



SLOVENSKI STANDARD

SIST EN 13284-1:2002

01-maj-2002

Emisije nepremičnih virov - Določevanje nizkih masnih koncentracij prahu - 1. del: Ročna gravimetrijska metoda

Stationary source emissions - Determination of low range mass concentration of dust -
Part 1: Manual gravimetric method

Emissionen aus stationären Quellen - Ermittlung der Staubmassenkonzentration bei
geringen Staubkonzentrationen - Teil 1: Manuelles gravimetrisches Verfahren

Emissions de sources fixes - Détermination de la faible concentration en masse de
poussieres - Partie 1: Méthode gravimétrique manuelle

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EUROPEAN STANDARD
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EN 13284-1

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Stationary source emissions - Determination of low range mass concentration of dust - Part 1: Manual gravimetric method

Emissions de sources fixes - Détermination de la faible concentration en masse de poussières - Partie 1: Méthode gravimétrique manuelle

Emissionen aus stationären Quellen - Ermittlung der Staubmassenkonzentration bei geringen Staubkonzentrationen - Teil 1: Manuelles gravimetrisches Verfahren

This European Standard was approved by CEN on 11 October 2001.

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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 Management Centre has the same status as the official versions.

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

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EN 13284-1:2001 (E)**Foreword**

This European Standard 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of an identical text or by endorsement, at the latest by May 2002, and conflicting national standards shall be withdrawn at the latest by May 2002.

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 EU Directive(s).

This European Standard consists of two parts:

- EN 13284-1, *Stationary source emissions – Determination of low range mass concentration of dust – Part 1: Manual gravimetric method*
- EN 13284-2, *Stationary source emissions – Determination of low range mass concentration of dust – Part 2: Automated measuring systems*

The annexes A, B, C, E and F are normative. The annexes D, G and H are informative.

This standard contains a Bibliography.

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

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1 Scope

This European Standard specifies a reference method for the measurement of low dust concentration in ducted gaseous streams in the concentrations below 50 mg/m^3 standard conditions. This method has been validated with special emphasis around 5 mg/m^3 on an average half hour sampling time.

This European Standard is primarily developed and validated for gaseous streams emitted by waste incinerators. More generally, it may be applied to gases emitted from stationary sources, and to higher concentrations.

If the gases contain unstable, reactive or semi-volatile substances, the measurement depend on the sampling and filter treatment conditions.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

ISO 3966:1977, *Measurement of fluid flow in closed conducts – Velocity area method using Pitot static tubes.*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and result – Part 2: Basis method for the determination of repeatability and reproducibility of a standard measurement method.*

3 Terms and definitions

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

3.1

dust

particles, of any shape, structure or density, dispersed in the gas phase at the sampling point conditions which may be collected by filtration under specified conditions after representative sampling of the gas to be analysed, and which remain upstream of the filter and on the filter after drying under specified conditions

3.2

filtration temperature

temperature of the sampled gas immediately downstream of the filter

3.3

"in-stack" filtration

filtration in the duct with the filter in its filter holder placed immediately downstream of the sampling nozzle

