



SLOVENSKI STANDARD
oSIST prEN 14789:2015
01-januar-2015

**Emisije nepremičnih virov - Določevanje volumske koncentracije kisika -
Standardna referenčna metoda – Paramagnetizem**

Stationary source emissions - Determination of volume concentration of oxygen -
Standard reference method: Paramagnetism

Emissionen aus stationären Quellen - Bestimmung der Volumenkonzentration von
Sauerstoff - Standardreferenzverfahren: Paramagnetismus

Emissions de sources fixes - Détermination de la concentration volumique en oxygène -
Méthode de référence normalisée: Paramagnétisme

Ta slovenski standard je istoveten z: prEN 14789

ICS:

13.040.40 Emisije nepremičnih virov Stationary source emissions

oSIST prEN 14789:2015

en,fr,de

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

DRAFT
prEN 14789

October 2014

ICS 13.040.40

Will supersede EN 14789:2005

English Version

Stationary source emissions - Determination of volume concentration of oxygen - Standard reference method: Paramagnetism

Emissions de sources fixes - Détermination de la concentration volumique en oxygène - Méthode de référence normalisée: Paramagnétisme

Emissionen aus stationären Quellen - Bestimmung der Volumenkonzentration von Sauerstoff - Standardreferenzverfahren: Paramagnetismus

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 264.

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Foreword

This document (prEN 14789:2014) has been prepared by Technical Committee CEN/TC 264 "Air quality", the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14789:2005.

Annex E provides details of significant technical changes between this document and the previous edition.

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SIST EN 14789:2017

<https://standards.iteh.ai/catalog/standards/sist/c95c8db3-c28b-4178-95f8-28001db35647/sist-en-14789-2017>

prEN 14789:2014 (E)**1 Scope**

This European Standard specifies the standard reference method (SRM) based on the paramagnetic principle for the determination of the oxygen concentrations in flue gases emitted to the atmosphere from ducts and stacks. It includes the sampling and the gas conditioning system as well as the analyser.

This European Standard specifies the performance characteristics to be determined and the performance criteria to be fulfilled by measuring systems based on this measurement method. It applies to periodic monitoring and the calibration or control of automated measuring systems (AMS) permanently installed on a stack, for regulatory or other purposes.

This European Standard specifies criteria for demonstration of equivalence of an alternative method (AM) to the SRM by application of prEN 14793.

This European Standard has been validated during field tests on waste incineration, co-incineration and large combustion plants and on a recognized test bench. It has been validated for sampling periods of 30 min in the range from 3 % to 21 %. Oxygen concentration values, expressed as volume concentrations, are used to allow results of emission measurements to be standardised to the oxygen reference concentration and dry gas conditions required e.g. by EU Directive 2010/75/EC on industrial emissions.

NOTE The characteristics of installations, the conditions during field tests and the values of repeatability and reproducibility in the field are given in Annex A.

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.

prEN 14793:2014, *Stationary source emission – Demonstration of equivalence of an alternative method with a reference method*

EN 15259:2007, *Air quality — Measurement of stationary source emissions — Requirements for measurement sections and sites and for the measurement objective, plan and report*

EN 15267-3:2007, *Air quality — Certification of automated measuring systems — Part 3: Performance criteria and test procedures for automated measuring systems for monitoring emissions from stationary sources*

EN ISO 14956:2002, *Air quality — Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty (ISO 14956:2002)*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

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

NOTE In this European Standard, the volume concentration of oxygen is expressed in percent.

3.1**adjustment of a measuring system**

set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured

[SOURCE: JCGM 200:2012]

Note 1 to entry: The adjustment can be made directly on the instrument or using a suitable calculation procedure.

3.2**ambient temperature**

temperature of the air around the measuring device

3.3**automated measuring system****AMS**

measuring system permanently installed on site for continuous monitoring of emissions or measurement of peripheral parameters

Note 1 to entry: An AMS is a method which is traceable to a reference method.

Note 2 to entry: Apart from the analyser, an AMS includes facilities for taking samples (e.g. probe, sample gas lines, flow meters, regulators, delivery pumps) and for sample conditioning (e.g. dust filter, moisture removal devices, converters, diluters). This definition also includes testing and adjusting devices that are required for regular functional checks.

[SOURCE: FprEN 14181:2014]

3.4**calibration of an AMS**

establishment of the statistical relationship between values of the measurand indicated by the automated measuring system (AMS) and the corresponding values given by the standard reference method (SRM) used during the same period of time and giving a representative measurement on the same measurement plane

Note 1 to entry: The result of calibration permits to establish the relationship between the values of the SRM and the AMS (calibration function).

3.5**zero drift**

difference between two zero readings at the beginning and at the end of a measuring period

3.6**span drift**

difference between two span readings at the beginning and at the end of a measuring period

3.7**emission limit value****ELV**

emission limit value according to EU Directives on the basis of 30 min, 1 hour or 1 day

3.8**influence quantity**

quantity that is not the measurand but that affects the result of the measurement

Note 1 to entry: Influence quantities are e.g. ambient temperature, atmospheric pressure, presence of interfering gases in the flue gas matrix or pressure of the gas sample.

