SLOVENSKI STANDARD
SIST EN 14790:2005

01-december-2005

Emisije nepremiļ nih virov - Doloļ evanje vodne pare v odvodnikih

Stationary source emissions - Determination of the water vapour in ducts

Emissionen aus stationären Quellen - Bestimmung von Wasserdampf in Leitungen

Emissions de sources fixes - Détermination de la vapeur d'eau dans les conduits

Ta slovenski standard je istoveten z: EN 14790:2005

ICS:

13.040.40 Emisije nepremiļ nih virov Stationary source emissions

SIST EN 14790:2005 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14790

November 2005

ICS 11.040.40

English Version

Stationary source emissions - Determination of the water vapour in ducts

Emissions de sources fixes - Détermination de la vapeur d'eau dans les conduits

Emissionen aus stationären Quellen - Bestimmung von Wasserdampf in Leitungen

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

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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.

CEN members are the national standards bodies of 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.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 14790:2005: E

Contents

Page

Foreword

This European Standard (EN 14790:2005) has been prepared by Technical Committee CEN/TC 264 "Air qualilty", 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of an identical text or by endorsement, at the latest by May 2006, and conflicting national standards shall be withdrawn at the latest by May 2006.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 condensation/adsorption technique, including the sampling system, to determine the water vapour concentration in the flue gases emitting to atmosphere from ducts and stacks.

This technique is usually used all over Europe for water vapour monitoring. However to be implemented as the Standard Reference Method (SRM), the user has to 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 ± 20 % of the measured value. This European Standard as the Standard Reference Method (SRM) is used for periodic monitoring and for calibration or control of Automatic Measuring Systems (AMS) permanently installed on a stack, for regulatory purposes or other purposes.

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.

The determination of water vapour is mainly necessary for:

— regulatory purposes, to express the concentration at standard conditions (on dry gas);

— adjust the flow rate for isokinetic sampling, when a dry gas flow rate metering device is used.

For both applications, the quantity to be measured is the amount of water present in the gas phase (vapour), which does not include water droplets.

This European Standard is applicable in the range from 4 % to 40 % relative humidity and for water vapour concentration from 29 g/m^3 to 250 g/m^3 as a wet gas, although for a given temperature the upper limit of the method is related to the maximum pressure of water in air or in the gas.

This European Standard 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 concentration range of 7 % to 26 % volume.

In this European Standard all the concentrations are expressed in normal conditions (273 K and 101,3 kPa).

NOTE For saturated conditions the condensation/adsorption method is not applicable. Some guidance is given in this European Standard to deal with flue gas when droplets are present.

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

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.

3.1
absorber
device in which water vapour is absorbed

3.2
detection limit (L_D)
concentration value of the measurand below which there is at least 95 % level of confidence that the measured value corresponds to a sample free of that measurand

3.3
dew point
temperature below which the condensation of water vapour begins at the given pressure condition of the flue gas

3.4
droplets
small liquid particles of condensed water vapour or water liquid in the flue gas (e.g. coming from a scrubber)

NOTE In adiabatic equilibrium conditions, droplets could arise only if a gas stream is saturated with water.

3.5
measurand
particular quantity subject to measurement

[VIM 2.6]

3.6
measuring series
several successive measurements carried out at the same sampling plane and with the same process operating conditions

[EN 13284-1]

3.7
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 sampling equipment, 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]

3.8
repeatability in the field
closeness of the agreement between the results of simultaneous measurements of the same measurand carried out with two equipments under the same conditions of measurement

NOTE 1 These conditions include:

- same measurement procedure;
- two equipments, 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 %.

3.9
reproducibility in the field
closeness of the agreement between the results of simultaneous measurements of the same measurand carried out with several equipments under the same conditions of measurement

NOTE 1 These conditions include:

- same measurement procedure;
- several equipments, the performances of which are fulfilling 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 %.

3.10
sampling location
specific area close to the sampling plane where the measurement devices are set up

3.11
sampling plane
plane normal to the centreline of the duct at the sampling position

[EN 13284-1]

3.12
sampling point
specific position on a sampling line at which a sample is extracted

[EN 13284-1]

3.13
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 (3.5) to be measured

3.14
uncertainty
parameter associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand

3.14.1
standard uncertainty u
uncertainty of the result of a measurement expressed as a standard deviation u

3.14.2
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 %.

3.14.3
combined uncertainty u_c
standard uncertainty uc attached to the measurement result calculated by combination of several standard uncertainties according to GUM

3.14.4
overall uncertainty U_c
expanded combined standard uncertainty attached to the measurement result calculated according to GUM

$U_c = k \times u_c$

3.15
uncertainty budget
calculation table combining all the sources of uncertainty according to ISO 14956 or ENV 13005 in order to calculate the overall uncertainty of the method at a specified value

3.16
vapour pressure
pressure of water in vapour form

4 Principle

4.1 General

This European Standard describes the Standard Reference Method (SRM) for determining water vapour content emitting to atmosphere from ducts and stacks. The specific components and the requirements for the measuring system are described. A number of performance characteristics, together with associated minimum performance criteria are specified for the measurement method (see Table 1 in 7.2). The overall uncertainty of the method shall meet the specifications given in this European Standard.

The method described hereafter is appropriate when the flue gas is free of droplets.