3.4

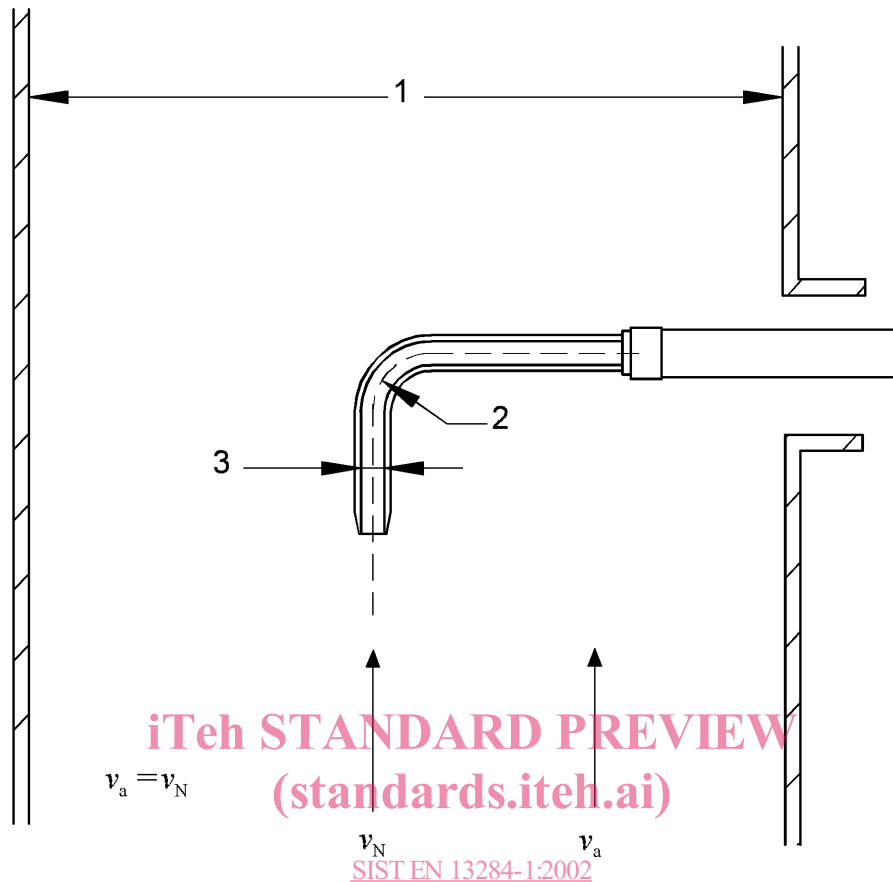
"out-stack" filtration

filtration outside of the duct with the filter in its heated filter holder placed downstream of the sampling nozzle and the suction tube (sampling probe)

3.5

isokinetic sampling

sampling at a flow rate such that the velocity v_N and direction of the gas entering the sampling nozzle are the same as the velocity v_a and direction of the gas in the duct at the sampling point (see Figure 1)



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Key

- 1 Duct
- 2 Internal diameter i
- 3 Radius of the bend (minimum $1,5 i$)

Figure 1 — Isokinetic sampling

3.6
isokinetic rate

velocity ratio v_N / v_a expressed in percentage as a characteristics of the deviation from isokinetic sampling (see 3.5)

3.7
hydraulic diameter

characteristic dimension of a duct cross-section defined by:

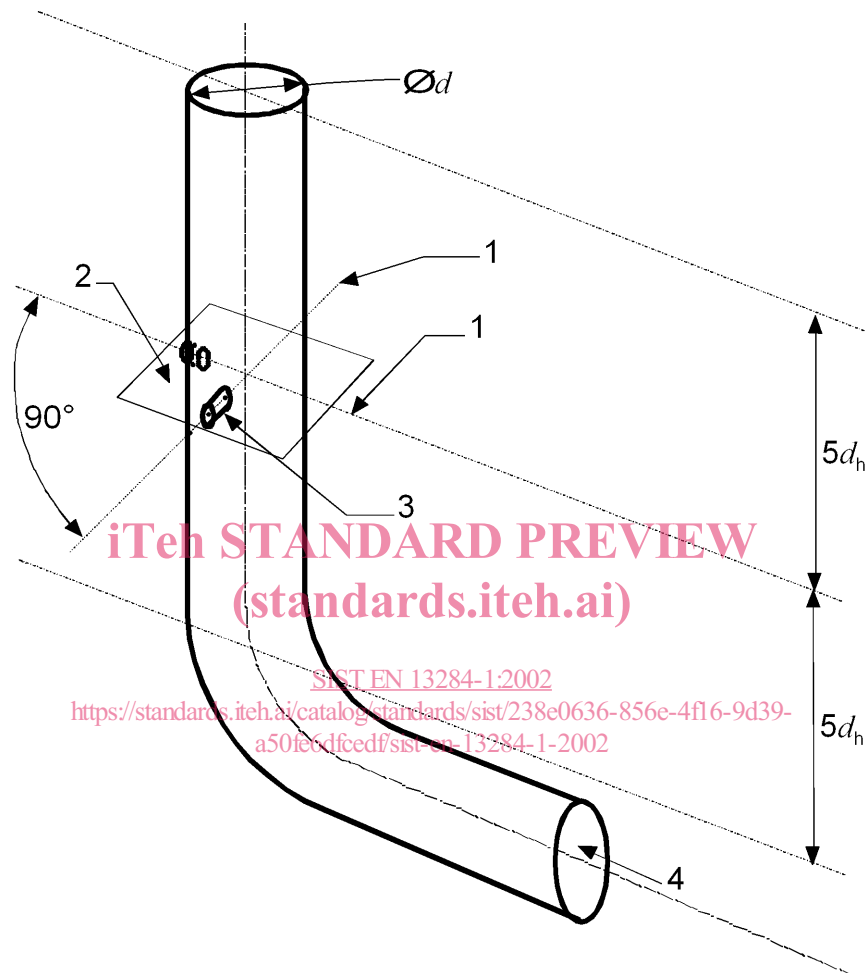
$$d_h = \frac{4 \times \text{area of sampling plane}}{\text{perimeter of sampling plane}} \quad (1)$$

