

Stationary source emissions — Determination of mass concentration of sulphur dioxide — Reference method

The European Standard EN 14791:2005 has the status of a
British Standard

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National foreword

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Emissions de sources fixes - Détermination de la concentration massique du dioxyde de soufre - Méthode de référence

Emissionen aus stationären Quellen - Bestimmung der Massenkonzentration von Schwefeldioxid - Referenzverfahren

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Contents

Page

Foreword	5
1 Scope	6
2 Normative references	6
3 Terms, definitions, symbols and abbreviations	6
3.1 Terms and definitions	6
3.2 Symbols	11
3.3 Abbreviations	12
4 Principle	13
4.1 General	13
4.2 Measuring principle	13
5 Reagents	13
5.1 General	13
5.2 Hydrogen peroxide	13
5.3 Water	13
5.4 Absorption solution, H_2O_2	13
5.5 Reagents for chromatographic analysis	14
5.5.1 Eluent solution	14
5.5.2 Standard sulphate stock solution, $10,4 \times 10^{-3} \text{ mol/l SO}_4^{2-}$	14
5.5.3 Regeneration solution for suppressor	14
5.6 Reagent for Thorin analysis	14
5.6.1 2-propanol [$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$]	14
5.6.2 Barium perchlorate, standard volumetric solution, $[\text{Ba}(\text{ClO}_4)_2] = 0,005 \text{ mol/l}$	14
5.6.3 Potassium hydroxide, standard volumetric solution, $[\text{KOH}] = 0,1 \text{ mol/l}$	15
5.6.4 Perchloric acid, standard volumetric solution, $[\text{HClO}_4] = 0,1 \text{ mol/l}$	15
5.6.5 Thorin, {4-[2-arsonophenyl)-azo]-3-hydroxy-2,7 naphthalene-disulfonic acid disodium salt} 2 g/l solution	15
6 Sampling equipment	15
6.1 General	15
6.2 Sampling probe	15
6.3 Filter housing	16
6.4 Particle filter	16
6.5 Temperature controller	16
6.6 Absorbers	16
6.6.1 General	16

6.6.2	Test of absorption efficiency	17
6.7	Sampling pump	17
6.8	Gas volume meter	17
7	Sampling procedure	18
7.1	General requirements	18
7.2	Preparation and installation of equipment.....	18
7.2.1	Sampling location	18
7.2.2	Sampling point(s).....	18
7.2.3	Assembling the equipment	19
7.2.4	Heating of the sampling line	19
7.2.5	Leak test	19
7.3	Performing sampling	19
7.3.1	Introduction of the probe in the duct.....	19
7.3.2	Sampling.....	19
7.3.3	Rinsing of the sampling system and preparation of the samples.....	20
7.4	Measuring series.....	20
7.5	Field blank	20
7.6	Absorption efficiency	21
8	Analysis equipment	21
8.1	Ion chromatograph	21
8.2	Thorin method	22
8.2.1	General	22
8.2.2	Spectrophotometer (optional).....	22
8.2.3	Glass optical cuvette	22
9	Analytical procedure.....	22
9.1	General	22
9.2	Ion Chromatography method	22
9.2.1	General procedure	22
9.2.2	Interferences	23
9.2.3	Calibration	23
9.3	Thorin Method	24
9.3.1	Pre-treatment of sample solution before analysis for Thorin method	24
9.3.2	General procedure	24
9.3.3	Preparation of a chemical blank solution	25
9.3.4	Interferents	25
10	Determination of the characteristics of the method: sampling and analyse.....	26
10.1	General	26
10.2	Relevant performance characteristics of the method and performance criteria	26
10.2.1	General	26

10.2.2	Sampling procedure	26
10.2.3	Analyse procedure.....	27
10.3	Establishment of the uncertainty budget.....	28
11	Expression of results.....	29
12	Evaluation of the method in the field.....	31
13	Equivalence of Thorin and ion chromatography methods	31
13.1	General	31
13.2	Range.....	31
13.3	Matrix effect.....	31
13.4	Comparison of repeatability and trueness.....	31
14	Equivalence with an alternative method	31
15	Test report	32
Annex A (informative)	Type of sampling equipment.....	33
Annex B (informative)	Examples of absorbers.....	34
Annex C (informative)	Example of assessment of compliance or reference method for SO ₂ with requirements on emission measurements.....	35
Annex D (informative)	Evaluation of the method	43
Annex E (informative)	Test of equivalency of Thorin method and ion chromatography	50
Annex ZA (informative)	Relationship with EU Directives	60
Bibliography		61

Foreword

This European Standard (EN 14791:2005) 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 a manual method for sampling and determining SO₂ content in ducts and stacks emitting to the atmosphere by two analytical methods: Ion chromatography and Thorin method.