Within the scope of this European Standard, it is assumed that gas streams in stacks or ducts are more or less in adiabatic (thermodynamic) equilibrium. In those conditions, droplets can arise only if a gas stream is saturated with water. When no droplets are present in the gas stream, the gas stream is then assumed to be unsaturated with water. A gas sample is extracted at a constant rate from the stack. The water vapour of that sample is subsequently trapped by adsorption or by condensation plus adsorption; the mass of the vapour is then determined by weighing the mass gain of the trapping unit.

When droplets are present in the gas stream, the implementation of the method described in this European Standard leads to an overestimation of the water vapour content. If the measured value is equal to or higher than the expected value shown in the table in Annex A for saturated conditions at the temperature and pressure of the flue gas, that means that the presence of droplets can lead to biased results; such results shall be rejected.

In such cases, the evidence suggests that the gas stream is saturated with water vapour. Under these conditions, the method is abridged to a determination of the gas temperature. Then, the water vapour concentration is calculated from the theoretical mass of water vapour per unit of standard gas volume at liquid-gas equilibrium, given the actual temperature, pressure and composition of the gas stream.

4.2 Adsorption or condensation/adsorption method

A measured quantity of sampled gas is extracted from the gas stream through a trapping unit, which meets the specifications of efficiency (see 6.4.2). The mass gain of the trapping unit is measured and divided by the volume sampled in order to determine the mass concentration of water vapour.

4.3 Temperature method

This method applies when gases are water saturated.

A temperature probe is placed in the gas stream saturated with water vapour, until it reaches equilibrium. The amount of water vapour present in the gas is subsequently derived from the temperature, using a water liquid-gas equilibrium chart or table (see Annex A).

5 Apparatus

5.1 General

A known volume of flue gas is extracted representatively from a duct or chimney during a certain period of time at a controlled flow rate. A filter removes the dust in the sampled volume; thereafter the gas stream is passed through a trapping unit. It is important that all parts of the sampling equipment upstream of the trapping unit are heated and that the components shall not react with or absorb water vapour (e.g. stainless steel, borosilicate glass, quartz glass, PTFE or titanium are suitable materials).

An example of suitable sampling trains are shown in Annex B. The user can choose between a trapping unit made up with either:

— adsorption unit (Figure B.1); or

— condensation and an adsorption unit (Figure B.2).

The choice shall be made to fulfil the efficiency that is required in 6.4.2.

5.2 Sampling probe

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.

The procedure of clause 6.2.2 can 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 sampling probe shall be surrounded by a heating jacket capable of producing a controlled temperature of at least 120 °C and 20 °C higher than the (acid) dew point of gases and shall be protected and positioned using an outer tube.

NOTE 1 It is possible to perform the sampling of SO_2 and water vapour simultaneously with the same probe (without nozzle providing no droplets are present).

NOTE 2 It is possible to perform the sampling of HCl and water vapour simultaneously with the same probe (without nozzle providing no droplets are present).

5.3 Filter housing

The filter housing shall be made of materials inert to water vapour and shall have the possibility to be connected with the probe thereby avoiding leaks.

The filter housing may be located either:

— in the duct or chimney, mounted directly behind the entry nozzle (in-stack filtration); or

— outside the duct or chimney, mounted directly behind the suction tube (out-stack filtration).

The filter holder shall be connected to the probe without any cold path between the two.

NOTE In special cases where the sample gas temperature is > 200 °C, the heating jacket around the sampling probe, filter holder and connector fine may be omitted. However the temperature in the sampled gas just after the filter housing should not fall below the acid dew point temperature.

5.4 Particle filter

Particle filters and filter housings of different designs may be used, but the residence time of the sample gas should be minimised.

5.5 Trapping unit

The trapping unit shall be made up with:

— adsorption unit; or

— condensation and an adsorption unit.

a) When using the adsorption unit alone, it shall consist of at least one cartridge, impinger or absorber, filled with a suitable drying agent, for example: coloured silica gel.

b) Condensation and adsorption unit shall consist of two stages:

   1) the first one shall be a condensation stage with an optional cooling system;

   2) the second one shall be an adsorption stage as described in a).

The temperature at the outlet of the condensation unit shall be as low as possible.

The efficiency of the sampling system shall be checked according to the procedure described in 6.4.2.

NOTE The trapping efficiency can be increased by increasing the residence time of sampled gases in the trapping unit and/or by improving the efficiency of the cooling system. The sampled volume should be sufficient to reach an appropriate accuracy of the measurement (see clause 5.8 and 7).

Condensation of water shall be avoided in all parts of the sampling system that are not weighed.

5.6 Cooling System (optional)

Any kind of cooling system may be used to condense water vapour in the sampled flue gas (e.g. crushed ice or cryogenic system).

5.7 Sampling pump

A leak-free pump capable of drawing sample gas at a set flow-rate is required.

NOTE 1 A rotameter (optional) could make easier the adjustment of the nominal sampling flow-rate.

NOTE 2 A small surge tank may be used between the pump and rotameter to eliminate the pulsation effect of the diaphragm pump on the rotameter.

NOTE 3 A regulating valve (optional) would also be useful for adjusting the sample gas flow-rate.

5.8 Gas volume meter

Two variants of gas volume meter may be used:

— dry-gas volume meter; or

— wet-gas volume meter.

a) Gas volume meter (wet or dry) shall have a relative uncertainty not exceeding ± 2,0 % of the measured volume (actual conditions).