3.8
sampling plane (or sampling section)

plane normal to the centreline of the duct at the sampling position (see Figure 2)

3.9**sampling lines**

lines in the sampling plane along which the sampling points are located (see Figure 2), bounded by the inner duct wall

**Key**

- 1 Sampling line
- 2 Sampling plane
- 3 Access port
- 4 Flow rate

Figure 2 — Illustration of definitions in relation to a circular duct

3.10**sampling point**

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

EN 13284-1:2001 (E)**3.11****standard conditions**

reference values for a dry gas at a pressure of 101,325 kPa rounded to 101,3 kPa and a temperature of 273,15 K rounded to 273 K

3.12**overall blank**

test sample taken at the plant site in an identical manner to the normal samples in the series, except that no gas is sampled during test duration

Note The measured mass variation provides an estimation of the uncertainties. The overall blank value, divided by the average sampling volume of the measurement series, provides an estimation of the detection limit (in milligrams per cubic metre) of the whole measurement process, as carried out by the operators. The overall blank includes possible deposits on the filter and on all parts upstream.

3.13**weighing control**

procedure for the detection/correction of apparent weight variations due to possible changes between pre and post sampling weighing conditions

3.14**measurement series**

successive measurements carried out at the same sampling plane, and at the same process conditions

3.15**limit value**

dust concentration which is permitted by authorities for the plant process (i.e. average limit value)

Note For purposes other than regulatory uses the measurement value should be compared to a stated reference value.

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4 Principle

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A sample stream of the gas is extracted from the main gas stream at representative sampling points for a measured period of time, with an isokinetically controlled flow rate and a measured volume. The dust entrained in the gas sample is separated by a pre-weighed plane filter, which is then dried and re-weighed. Deposits upstream of the filter in the sampling equipment are also recovered and weighed. The increase of mass of the filter and the deposited mass upstream the filter are attributed to dust collected from the sampled gas, which allows the dust concentration to be calculated.

Two different configurations of the sampling equipment may be used depending on the characteristics of gases to be sampled (see 6.2.2).

Valid measurements can be achieved only when:

- a) the gas stream in the duct at the sampling location has a sufficiently homogeneous and steady velocity profile (see 5.2);
- b) sampling is carried out without disturbance of the gas stream with a sharp edged nozzle facing into the stream under isokinetic conditions;
- c) samples are taken at a pre-selected number of stated positions in the sampling plane, to allow for a non uniform distribution of dust in the duct;
- d) the sampling train is designed and operated to avoid condensation, chemical reactions and to minimise dust deposits upstream of the filter and to be leak free;
- e) dust deposits upstream of the filter are taken into account;
- f) the overall blank value does not exceed 10 % of the daily limit value set for the process;

g) the sampling and weighing procedures are adapted to the expected dust quantities.

5 Sampling plane and sampling points

5.1 General

Sampling is only possible when a suitable location is available, with sufficiently high and homogeneous gas velocity at the sampling plane.

The sampling plane shall be easily reached from convenient access ports and a safe working platform (see annex A).

Sampling shall be carried out at a sufficient number of sampling points located on the sampling plane.

5.2 Sampling plane

The sampling plane shall be situated in a length of straight duct, (preferably vertical) and with constant shape and cross-sectional area. Where possible, the sampling plane shall be as far downstream and upstream from any disturbance, which could produce a change in direction of flow (e.g. disturbances can be caused by bends, fans or partially closed dampers).

Measurements at all the sampling points defined in 5.3 and annex C shall prove that the gas stream at the sampling plane meets the following requirements:

- a) angle of gas flow less than 15° with regard to duct axis (method for determination is indicated in annex B);
- b) no local negative flow;
- c) minimum velocity depending on the flow rate measuring method used (for Pitot tubes a differential pressure larger than 5 Pa);
- d) ratio of the highest to lowest local gas velocities less than 3:1.

If the above requirements cannot be met, the sampling location is not in compliance with this European Standard (see 10.2).

NOTE The above requirements are generally fulfilled in sections of duct with at least five hydraulic diameters of straight duct upstream of the sampling plane and two hydraulic diameters downstream (five hydraulic diameters form the top of a stack). Therefore, it is strongly recommended to design sampling locations accordingly.

5.3 Minimum number and location of sampling points

The dimensions of the sampling plane dictate the minimum number of sampling points. This number increases as the duct dimensions increase.