This European Standard is the Standard Reference Method (SRM) for periodic monitoring and for 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 $\pm 20,0$ % relative at the daily Emission Limit Value (ELV).

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 of (0,5 to 2 000) mg/m³ SO₂ for Ion Chromatography variant and 5 mg/m³ to 2 000 mg/m³ SO₂ for Thorin method according to emission limit values laid down in 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.

The limit values of EU Directives are expressed in mg SO₂/m³, on dry basis and at the reference conditions of 273 K and 101,3 kPa.

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 uncertainty in measurement*.

EN 13284-1, *Stationary source emissions — Determination of low range mass concentration of dust — Part 1: Manual gravimetric method*.

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

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

3.1.1

absorber

device in which sulphur oxide is absorbed into an absorption liquid

3.1.2**absorption efficiency (ε)**

ratio ε of quantity of the analyte q_1 collected in the first absorber divided by the quantity of the analyte collected in the first and the second absorber ($q_1 + q_2$)

$$\varepsilon = q_1 / (q_1 + q_2)$$

3.1.3**analytical 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

3.1.4**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.

3.1.5**calibration of an AMS**

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).

3.1.6**calibration of the SRM**

set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, and the corresponding values realized by standard reference methods implemented in the state of the art in order to provide representative results

[VIM]

3.1.7**chemical blank value**

sulphate ion content of an unexposed sample of the absorption solution, plus reagents that are added to the solution before analysis if necessary

3.1.8**emission limit value (ELV)**

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

3.1.9**field blank**

value determined by a specific procedure used to ensure that no significant contamination has occurred during all steps of the measurement and to check that the operator can achieve a quantification level adapted to the task

3.1.10

influence quantity

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

[adapted VIM 2.7]

Examples

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

3.1.11

measurand

particular quantity subject to measurement

[VIM 2.6]

3.1.12

measurement series

several successive measurements carried out on the same sampling plane and at the same process operating conditions

[EN 13284-1]

3.1.13

measuring system

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

[VIM 4.5]

3.1.14

performance characteristic

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

3.1.15**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]

3.1.16**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 %.

3.1.17

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 performance of which fulfils 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 %.

3.1.18

sampling location

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

3.1.19

sampling plane

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

[EN 13284-1]

3.1.20

sampling point

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

[EN 13284-1]

3.1.21

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 (3.1.11) to be measured

3.1.22

uncertainty

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

3.1.22.1

standard uncertainty u

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

3.1.22.2

combined uncertainty u_c

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

3.1.22.3**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 %.

3.1.22.4**overall uncertainty U_c**

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

$$U_c = k \times u_c$$

3.1.23**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

3.2 Symbols

C_m	mass concentration of sulphur dioxide in the sample gas, in milligrams per cubic metre (of gas)
Cl_r	repeatability confidence interval, in milligrams per cubic metre
Cl_R	reproducibility confidence interval, in milligrams per cubic metre
f_a	equivalent mass of sulphur dioxide of 1 mm of titration solution (barium perchlorate standard volumetric solution) used for titration in Thorin method, in milligrams per millilitre
f_v	ratio of the volume of the pre-treated sample solution (sample absorption solution pre-treated before analyse) to the volume of the aliquot taken for the titration in Thorin method
L_D	limit of detection, in milligrams per litre of SO_4^{2-}
L_Q	limit of quantification, in milligrams per litre of SO_4^{2-}
m_s	weight of the sample solution (absorption solution used for sampling + rinsing solution), in grams
P_m	absolute pressure at the gas volume meter, in kilopascals
P_{std}	standard pressure: 101,3 kPa
$P_{sat}(T_m)$	saturation vapour pressure of water at volume gas meter temperature, in kilopascals
q_s	mass concentration of sulphate in sample absorption solution, in milligrams per litre (of solution)
q_{cb}	mass concentration of sulphate in chemical blank solution, in milligrams per litre (of solution)
r	repeatability, in milligrams per cubic metre or percentage
R	reproducibility, in milligrams per cubic metre or percentage

