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Zunanji zrak - Standardna metoda za določanje koncentracije dušikovega dioksida in dušikovega monoksida s kemiluminiscenco

Ambient air - Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence

Außenluft - Messverfahren zur Bestimmung der Konzentration von Stickstoffdioxid und Stickstoffmonoxid mit Chemilumineszenz

Air ambiant - Méthode normalisée pour le mesurage de la concentration en dioxyde d'azote et monoxyde d'azote par chimiluminescence

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Ambient air - Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence

Air ambiant - Méthode normalisée pour le mesurage de la concentration en dioxyde d'azote et monoxyde d'azote par chimiluminescence

Außenluft - Messverfahren zur Bestimmung der Konzentration von Stickstoffdioxid und Stickstoffmonoxid mit Chemilumineszenz

This European Standard was approved by CEN on 11 November 2024.

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European foreword

This document (EN 14211:2024) 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of an identical text or by endorsement, at the latest by June 2025, and conflicting national standards shall be withdrawn at the latest by June 2025.

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

This document supersedes EN 14211:2012.

The technical modifications in comparison with the previous edition are listed in Annex H of this document.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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

1 Scope

This document specifies a continuous measurement method for the determination of the concentrations of nitrogen dioxide and nitrogen monoxide present in ambient air based on the chemiluminescence measuring principle. This document describes the performance characteristics and sets the relevant minimum criteria required to select an appropriate chemiluminescence analyser by means of type testing. It also includes the evaluation of the suitability of an analyser for use in a specific fixed site so as to meet the data quality requirements (see Annex I of Directive 2008/50/EC [1] for additional information) and requirements during sampling, calibration and quality assurance for use.

The method is applicable to the determination of the concentration of nitrogen dioxide present in ambient air up to 500 µg/m^3. This concentration range represents the certification range for nitrogen dioxide for type testing.

The method is applicable to the determination of the concentration of nitrogen monoxide present in ambient air up to 1 200 µg/m^3. This concentration range represents the certification range for nitrogen monoxide for the type testing.

NOTE 1 It is possible to use other ranges depending on the levels present in ambient air.

NOTE 2 Exemplar uncertainty budget calculations are given in Annexes F to H referring to Directive 2008/50/EC [1]. In the event that the Limit Values are updated in future iterations of Directive 2008/50/EC [1], the user can use these new values to calculate measurement uncertainties.

The method covers the determination of ambient air concentrations of nitrogen dioxide and nitrogen monoxide in zones classified as rural areas, urban-background areas, traffic-orientated locations and locations influenced by industrial sources.

The results are expressed in µg/m^3 (at 20 °C and 101,3 kPa).

NOTE 3 500 µg/m^3 of nitrogen dioxide corresponds to 261 nmol/mol of nitrogen dioxide at 20 °C and 101,3 kPa. 1 200 µg/m^3 of nitrogen monoxide corresponds to 962 nmol/mol of nitrogen monoxide at 20 °C and 101,3 kPa.

This document contains information for different groups of users.

Clause 5 to Clause 7 and Annex B and Annex C contain general information about the principles of NO_x measurement by chemiluminescence analyser and sampling equipment.

Clause 8, Annex E is specifically directed towards test houses and laboratories that perform type testing of NO_x analysers. These sections contain information about:

— type testing conditions, test procedures and test requirements;

— analyser performance requirements;

— evaluation of the type testing results;

— evaluation of the associated uncertainty of the measurement performed by the NO_x analyser based on the type testing results.

Clause 9 to Clause 11 and Annex F and Annex G are directed towards monitoring networks performing the practical measurements of NO_x in ambient air. These sections contain information about:

— initial installation of the analyser in the monitoring network and acceptance testing;

— ongoing quality assurance/quality control;

— calculation and reporting of measurement results;

— evaluation of the associated uncertainty of the measurements under practical monitoring conditions.

This document represents an evolution of earlier editions (EN 14211:2005 and EN 14211:2012).