3.9**interference**

negative or positive effect upon the response of the measuring system, due to a component of the sample that is not the measurand

prEN 14789:2014 (E)**3.10****lack of fit**

systematic deviation within the range of application between the measurement result obtained by applying the calibration function to the observed response of the measuring system measuring test gases and the corresponding accepted value of such test gases

Note 1 to entry: Lack of fit may be a function of the measurement result.

Note 2 to entry: The expression "lack of fit" is often replaced in everyday language by "linearity" or "deviation from linearity".

3.11**measurand**

quantity intended to be measured

[SOURCE: JCGM 200:2012]

3.12**measurement plane**

plane normal to the centreline of the duct at the sampling position

Note 1 to entry: Measurement plane is also known as sampling plane.

[SOURCE: EN 15259:2007]

3.13**measurement point**

position in the measurement plane at which the sample stream is extracted or the measurement data are obtained directly

Note 1 to entry: Measurement point is also known as sampling point.

[SOURCE: EN 15259:2007] standards.iteh.ai/catalog/standards/sist/c95c8db3-c28b-4178-95f8-28001db35647/sist-en-14789-2017

3.14**measurement site**

place on the waste gas duct in the area of the measurement plane(s) consisting of structures and technical equipment, for example working platforms, measurement ports, energy supply

Note 1 to entry: Measurement site is also known as sampling site.

[SOURCE: EN 15259:2007]

3.15**measuring system**

set of one or more measuring instruments and often other devices, including any reagent and supply, assembled and adapted to give information used to generate measured quantity values within specified intervals for quantities of specified kinds

[SOURCE: JCGM 200:2012]

3.16**performance characteristic**

one of the quantities (described by values, tolerances, range) assigned to equipment in order to define its performance

3.17**repeatability in the laboratory**

closeness of the agreement between the results of successive measurements of the same measurand carried out under the same conditions of measurement

Note 1 to entry: Repeatability conditions include:

- same measurement procedure;
- same laboratory;
- same measuring instrument, used under the same conditions;
- same location;
- repetition over a short period of time.

Note 2 to entry: Repeatability can be expressed quantitatively in terms of the dispersion characteristics of the results.

Note 3 to entry: In this European Standard the repeatability is expressed as a value with a level of confidence of 95 %.

3.18**repeatability in the field**

closeness of the agreement between the results of simultaneous measurements of the same measurand carried out with two sets of equipment under the same conditions of measurement

Note 1 to entry: These conditions include:

- same measurement procedure;
- two sets of equipment, the performances of which are fulfilling the requirements of the reference method, used under the same conditions;
- same location;
- implemented by the same laboratory;
- typically calculated on short periods of time in order to avoid the effect of changes of influence parameters (e.g. 30 min).

Note 2 to entry: Repeatability can be expressed quantitatively in terms of the dispersion characteristics of the results.

Note 3 to entry: In this European Standard, the repeatability under field conditions is expressed as a value with a level of confidence of 95 %.

3.19**reproducibility in the field**

closeness of the agreement between the results of simultaneous measurements of the same measurand carried out with several sets of equipment under the same conditions of measurement

Note 1 to entry: These conditions are called field reproducibility conditions and include:

- same measurement procedure;
- several sets of equipment, the performances of which fulfil the requirements of the reference method, used under the same conditions;
- same location;

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— implemented by several laboratories.

Note 2 to entry: Reproducibility can be expressed quantitatively in terms of the dispersion characteristics of the results.

Note 3 to entry: In this European Standard, the reproducibility under field conditions is expressed as a value with a level of confidence of 95 %.

3.20**residence time in the measuring system**

time period for the sampled gas to be transported from the inlet of the probe to the inlet of the measurement cell

3.21**response time**

duration between the instant when an input quantity value of a measuring instrument or measuring system is subjected to an abrupt change between two specified constant quantity values and the instant when a corresponding indication settles within specified limits around its final steady value

Note 1 to entry: By convention time taken for the output signal to pass from 0 % to 90 % of the final change.

[SOURCE: JCGM 200:2012]

3.22**span gas**

test gas used to adjust and check a specific point on the response line of the measuring system

Note 1 to entry: This concentration is often chosen around 80 % of the upper limit of the range.

3.23**reference method****RM**

measurement method taken as a reference by convention, which gives the accepted reference value of the measurand

Note 1 to entry: A reference method is fully described.

Note 2 to entry: A reference method can be a manual or an automated method.

Note 3 to entry: Alternative methods can be used if equivalence to the reference method has been demonstrated.