R_s	peak resolution S_s : volume of titration solution used for titration of sample absorption solution, in millilitre
S_{cb}	volume of titration solution used for titration of chemical blank solution, in millilitre
S_r	repeatability standard deviation, in milligrams per cubic metre or percentage
S_R	reproducibility standard deviation, in milligrams per cubic metre or percentage
$S_{r\ limit}$	maximum allowable repeatability standard deviation, in milligrams per cubic metre
S_s	volume of titration solution used for the titration of the aliquot of the pre-treated sample solution, in millilitres
t_1	retention time of the first peak, in seconds
t_2	retention time of the second peak, in seconds
T_j	temperature at the gas meter, in Kelvin
T_m	mean temperature at the gas volume meter in Kelvin
T_{std}	standard temperature, 273 K
V_1	reading at the gas volume meter at the beginning of the sampling period in cubic metres
V_2	reading at the gas volume meter at the end of the sampling period in cubic metres
$V_{m\ (std)}$	dry gas volume measured, corrected to standard conditions, in cubic metres
V_s	volume of the sample solution (absorption solution used for sampling + rinsing solution), in litres
w_1	peak width, on the time axis, of the first peak, in seconds
w_2	peak width on the time axis, of the second peak, in seconds
ε	absorption efficiency in percentage
σ	conductivity in micro-siemens per metre
ρ_{20}^4	density of a liquid at 20 °C compared to water's at 4 °C in kilogrammes per litre
χ	volume content in percentage

3.3 Abbreviations

PE	Polyethylene
PTFE	Polytetrafluoroethene

4 Principle

4.1 General

This European Standard describes the Standard Reference Method (SRM) with two alternative analytical techniques for determining sulphur dioxide (SO_2) 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 with associated minimum performance criteria are specified for the measuring system (see Tables 2 and 3 in 10.2). These performance characteristics and the overall uncertainty of the method shall meet the specifications given in this European Standard.

4.2 Measuring principle

A representative sample of gas is extracted via a heated temperature-controlled probe. The sample is filtered and drawn through hydrogen peroxide absorber solutions for a specified time and at a controlled flow rate. The sulphur dioxide in the sampled gas is absorbed and oxidised to sulphate ion. The mass concentration of sulphate in the absorption solutions is subsequently determined using ion chromatography or by titration with a barium perchlorate solution using Thorin as indicator. SO_3 is also absorbed and transformed in sulphate ion and is therefore an interferent.

This European Standard has been validated with a 0,3 % H_2O_2 absorption solution up to 1 000 mg/m^3 and with a 3,0 % H_2O_2 absorption solution up to 2 000 mg/m^3 . Typical concentration of the absorption solution is 0,3 % H_2O_2 . However, for concentrations higher than 1 000 mg/m^3 it is recommended, in case of a bad efficiency either to decrease the flow or to increase the concentration.

5 Reagents

5.1 General

During the analysis, use only reagents of recognised analytical grade.

Normal, accepted laboratory safety practices and cleaning procedures for glassware should be followed during reagent preparation.

WARNING — Use the reagents in accordance with the appropriate health and safety regulations.

5.2 Hydrogen peroxide

Commercially available solution of H_2O_2 ; mass content 30 %, $\rho_{20}^4 = 1,11 \text{ kg/l}$.

5.3 Water

H_2O ; ultra pure water with conductivity $\sigma < 10 \mu\text{S m}^{-1}$.

5.4 Absorption solution, H_2O_2

The absorption solution is a hydrogen peroxide solution (5.2) diluted to a mass concentration of 0,3 % H_2O_2 in water (5.3). For concentrations higher than 1 000 mg/m^3 it is suggested in case of a bad efficiency, either to decrease the flow, or increase the concentration of the absorption solution.

