SLOVENSKI STANDARD
SIST EN 14789:2005

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Emisije nepremiļ nih virov - Doloļ evanje volumske koncentracije kisika (O2) ï Referenļ na metoda ï Paramagnetizem

Stationary source emissions - Determination of volume concentration of oxygen (O2) - Reference method - Paramagnetism

Emissionen aus stationären Quellen - Bestimmung der Volumenkonzentration von Sauerstoff (O2) - Referenzverfahren - Paramagnetismus

Emissions de sources fixes - Détermination de la concentration volumique en oxygene (O2) - Méthode de référence: Paramagnétisme

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ICS:

13.040.40	Emisije nepremiļ nih virov	Stationary source emissions

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EUROPEAN STANDARD
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English Version

Stationary source emissions - Determination of volume concentration of oxygen (O2) - Reference method - Paramagnetism

Emissions de sources fixes - Détermination de la concentration volumique en oxygène (O2) - Méthode de référence: Paramagnétisme

Emissionen aus stationären Quellen - Bestimmung der Volumenkonzentration von Sauerstoff - Referenzverfahren - Paramagnetismus

This European Standard was approved by CEN on 30 September 2005.

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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 Central Secretariat has the same status as the official versions.

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Foreword

This European Standard (EN 14789:2005) 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of an identical text or by endorsement, at the latest by May 2006, and conflicting national standards shall be withdrawn at the latest by May 2006.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this European Standard.

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

1 Scope

This European Standard describes the paramagnetic method, including the sampling and the gas conditioning system, to determine the oxygen concentrations in flue gases emitted to the atmosphere from ducts and stacks.

This European Standard is the Standard Reference Method (SRM) for periodic monitoring and for the calibration or control of Automatic Measuring Systems (AMS) permanently installed on a stack, for regulatory purposes or other purposes. To be used as the SRM, the user shall demonstrate that the performance characteristics of the method are better than the performance criteria defined in this European Standard and that the overall uncertainty of the method is less than ± 6,0 % of the measured concentration.

NOTE When paramagnetism is the measurement principle used for AMS, reference should be made to EN 14181 and other relevant standards provided by CEN/TC 264.

An alternative method to this SRM may be used provided that the user can demonstrate equivalence according to the Technical Specification CEN/TS 14793, to the satisfaction of his national accreditation body or law.

This Standard Reference Method has been evaluated during field tests on waste incineration, co-incineration and large combustion installations. It has been validated for sampling periods of 30 min in the range: 5 % to 26 %. Oxygen concentration values, expressed in % volume, are used in order to allow emission measurements of pollutants to be standardised to the reference O_2 concentration and dry gas conditions required by the following Council Directives:

- Council Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants;
- Council Directive 2000/76/EC on waste incineration plants.

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.

CEN/TS 14793, *Stationary source emission – Intralaboratory validation procedure for an alternative method compared to a reference method*.

ENV 13005, *Guide to the expression of uncertainty in measurement*.

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

3 Terms and definitions

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

NOTE In this European Standard, the concentration of O_2 is expressed in % volume.

3.1
adjustment (of a measuring system)
operation of bringing a measuring system into a state of performance suitable for its use

[VIM 4.30]

3.2
ambient temperature
temperature of the air around the measuring device

3.3
automatic measuring system (AMS)
measuring system permanently installed on site for continuous monitoring of emissions

NOTE 1 An AM is a method which is traceable to a reference method.

NOTE 2 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.

[EN 14181]

3.4
calibration
statistical relationship between values of the measurand indicated by the 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 sampling plane

NOTE The result of calibration permits to establish the relationship between the values of the SRM and the AMS (calibration function).

3.5
drift
difference between two zero (zero drift) or span readings (span drift) at the beginning and at the end of a measuring period

3.6
emission limit value (ELV)
emission limit value according to EU Directives on the basis of 30 min, 1 hour or 1 day

3.7
influence quantity
quantity that is not the measurand but that affects the result of the measurement

[adapted VIM 2.7]

NOTE Examples:

- ambient temperature;
- atmospheric pressure;
- presence of interfering gases in the flue gas matrix;
- pressure of the gas sample.

3.8
interference
negative or positive effect upon the response of the measuring system, due to a component of the sample that is not the measurand

3.9
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 Lack of fit may be a function of the measurement result.

NOTE 2 The expression "lack of fit" is often replaced in everyday language by "linearity" or "deviation from linearity".

3.10
measurand
particular quantity subject to measurement

[VIM 2.6]

3.11
measuring system
complete set of measuring instruments and other equipment assembled to carry out specified measurements

[VIM 4.5]

3.12
performance characteristic
one of the quantities (described by values, tolerances, range) assigned to equipment in order to define its performance

3.13
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 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 Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results.

