whole, to be attained within a given period and not to be exceeded once attained

[SOURCE: 2008/50/EC]

3.1.9
monitoring station
enclosure located in the field in which a sampler has been installed to measure particulate matter in such a way that its performance and operation comply with the prescribed requirements

3.1.10
parallel measurement
measurements from measuring systems, sampling from the same air over the same time period

3.1.11
performance characteristic
one of the parameters assigned to a sampler in order to define its performance

3.1.12
performance criterion
limiting quantitative numerical value assigned to a performance characteristic, to which conformance is tested

3.1.13
period of unattended operation
time period over which the sampler can be operated without requiring operator intervention

3.1.14
PM_x
particulate matter suspended in air which is small enough to pass through a size-selective inlet with a 50 % efficiency cut-off at x µm aerodynamic diameter

Note 1 to entry: By convention, the size-selective standard inlet designs prescribed in this European Standard – used at the prescribed flow rates – possess the required characteristics to sample the relevant PM fraction suspended in ambient air.

Note 2 to entry: The efficiency of the size selectiveness of other inlets used may have a significant effect on the fraction of PM surrounding the cut-off, and, consequently on the mass concentration of PMx determined.

3.1.15
reference method
RM
measurement method(ology) which, by convention, gives the accepted reference value of the measurand

3.1.16
sampled air
ambient air that has been sampled through the sampling inlet and sampling system

3.1.17
sampling inlet
entrance to the sampling system where ambient air is collected from the atmosphere

3.1.18
standard uncertainty
uncertainty of the result of a measurement expressed as a standard deviation

[SOURCE: JCGM 100]

3.1.19
suspended particulate matter
SPM
notion of all particles surrounded by air in a given, undisturbed volume of air

3.1.20
time coverage
percentage of the reference period of the relevant limit value for which valid data for aggregation have been collected

3.1.21
uncertainty (of measurement)
parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurand

[SOURCE: JCGM 100]

3.2 Symbols and abbreviations

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

— φ Flow rate related to standard conditions

— φ_a Flow rate related to ambient conditions (T_a, P_a)

— ΔP Pressure difference determined for the time interval Δt (leak test)

— Δt Time interval needed for the pressure rise (leak test)

— C Concentration of PM (µg/m^3) at ambient conditions

— k Coverage factor

— m Filter mass

— m_c Mass of blank conditioned filter

— m_l Mass of sampled filter

— m_s Mass of sampled and conditioned filter

— m_u Mass of unsampled filter

— P_0 Pressure at t = 0 (leak test)

— P_a Ambient pressure
— t Sampling time
— T_a Ambient temperature
— u Standard uncertainty
— u_{bs} Between-sampler uncertainty
— u_f Uncertainty of flow
— u_{mfb} Uncertainty due to the effect of humidity on a blank filter
— u_{mh} Uncertainty due to hysteresis effects on mass of PM
— u_m Uncertainty of the mass of PM (ml – mu)
— u_{mb} Uncertainty due to buoyancy
— u_{mba} Uncertainty due to balance calibration
— u_{mc} Uncertainty due to contamination
— u_{mfe} Uncertainty due to lack of filter efficiency
— u_{mg} Uncertainty due to the interaction with gases
— u_{mhp} Uncertainty due to the effect of humidity on particulate matter
— u_{mip} Uncertainty due to inlet performance
— u_{ml} Uncertainty of the mass of a sampled filter
— u_{ms} Uncertainty due to static charging of the filter
— u_{mtl} Uncertainty due to losses of PM on transport and storage
— u_{mu} Uncertainty of the mass of an unsampled filter
— u_{mzd} Uncertainty due to balance zero drift
— φ_L Leak flow rate (leak test)
— V_{sys} Estimated total volume of the system (dead volume)
— w Relative uncertainty
— W Expanded relative uncertainty
— x_i Individual measurement result from a sampler
— u_{fc} Uncertainty due to flow calibration
— u_{fd} Uncertainty due to flow drift
— u_t Uncertainty of sample time

— EU European Union
— GDE Guide to the Demonstration of Equivalence of Ambient Air Monitoring Methods
— GUM Guide to the Expression of Uncertainty in Measurement
— JCGM Joint Committee for Guides in Metrology
— PM Particulate Matter
— POM Polyoxymethylene
— PTFE Polytetrafluoroethylene
— QA/QC Quality Assurance / Quality Control
— RH Relative Humidity
— RM Reference Method(ology)

— SPM Suspended Particulate Matter

4 Principle

4.1 Description of the standard measuring principle

Ambient air is passed through a size-selective inlet at a known, constant flow rate. The relevant PM fraction is collected on a filter for a known period of nominally 24 h. The mass of the PM material is determined by weighing the filter at pre-specified, constant conditions before and after collection of the particulate matter.