[SOURCE: EN 15259:2007]

3.24**standard reference method****SRM**

reference method prescribed by European or national legislation

[SOURCE: EN 15259:2007]

3.25**uncertainty**

parameter associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand

3.26**standard uncertainty**

u

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

3.27 combined uncertainty

u_c

standard uncertainty attached to the measurement result calculated by combination of several standard uncertainties according to the principles laid down in ISO/IEC Guide 98-3 (GUM)

3.28 expanded uncertainty

U

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

$$U = k \times u$$

Note 1 to entry: In this European Standard, the expanded uncertainty is calculated with a coverage factor of $k = 2$, and with a level of confidence of 95 %.

Note 2 to entry: The expression overall uncertainty is sometimes used to express the expanded uncertainty.

3.29 uncertainty budget

calculation table combining all the sources of uncertainty according to EN ISO 14956 or ISO/IEC Guide 98-3 in order to calculate the combined uncertainty of the method at a specified value

4 Principle

4.1 General

This European Standard describes the standard reference method (SRM), based on the paramagnetism principle for sampling and determining oxygen concentration in flue gases emitted to atmosphere from ducts and stacks. The specific components and the requirements for the sampling system and the paramagnetic analyser are described in Clause 5. A number of performance characteristics, together with associated performance criteria are specified for the analyser. These performance characteristics and the combined uncertainty of the method shall meet the performance criteria given in this European Standard. Requirements and recommendations for quality assurance and quality control are given in Clause 8 for measurements in the field.

4.2 Measuring principle

The paramagnetic method is based on the principle that oxygen molecules are strongly attracted to a magnetic field. This property, known as paramagnetism, can be used for the selective measurement of oxygen in flue gases where the other constituents are either slightly or non-paramagnetic. The magnetic susceptibility or degree of magnetisation produced in a gas sample by a magnetic field is inversely proportional to its absolute temperature. A gas sample containing oxygen, when exposed to the combined effect of a magnetic gradient in a confined space, shall be constrained to flow in the direction of the magnetic field. The magnitude of this flow, other factors being equal, is dependent on the oxygen concentration in the gas sample induced flow. A number of devices, described in clause 5 have been developed to measure the paramagnetically induced flow (see in Annex B an example of assessment of compliance of paramagnetic method for oxygen with given uncertainty requirements).

Paramagnetic analysers are combined with an extractive sampling system and a gas conditioning system. A sample of gas is taken from the stack with a sampling probe and conveyed to the analyser through a measurement line and suitable gas conditioning system. The values from the analyser are recorded and/or stored by means of electronic data processing systems.

5 Description of the measuring system

5.1 General on sampling and sample gas conditioning systems

A volume of flue gas (see 8.2) is extracted from the emission source for a fixed period of time at a controlled flow rate. A filter removes the dust in the sampled volume before the sampled gas is conditioned and passed to the analyser.

Two different sampling and conditioning configurations are available in order to avoid uncontrolled water condensation in the measuring system. Both approaches require that the user shall check that the dew point temperature is lower or equal to 4 °C at the outlet of the analyser. The user may correct the results for the remaining water content in order to report results on a dry basis (refer to the table of Annex B in prEN 14790).

These configurations are:

- configuration 1: removal of water vapour by condensation using a cooling system;
- configuration 2: removal of water vapour through elimination within a permeation drier.

Schematic diagrams of typical measuring systems are shown in Annex C.

It is important that all components of the sampling system upstream of the analyser are made of materials that do not react with or absorb oxygen. Except for the cooling system of configuration 1, the temperature of its components coming into contact with the gas, shall be maintained at a sufficiently high temperature to avoid any condensation.

Conditions and layout of the sampling and sample gas conditioning system contribute to the combined uncertainty of the measurement. In order to minimise this contribution to the combined measurement uncertainty, performance criteria for the sampling system and sampling conditions are given in 5.2 and Clause 6.

Some other sample gas conditioning systems may exist and could be acceptable, provided they fulfil the requirements of this European Standard and have been validated with success during the certification process. For example, some systems put gas in depression using a simple sonic nozzle in the collection probe in order to create a partial vacuum (between 50 hPa and 100 hPa absolute pressure) so that the head of collection and the measurement line does not need to be heated and water vapour condensation is avoided.

5.2 Sampling and conditioning system

5.2.1 Sampling probe

In order to reach the measurement points in the measurement plane, probes of different lengths and inner diameters may be used. The design and configuration of the probe used shall ensure the residence time of the sample gas within the probe is minimised in order to reduce the response time of the measuring system.

NOTE 1 The probe can be marked before sampling in order to demonstrate that the measurement points in the measurement plane have been reached.

NOTE 2 A sealable connection can be installed on the probe in order to introduce test gases for adjustment.

5.2.2 Filter

The filter and filter holder shall be made of an inert material (e.g. ceramic or sinter metal filter with an appropriate pore size). It shall be heated above the water or acid dew point. The particle filter shall be changed or cleaned periodically depending on the dust loading at the measurement site.

NOTE Overloading of the particle filter can increase the pressure drop in the measurement line.