Tables 1 and 2 give the minimum number of sampling points to be used for circular and rectangular ducts respectively. The sampling points to be used shall be located at the centre of equal areas in the sampling plane (see Annex C).

Sampling points shall be located either more than 3 % of the sampling line length or more than 5 cm whichever is the greater value from the inner duct wall. This may arise when selecting more than the minimum numbers of sampling points presented in Tables 1 and 2, for example in cases of unusual duct shape.

NOTE When the requirements for the sampling plane (see 5.2) cannot be met it may be possible to improve representative sampling by increasing the number of sampling points above those specified in Tables 1 and 2.

Table 1 — Minimum number of sampling points for circular ducts

Range of sampling plane areas m ²	Range of ducts diameters m	Minimum number of sampling lines (diameters)	Minimum number of sampling points per plane
< 0,1	< 0,35	—	1 ^a
0,1 to 1,0	0,35 to 1,1	2	4
1,1 to 2,0	1,1 to 1,6	2	8
> 2,0	> 1,6	2	at least 12 and 4 per m ² ^b

^a Using only one sampling point may give rise to errors greater than those specified in this standard.

^b For large ducts, a number of 20 sampling points is generally sufficient.

Table 2 — Minimum number of sampling points for rectangular ducts

Range of sampling plane areas m ²	Minimum number of side divisions ^a	Minimum number of sampling points
< 0,1	1	1 ^b
0,1 to 1,0	2	4
1,1 to 2,0	3	9
> 2,0	≥3	at least 12 and 4 per m ² ^c

^a Other side divisions may be necessary, for example if the longest duct side length is more than twice the length of the shortest side (see C.3).

^b Using only one sampling point may give rise to errors greater than those specified in this standard.

^c For large ducts, a number of 20 sampling points is generally sufficient.

5.4 Access ports and working platform

Ports shall be provided for access to the sampling points selected in accordance with 5.3 and annex C.

The port dimensions shall allow sufficient space for insertion and withdrawal of the sampling equipment. A minimum diameter of 125 mm or a surface area of 100 mm x 250 mm are recommended, except for small ducts (less than 0,7 m diameter) for which the port size needs to be smaller.

Two examples of suitable access ports are given in annex D.

For safety and practical reasons, the working platform shall comply with the requirements of annex A.

6 Equipment and materials

6.1 Gas velocity, temperature, pressure and composition measurement devices

Velocity measurements shall be carried out using standardised type L Pitot tubes, as described in ISO 3966:1977, annex A. Alternatively, other measurement devices (e.g. type S Pitot tube) may also be used, provided that they are calibrated against standardised Pitot tubes (see [5]).

The temperature and the pressure in the duct shall be measured in order to calculate the actual density of the gas within $\pm 0,05 \text{ kg/m}^3$, also taking the gas composition into account.

When expressing dust concentrations on a dry basis, and/or where the concentrations shall be expressed in relation to a reference oxygen concentration, humidity (moisture) and/or oxygen measurements shall be carried out in the vicinity of the sampling plane.

6.2 Sampling equipment

6.2.1 The sampling train principally consists of:

- a) entry nozzle;
- b) filtration device;
- c) suction tube;
- d) gas pump;
- e) system for measurement of sampled gas volume at identified temperature and pressure;
- f) system for controlling isokinetic sampling conditions.

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6.2.2 The filtration device is either located in the duct ("in-stack filtration") or placed outside the duct ("out-stack filtration"):

- a) "in-stack" filtration devices (see Figure 3): the part of the tubing between nozzle and filter – should be very short, thereby minimising dust deposits upstream of the filter. Due to available access port dimensions on ducts, the filter diameter is then typically limited to 50 mm, with a sample flow rate of approximately $1 \text{ m}^3/\text{h}$ to $3 \text{ m}^3/\text{h}$. Since the filtration temperature is generally identical to that of the gas in the duct, filter clogging may occur if the stack gas contains water droplets.

To allow access to all sampling points in the duct, a leak free rigid tube of sufficient length (support tube) is used downstream of the filter housing for mechanical support of the nozzle and filter housing.

- b) "out-stack" filtration devices (see Figure 4): the part of tubing between the nozzle and the filter (suction tube) shall be of sufficient length to allow access to all sampling points in the duct. The suction tube and the filter holder shall be temperature controlled, which provides evaporation of possible water droplets or avoids filtration difficulties related to high acid dew point gases. Filter diameters between 50 mm and 150 mm are generally used, with associate flow rate of $1 \text{ m}^3/\text{h}$ to $10 \text{ m}^3/\text{h}$.