For the preparation of the mass concentration of 0,3 % H_2O_2 in water, thoroughly mix about 10 ml of 30 % of H_2O_2 (5.2) with 500 ml of water (5.3) and make up to 1 000 ml with water (5.3). Store the solution in a glass or PE bottle in a dark place and for no longer than one week.

WARNING — Decomposition of the solution may occur and may lead to the explosion of the storage bottle. It is recommended that the lid of this bottle is not closed too tightly or to use a security cap.

NOTE Cleanliness of the glassware is important to avoid a possible decomposition of hydrogen peroxide.

5.5 Reagents for chromatographic analysis

5.5.1 Eluent solution

The choice of eluent depends on the manufacturer's separator column and detector. For the exact composition of the eluent, use a validated solvent for the method and/or refer to the instructions given by the manufacturer.

NOTE For an ion chromatograph using the suppressor technique, a typical eluent is a solution of $1,7 \times 10^{-3}$ mol/l NaHCO_3 and $1,8 \times 10^{-3}$ mol/l Na_2CO_3 .

5.5.2 Standard sulphate stock solution, $10,4 \times 10^{-3}$ mol/l SO_4^{2-}

Use a commercially available sulphate stock solution of 1 000 mg/l sulphate ($10,4 \times 10^{-3}$ mol/l) with a minimum content of 99,0 %. As an alternative prepare the standard solution as follows:

Dissolve 1,814 g of analytical grade potassium sulphate (K_2SO_4) in water (5.3) and dilute to a 1 000 ml volumetric flask. 1 ml of stock solution corresponds to 1 mg of SO_4^{2-} .

NOTE Calibration standards are prepared by diluting the standard stock solution with the absorption solution as specified in 9.2.3.2.

5.5.3 Regeneration solution for suppressor

For the exact composition of the suppressor regeneration solution, refer to the instructions given by the manufacturer of the suppressor.

NOTE An example is a solution of $12,5 \times 10^{-3}$ mol/l H_2SO_4 .

5.6 Reagent for Thorin analysis

5.6.1 2-propanol [$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$]

Use commercially available 2-propanol [$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$] in analytical grade (minimum content 99,8 %).

5.6.2 Barium perchlorate, standard volumetric solution, $[\text{Ba}(\text{ClO}_4)_2] = 0,005$ mol/l

Use a commercially available barium perchlorate solution (80 % 2-propanol/20 % water) with concentration of 0,005 mol/l $\text{Ba}(\text{ClO}_4)_2$, or prepare the standard solution as follows:

Dissolve 1,7 g of anhydrous barium perchlorate [$\text{Ba}(\text{ClO}_4)_2$] in about 200 ml of water in a 1 000 ml one-mark volumetric flask. Make up to the mark with 2-propanol (5.6.1) and mix well.

Titrate the solution accurately against a 0,005 mol/l standard volumetric sulphuric acid solution.

1 ml of exactly 0,005 mol/l barium perchlorate solution is equivalent to a mass of sulphur dioxide of 0,320 mg; ($f_a = 0,320 \text{ mg/ml}$).

5.6.3 Potassium hydroxide, standard volumetric solution, $[\text{KOH}] = 0,1 \text{ mol/l}$

Use a commercially available solution of 0,1 mol/l KOH in water.

NOTE This reagent is only necessary if the sampling gas contains high concentration of acid components (e.g. $\text{SO}_2 > 100 \text{ mg/m}^3$ or $\text{HCl} > 200 \text{ mg/m}^3$ or $\text{NO}_2 > 400 \text{ mg/m}^3$).

5.6.4 Perchloric acid, standard volumetric solution, $[\text{HClO}_4] = 0,1 \text{ mol/l}$

Prepare an approximate 1 % solution of perchloric acid by mixing 16 ml of a commercially available solution of 60 % perchloric acid in water (5.3) and make up to 1 000 ml with water. Store this solution in a glass or PE bottle.

NOTE This reagent is only necessary if the sampling gas contains high concentrations of alkali components (e.g. $\text{NH}_3 > 50 \text{ mg/m}^3$).