Key factors which can affect the result of the measurement, and which are addressed by the procedures prescribed within this European Standard, include:

— (variations in) the design and construction of the size-selective inlet;

— the sampling flow rate;

— deposition losses of PM within the pipework between the inlet and the filter;

— uncontrolled losses within the pipework between the inlet and the filter, and on the filter due to volatilization of water and semi-volatile PM at any time between collection and weighing;

— changes in weight of the filters or PM due to, e.g. adsorption of water and semi-volatile compounds, spurious addition or loss of material, buoyancy, or static electricity.

In order to minimize the effects of these factors, this European Standard gives requirements for a series of parameters that determine the magnitudes of these effects.

4.2 Initial use and procedures for ongoing QA/QC

QA/QC procedures are described for sample collection, filter transport and handling, and filter weighing.

The quality assurance/quality control (QA/QC) procedures within this European Standard are separated into those activities typically carried out with each measurement, and those carried out less frequently.

QA/QC procedures which are used for each measurement, including filter handling and conditioning, weighing room conditions, proper functioning of the weighing instrument, and the use of blank filters, are described in Clause 6.

It is of particular importance that the facilities used for the weighing of the filters before and after sampling fulfil the requirements of this European Standard. Consequently, a series of tests is described through which the user may ensure the proper operation of the facilities.

Additional QA/QC procedures which are used on a less frequent basis, including flow calibration, calibration of the weighing instrument, and maintenance (inlet cleaning) and leak testing of the sampling system, are described in Clause 7.

5 Equipment and facilities

5.1 Sampling system components

5.1.1 General

This European Standard describes the designs for the sampling systems to be used within the standard method.

Sequential sampling systems for the standard measurement methods for PM_{10} and $PM_{2,5}$ typically consist of the following elements, illustrated schematically in Annex C:

— size-selective inlets, whose designs are prescribed in 5.1.2;

— connecting pipe-work between the inlet and the filter holder, described in 5.1.3;

— filter holder and filter, described in 5.1.4;

— flow control system, given by performance specifications in 5.1.5;

— sample changer;

— storage facility for filters in the sampler.

NOTE There are different filter storage facilities possible. Two options are given as an example: in option A there is only one combined blank and sampled filter magazine from which the unsampled filter is taken and where - after the 24 h loading period - the sampled filter is moved back to (see Annex C, option A). In option B the unsampled filter is taken from the left blank filter magazine and – after the 24 h loading period – the sampled filter is moved to the sampled filter magazine in the right (see Annex C, option B).

Requirements for the correct operation of the sampling system are specified in Table 1.

Table 1 — Requirements for sampling equipment

	Design/performance characteristic	Requirement [a]	Subclause
1	Sampler design	The sampler shall be designed in a way that it is possible to check and calibrate all sensors important to ensure the correct performance of the sampler. The manual of the sampler shall contain instructions on how to access the sensors.	
2	Inlet design	As prescribed	5.1.2
3	Temperature of filter during sampling	Within 5 °C of ambient temperature for ambient temperatures ≥ 20 °C	5.1.4
4	Nominal flow rate	2,3 m^3/h at ambient conditions	5.1.5
5	Constancy of sample volumetric flow	≤ 2,0 % sampling time (averaged flow) ≤ 5,0 % rated flow (instantaneous flow)	5.1.5
6	Leak tightness of the sampling system	φ_L ≤ 1,0 % of sample flow rate	5.1.7
7	Single-filter sampling period	24 h ± 1 h	5.1.6
8	Uncertainty (95 % confidence) of sampling	≤ 5 min	5.1.6