NOTE 4 Analysers type tested prior to the publication of this document can still be used for regulated monitoring purposes. As newer versions of analysers tested under this document become available, discontinue the use of older reference analysers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 15267-1, *Air quality - Assessment of air quality monitoring equipment - Part 1: General principles of certification*

EN 15267-2, *Air quality - Assessment of air quality monitoring equipment - Part 2: Initial assessment of the manufacturer's quality management system and post certification surveillance for the manufacturing process*

EN ISO 6142-1, *Gas analysis — Preparation of calibration gas mixtures — Gravimetric method (ISO 6142-1)*

EN ISO 6143, *Gas analysis - Comparison methods for determining and checking the composition of calibration gas mixtures (ISO 6143)*

EN ISO 6144, *Gas analysis - Preparation of calibration gas mixtures - Static volumetric method (ISO 6144)*

EN ISO 6145-6, *Gas analysis - Preparation of calibration gas mixtures using dynamic methods - Part 6: Critical flow orifices (ISO 6145-6)*

EN ISO 6145-7, *Gas analysis - Preparation of calibration gas mixtures using dynamic methods - Part 7: Thermal mass-flow controllers (ISO 6145-7)*

EN ISO 6145-10, *Gas analysis - Preparation of calibration gas mixtures using dynamic volumetric methods - Part 10: Permeation method (ISO 6145-10)*

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

ISO 19229, *Gas analysis - Purity analysis and the treatment of purity data*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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

Note 1 to entry: Types of adjustment of a measuring system include zero adjustment of a measuring system, offset adjustment, and span adjustment (sometimes called gain adjustment).

Note 2 to entry: Adjustment of a measuring system should not be confused with calibration, which is a prerequisite for adjustment.

Note 3 to entry: In the context of this document, adjustment is generally performed on measurement data rather than on the analyser.

[SOURCE: JCGM 200:2012, 3.11] [2]

3.2
ambient air
outdoor air in the troposphere where provisions concerning health and safety at work apply and to which members of the public do not have regular access

Note 1 to entry: This excluding workplaces as defined by Directive 89/654/EEC.

[SOURCE: Council Directive 2008/50/EC] [1]

3.3
analyser
measuring system that provides an output signal which is a function of the concentration or partial pressure of one or more components in a gas mixture and flow or temperature of this gas mixture

3.4
availability of the analyser
fraction of the time period for which valid measuring data of the ambient air concentration is available from an analyser

3.5
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

Note 1 to entry: A calibration can be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it can consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

Note 2 to entry: Calibration should not be confused with adjustment of a measuring system, often mistakenly called “self-calibration”, nor with verification of a calibration.

Note 3 to entry: Often, the first step alone in the above definition is perceived as being calibration.

Note 4 to entry: In the context of this document, calibration is a comparison of the analyser response to a known gas concentration with a known uncertainty when the information obtained from the comparison is used for the successive adjustment (if needed) of the analyser.

[SOURCE: JCGM 200:2012, 2.39] [2]

3.6
certification range
concentration range for which the analyser is type tested

3.7
check
verification that the analyser is still operating within specified performance limits

3.8
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 co-variances of these other quantities weighted according to how the measurement result varies with changes in these quantities

[SOURCE: JCGM 100:2008, 2.3.4] [3]

3.9
converter efficiency
degree of conversion of nitrogen dioxide present in the sample gas into nitrogen monoxide, given as a percentage

3.10
coverage factor
numerical factor used as a multiplier of the combined standard uncertainty in order to obtain an expanded uncertainty

[SOURCE: JCGM 100:2008, 2.3.6] [3]

3.11
competent body
organization which can demonstrate its competence for a specific task to the national competent authority of the Member State

3.12
detection limit
smallest concentration of a measurand that can be reliably detected by a specific measurement process

Note 1 to entry: The detection limit is calculated as 3,3 × ($s_{r,z}$/B) where $s_{r,z}$ is the standard deviation of analyser response at zero measurand concentration (see 8.4.5) and B is the slope of the calibration function [4].

3.13
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 can 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 can be attributed to this interval can be known only to the extent to which such assumptions can be justified.

[SOURCE: JCGM 100:2008, 2.3.5] [3]

Note 3 to entry: For the purpose of this document, the expanded uncertainty is the combined standard uncertainty multiplied by a coverage factor k = 2 resulting in an interval with a level of confidence of 95 %.