5.6.5 Thorin, {4-[2-arsonophenyl]-azo]-3-hydroxy-2,7 naphthalene-disulfonic acid disodium salt} 2 g/l solution

Thorin is also known as Thoron or Thoronol, the sodium salt of 4-(2-arsonophenyl)-azo]-3-hydroxy-2,7 -naphthalene -disulfonic acid.

Dissolve 0,2 g of Thorin in water (5.3) in a 100 ml one-mark volumetric flask. Make up to the mark with water and mix well.

Store this solution in a bottle made of glass or polyethylene.

6 Sampling equipment

6.1 General

A known volume of flue gas is extracted representatively from a duct or a 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 series of absorbers containing an absorption solution.

All parts of the sampling equipment upstream of the first absorber shall not react with or adsorb SO_2 (i.e. borosilicate glass, quartz glass, PTFE or titanium are suitable materials).

If an unheated gas connector line is used between the heated filter and the first absorber, it shall be thoroughly rinsed with fresh absorption solution after sampling and the rinsing solutions shall be combined with the sample.

An example of a suitable sampling train is shown in Figure A.1 in Annex A.

6.2 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, but the residence time of the sample gas in the probe shall be minimised.

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 procedure described in 7.2.2 shall be used when the operator suspects that the flue gas is inhomogeneous.

When droplets are present in the flue gases, they may contain SO₂ dissolved in it. In that case, the probe is equipped with a nozzle and an isokinetic sampling shall be performed according to EN 13284-1.

NOTE 1 It is possible to perform the sampling of SO₂ and HCl simultaneously with the same probe without nozzle providing no droplets are present.

NOTE 2 SO₂ and H₂O can be measured simultaneously by using the same probe without nozzle and the same side stream absorbers, providing no droplets are present in the flue gases.

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

6.3 Filter housing

The filter housing may be located either:

- directly in front of the probe behind the entry nozzle (in-stack filtration); or
- directly behind the probe (out-stack filtration).

If condensation is liable to occur in the sampling probe or in the filter housing, then a heated out-stack filter housing shall be used. For out-stack filtration, the filter housing shall be heated at a controlled temperature of at least 120 °C or 20 °C higher than the (acid) dew point of gases. It shall be connected to the probe without any cold path between the two.

Filter housings of different designs may be used, but the residence time of the sample gas shall be minimised.

NOTE 1 The filter housing shall have the possibility to be jointed with the probe thereby avoiding leaks.

NOTE 2 A stop valve after the filter housing can be useful to prevent back flush of absorption solution into the probe or into the filter when sampling in flue gases under unfavourable conditions (e.g. high depression in the duct).

NOTE 3 In special cases where the sample gas temperature is > 200 °C, the heating jacket around the sampling probe, filter housing and connector line may be switched off. However the temperature in the sampled gas just after the filter housing, should not fall below 20 °C above the (acid) dew point temperature.

6.4 Particle filter

The filter shall have an efficiency better than 99,5 % on a test aerosol with a mean particle diameter of 0,3 µm, at the maximum flow rate anticipated, (or 99,9 % on a test aerosol of 0,6 µm mean diameter).

Glass filters cannot be used because glass reacts with SO₃, but ceramic, quartz or PTFE are suitable materials.

6.5 Temperature controller

A temperature controller is required for the filter housing. It shall be capable of controlling temperature with an uncertainty of ± 2,5 K or better.

6.6 Absorbers

6.6.1 General

For efficient absorption two absorbers shall be placed in series.

NOTE Downstream of these absorbers, an extra empty absorber may be used as a liquid trap and as a protection for the downstream equipment.

Some examples of absorbers are given in Annex B.

The absorption efficiency of the first absorber shall be better than 95 % or the concentration of sulphate ion in the second absorber shall be less than the detection limit. This efficiency shall be checked periodically at the normal flow rate according to the procedure described in 6.6.2. Except when the absorption efficiency shall be checked, the solutions from the two absorbers can be combined and analysed together.

NOTE Cooling of the absorbers may be useful to avoid excessive evaporation from the first absorption bottle.

6.6.2 Test of absorption efficiency

Place a suitable volume of absorption solution into each of the two absorbers, where the first absorber is denoted 1 and the second absorber 2. Assemble the apparatus to obtain a sampling train as illustrated in Figure A.1.