In this European Standard the repeatability is expressed as a value with a level of confidence of 95 %.

[VIM 3.6]

3.14
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 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 Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results.

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

3.15
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 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;
- implemented by several laboratories.

NOTE 2 Reproducibility may be expressed quantitatively in terms of the dispersion characteristics of the results.

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

3.16
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

3.17
response time
time interval between the instant when a stimulus is subjected to a specified abrupt change and the instant when the response reaches and remains within specified limits around its final steady value

NOTE By convention time taken for the output signal to pass from 0 % to 90 % of the final change.

[VIM 5.17]

3.18
sampling location
specific area, close to the sampling plane, where the measurement devices are set up

3.19
sampling plane
plane normal to the centreline of the duct at the sampling position

[EN 13284-1]

3.20
sampling point
specific position on a sampling line at which a sample is extracted

[EN 13284-1]

3.21
span gas
test gas used to adjust and check a specific point on the response line of the measuring system

NOTE This concentration is often chosen around 80 % of the upper limit of the range.

3.22
Standard Reference Method (SRM)
measurement method recognised by experts and taken as a reference by convention, which gives, or is presumed to give, the accepted reference value of the concentration of the measurand (3.10) to be measured

3.23
uncertainty
parameter associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand

3.23.1
standard uncertainty u
uncertainty of the result of a measurement expressed as a standard deviation u

3.23.2
combined uncertainty u_c
standard uncertainty u_c attached to the measurement result calculated by combination of several standard uncertainties according to GUM

3.23.3
expanded uncertainty U
quantity defining a level of confidence about the result of a measurement that may be expected to encompass a specific fraction of the distribution of values that could reasonably be attributed to a measurand

$U = k \times u$

NOTE In this European Standard, the expanded uncertainty is calculated with a coverage factor of k=2, and with a level of confidence of 95 %.

3.23.4
overall uncertainty U_c
expanded combined standard uncertainty attached to the measurement result calculated according to GUM

$U_c = k \times u_c$

3.24
uncertainty budget
calculation table combining all the sources of uncertainty according to EN ISO 14956 or ENV 13005 in order to calculate the overall 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 O_2 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. A number of performance characteristics, together with associated minimum performance criteria are specified for the analyser. These performance characteristics and the overall 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 for measurements in the field (see Table 1 in 7.2).

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 6 have been developed to measure the paramagnetically induced flow.

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

5 Description of measuring equipment - Sampling and sample gas conditioning systems

5.1 General

A representative 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 A in EN 14790:2003).

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 A.

It is important that all parts of the sampling equipment upstream of the analyser are made of materials that do not react with or absorb O_2. 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 equipment contribute to the overall uncertainty of the measurement. In order to minimise this contribution to the overall measurement uncertainty, the performance criteria for the sampling equipment and sampling conditions are given in sections 5.2 and 6.

5.2 Sampling line components

5.2.1 Sampling line

In order to access the representative measurement point(s) of the sampling 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.

The procedure of sub-clause 8.2 shall be used when the operator suspects that the flue gas is inhomogeneous.

The probe may be marked before sampling in order to demonstrate that the representative measurement point(s) in the measurement plane has (have) been reached.

The line shall be made of a suitable, corrosion resistant material (e.g. stainless steel, borosilicate glass, ceramic, titanium, PTFE is only suitable for flue gas temperatures lower than 200 °C).

A seal-able connection may be installed on the probe in order to introduce test gases for adjustment.

5.2.2 Filter

The particle filter 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 sampling site.

NOTE Overloading of the particle filter may increase the pressure drop in the sampling line.

5.2.3 Sample cooler or permeation drier

The sample cooler or permeation drier is used before the gas enters the analyser in order to separate water vapour from the flue gas. A maximum dew-point temperature of 4 °C shall not be exceeded at the outlet of the system.

NOTE The measured oxygen concentration, given by these sampling configurations, can be considered to be dry. However, the user may correct the results for the remaining water (refer to the Table of Annex A in EN 14790:2003).

5.2.4 Sample pump

When a pump is not an integral part of the paramagnetic analyser, an external pump is necessary to draw the sampled air through the apparatus. It shall be capable of operating according to the specified flow requirements of the manufacturer of the analyser and pressure conditions required for the reaction chamber. The pump shall be resistant to corrosion and consistent with the requirements of the analyser to which it is connected.

NOTE The quantity of sample gas required can vary between 15 l/h and 500 l/h, depending upon the analyser and the expected response time.