3.14
fall time
difference between the response time (fall) and the lag time (fall)

3.15
independent measurement
individual measurement that is not influenced by a previous individual measurement by separating two individual measurements by at least four response times

Note 1 to entry: The largest value of response time (rise) and response time (fall) are intended.

3.16
individual measurement
measurement averaged over a time period equal to the response time of the analyser

Note 1 to entry: The largest value of response time (rise) and response time (fall) are intended.

Note 2 to entry: This definition differs from the meaning of the concept “individual measurement” in Directive 2008/50/EC [1].

3.17
influence quantity
quantity that is not the measurand but that affects the result of the measurement

[SOURCE: JCGM 100:2008, B.2.10] [3]

3.18
interferent
component of the air sample, excluding the measured constituent, that affects the output signal

3.19
lack of fit
maximum deviation from the linear regression line of the average of a series of measurement results at the same concentration

3.20
lag time
time interval from the moment at which a step change of sample concentration occurs at the inlet of the analyser to the moment at which the output reading reaches a level corresponding to a predefined change of the stable output reading

3.21
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: Council Directive 2008/50/EC] [1]

3.22
long-term drift
difference between zero or span readings over a determined period of time (e.g., period of unattended operation)

3.23
monitoring station
enclosure located in the field in which an analyser has been installed to monitor concentrations of one or more ambient air pollutants

3.24
parallel measurement
measurement from different analysers, sampling with the same sampling system, starting at the same time and ending at the same time

Note 1 to entry: sampling can be performed from one and the same sampling manifold or with identical individual sampling lines

3.25
performance characteristic
one of the parameters assigned to equipment in order to define its performance

3.26
performance criterion
limiting quantitative numerical value assigned to a performance characteristic, to which conformance is tested

3.27
period of unattended operation
time period over which the drift complies with the performance criterion for long-term drift

3.28
repeatability of results of measurement
closeness of the agreement between the results of successive individual measurements of nitrogen monoxide and nitrogen dioxide carried out under the same conditions of measurement

Note 1 to entry: These conditions include:

a) the same measurement procedure;

b) the same observer;

c) the same analyser, used under the same conditions;

d) at the same location;

e) repetition over a short period of time.

3.29
reproducibility under field conditions
closeness of the agreement between the results of simultaneous measurements with two analysers in ambient air carried out under the same conditions of measurement

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

a) the same measurement procedure;

b) two identical analysers, used under the same conditions;

c) at the same monitoring station;

d) the period of unattended operation.

3.30
residence time inside the analyser
time period for the sampled air to be transported from the inlet of the analyser to the reaction chamber for the NO-channel

3.31
residence time in the sampling system
time period for the sampled air to be transferred to the inlet of the analyser

3.32
response time
time interval from the instant at which a step change of sample concentration occurs at the inlet of the analyser to the instant at which the output reading reaches a level corresponding to a predefined change of the output reading

3.33
sampled air
part of ambient air that is transferred through the sampling inlet and sampling system for subsequent measurement

3.34
sample gas temperature
temperature of the sampled gas at the sample inlet

Note 1 to entry: The term "gas" can refer to a test gas used in type testing or to ambient air transferred to the analyser.

3.35
sampling system
the assembly of components needed to transfer ambient air to the analyser

3.36
short-term drift
difference between zero or span readings at the beginning and end of a 12 h period

3.37
standard uncertainty
uncertainty of the result of a measurement expressed as a standard deviation

[SOURCE: JCGM 100:2008, 2.3.1] [3]

3.38
surrounding temperature
temperature of the air directly surrounding the analyser

3.39
total residence time
sum of the residence time in the sampling system and the residence time inside the analyser

3.40
type testing
examination of two or more analysers of the same design which are submitted by a manufacturer to a competent body including the tests necessary for approval of the design (determination of fitness for purpose of a specific device model/of an unambiguous designated analyser)

Note 1 to entry: In EN 15267-1 and -2, type testing is referred to as performance testing.

3.41
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 100:2008, 2.2.3 [3]]

4 Abbreviated terms

AMS	automated measuring system (sometimes referred to as continuous automated measuring system (CAMS))
PFA	perfluoro-alkoxy
PTFE	Polytetrafluoroethylene