Carry out sampling in normal conditions. At the end of the sampling period, switch off the sampling pump, record the time and volume on the gas meter.

Remove the absorber from the sampling train and transfer the sample solutions from absorber 1 and 2 into two separate sample bottles. If a trap is used behind the absorbers to collect any solution carry-over, its contents shall be combined with the sample of bottle 2. Rinse each absorber with the absorption solution (5.4) thoroughly and particularly the fritted glass dividers to recover the absorption solution trapped in it and add the rinsing solutions to the appropriate absorber sample. Rinse all the unheated parts of the sampling system between the filter and the absorber 1 and add the rinsing to the content of bottle 1.

Analyse samples 1 and 2 as described in clause 9 to determine the sulphate content, q_{s1} and q_{s2} . Calculate the absorption efficiency ε of absorber 1 as follows:

Absorption efficiency of absorber 1 in % is $\varepsilon = q_{s1} \times 100 / (q_{s1} + q_{s2})$.

6.7 Sampling pump

Leak-free pump capable of sampling gas at a set flow-rate.

A sampling flow rate between 0,06 m³/h to about 0,2 m³/h allows to reach a good absorption with a low pressure of -10 kPa to -30 kPa.

NOTE 1 A small surge tank may be used between the pump and the rotameter to eliminate the pulsation effect of the diaphragm pump on the rotameter.

NOTE 2 A rotameter (optional) facilitates the adjustment of the nominal sampling flow-rate.

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

6.8 Gas volume meter

Any dry or wet gas volume meter may be used providing the volume is measured with a relative uncertainty not exceeding ± 2 % at actual conditions.

The gas volume-meter shall be equipped with a temperature measuring device (uncertainty of calibration less than $\pm 2,5$ K). The absolute pressure at the gas volume meter (uncertainty of calibration less than $\pm 1,0\%$) can be determined from the relative pressure and the ambient pressure.

When using a dry gas volume meter, a condenser and/or a gas drying system shall be used which can lead to a residual water vapour content of less than 10 g/m^3 (equivalent to a dew point of $10,5^\circ\text{C}$ or a volume content $\chi(\text{H}_2\text{O}) = 1,25 \%$).

NOTE For example a glass cartridge or absorption bottle packed with silica gel (1 mm to 3 mm particle size), which has been previously dried at least at 110°C for at least 2 h.

When using a wet gas volume meter, a correction shall be applied for water vapour, to obtain a dry gas sampled volume.

7 Sampling procedure

7.1 General requirements

The sample and the point of measurement shall be representative of the emission of the process.

The following points should be considered when sampling:

- nature of the plant process e.g. steady state or discontinuous. If possible the sampling and measuring programme should be carried out under steady operating conditions at the plant;
- expected concentration to be measured and any required averaging period, both of which can influence the measuring and sampling time.

The minimum sampling period is 30 min. When the expected mass concentration of SO_2 is low, the sampling period or the sampling volume may be extended.

7.2 Preparation and installation of equipment

7.2.1 Sampling location

The sampling location chosen for the measurement devices and samplings shall be of sufficient size, easily passable and made in such a way that an emission measurement representative for the measurement task and technically perfect is possible. In addition, the sampling location shall be chosen with regard to safety of the personnel, accessibility and availability of electrical power.

7.2.2 Sampling point(s)

It is necessary to ensure that the gas concentrations measured are representative of the average conditions inside the waste gas duct. In most cases, a single sampling point situated in the middle of the duct shall be selected. For larger ducts, this point can be situated closer to the sampling port but not too close to avoid any disturbance of the flow or concentration due to influences from the sampling port.

However, when non-homogeneity of the flue gas is suspected, it shall be demonstrated if the flue gas is homogeneous or not. The homogeneity can be demonstrated with a continuous measurement of O_2 or CO_2 using a fixed and a moving probe. Sampling in non-homogeneous flue gases requires following relevant standards or technical specifications proposed by CEN TC 264.

When droplets are present in the flue gases, then the probe is equipped with a nozzle and an isokinetic sampling shall be performed at the different points required by EN 13284-1.