INTERNATIONAL STANDARD

ISO 10397

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Stationary source emissions — Determination of asbestos plant emissions — Method by fibre count measurement

Émissions de sources fixes — Détermination des émissions par des usines d'amiante — Méthode par comptage des fibres

Reference number
ISO 10397:1993(E)

Contents

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Annexes

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10397 was prepared by Technical Committee ISO/TC 146, *Air quality*, Sub-Committee SC 1, *Stationary source emissions*.

Annexes A, B, C, D and E of this International Standard are for information only.

Introduction

This International Standard is essentially made up of two parts:

— sampling of asbestos-containing emissions to the atmosphere;

— fibre counting.

Unfortunately the accuracy of the analysis (fibre counting) is such that it adversely affects the accuracy of the whole method. Therefore, it is vitally important that the analytical side be carried out by experienced analysts who have been specially trained in conjunction with an approved quality control scheme.

Although this method has been designed to deal specifically with fibre emissions from asbestos works, it can also be applied to other processes dealing with fibrous materials. Indeed, many asbestos works use substitute fibres and therefore may contain mixed fibre emissions at times. Where this is probable, or where there is a need to identify which fibres are asbestos and which are not, it will be necessary to employ more sophisticated techniques for fibre identification (see ISO 10312). This is not covered in this International Standard.

It should be noted that differences exist at present in the way asbestos fibres and non-asbestos fibres are assessed, especially in the workplace. However, these differences should not affect the way this method is used to assess the effectiveness of the arrestment plant.

This International Standard is intended not only to be used to give a quantitative concentration of fibres in emissions from asbestos works, but also as a means of showing the effectiveness or otherwise of the operation of dust and fibre collection equipment.

Because of the relatively short duration of sampling, this method is fairly sensitive to process fluctuations, and therefore a full record of test parameters is required.

The analytical technique for fibre counting used in this method follows that described in ISO 8672.

Stationary source emissions — Determination of asbestos plant emissions — Method by fibre count measurement

WARNING — SAFETY PRECAUTIONS

GENERAL

Sampling operations may involve a variety of hazards depending on the circumstances. Management, sampling operators and control authorities, shall consider the likely hazards well before sampling commences. The sampling site shall be assessed prior to sampling. If hazards cannot be eliminated, appropriate safety arrangements shall be made with regard to any specific local, national or international regulations or codes of practice. Special care is needed concerning asbestos and the method should be carried out by experienced personnel.

The hazards that may be encountered and advice on ways to alleviate them are given below.

PLANT MANAGEMENT

It is essential that plant management and plant operators be made aware that sampling is taking place. Also plant safety procedures shall be followed, e.g. work permits, etc.

HAZARDS TO SAMPLING OPERATORS

a) Exposure to asbestos and other substances: Consider visual inspection and/or cleaning of site, monitoring or personal protective equipment.

b) Inadequate sampling facilities: Provide sufficient workspace for sampling equipment and operators, consider appropriate services, electricity, compressed air, lighting, weather protection, hoists, etc.

c) Working at heights or in remote locations: Consider means of escape, guard rails, warning systems and the need for communications.

d) Exposure to toxic, corrosive, hot or pressurized gases: Consider sampling location, monitoring or warning systems, personal protective equipment, etc.

e) Electrical hazards: Consider equipment protection, earthing, earth leakage circuit breakers and national safety standards, etc.

f) Noise and heat: Consider protective measures.

HAZARDS TO OTHER PERSONNEL

a) Objects falling from the platform: Consider warning signs, barricading, etc.

b) Presence of temporary equipment, e.g. cables causing trip hazards: Consider warning signs, etc.

HAZARDS TO PLANT/PROPERTY

a) Ignition of flammable gases: Consider using non-electrical equipment and non-sparking tools, etc.

b) Equipment dropping into duct: Ensure that equipment is properly assembled.

1 Scope

This International Standard specifies a method, using a fibre count technique, for the assessment of fibre concentrations in flowing gas streams in ducts, chimneys or flues from industrial processes using asbestos.

This method may be used to determine fibre concentrations from a wide range of processes where it is known that "regulated" fibres are present in emissions. No attempt is made to identify asbestos fibre types separately from other fibres.

NOTES

1 If fibre identification is required, reference should be made to ISO 10312.

2 This method may be used to check that dust collection equipment, used to trap or prevent asbestos fibres escaping into the atmosphere, is working properly and effectively.

3 This International Standard may be used to measure fibre concentrations as described in European Community Council Directive No. 87/217/EEC on the prevention and reduction of environmental pollution by asbestos.

The range of application of the method for concentrations of fibres in ducts is about 0,05 fibres/cm^3 to 10 fibres/cm^3, although this range may vary according to the sampled volume which in turn will depend on duct velocities and the sampling apparatus used.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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

ISO 8672:1993, *Air quality — Determination of the number concentration of airborne inorganic fibres by phase contrast optical microscopy — Membrane filter method.*

ISO 9096:1992, *Stationary source emissions — Determination of concentration and mass flow rate of particulate material in gas-carrying ducts — Manual gravimetric method.*

ISO 10312:—[1], *Ambient air — Determination of asbestos fibres — Direct transfer transmission electron microscopy method.*

3 Definitions

For the purposes of this part of ISO 10397, the following definitions apply.

3.1 aspect ratio: Ratio of the length of the fibres to their diameter.

3.2 access port: A hole in the duct, provided with a flanged or threaded socket, through which the sampling probe is inserted along the sampling line.

3.3 cumulative sampling: The collection of a single composite sample obtained by sampling for the required period at each sampling point in turn.

3.4 duct: A chimney stack or ducting at the outlet of dust collecting equipment carrying asbestos-fibre laden gases.

3.5 fibre concentration: The number of "regulated" fibres per normal cubic centimetre of gas.

3.6 fibre count technique: A method for counting the number of "regulated" fibres present on a membrane filter and the calculation of fibre concentrations. [ISO 8672]

3.7 isokinetic sampling: Sampling at a rate such that the velocity and direction of the gas entering the sampling nozzle is the same as that of the gas in the duct just prior to the sampling point.

3.8 pump: A fan, vacuum pump or other apparatus used for extracting a sample of gas from ducts or chimneys.

3.9 "regulated" fibres: Fibres that meet the following criteria:

length $\geqslant$ 5 µm,

diameter $\leqslant$ 3 µm,

minimum aspect ratio 3:1.

3.10 hydraulic diameter D_1: The equivalent diameter of a rectangular duct given by the formula

$$D_1 = \frac{4 \times \text{Area of the sampling plane}}{\text{Perimeter of the sampling plane}}$$

1) To be published.

4 Symbols with their corresponding units and subscripts

See table 1 for symbols and their corresponding units and table 2 for subscripts.

Table 1 — Symbols and their corresponding units

Symbol	Meaning	Unit
A_F	Effective filtering area of the membrane filter	mm^2
C	The concentration of fibres in the stack	$fibres/cm^3$
D_G	Diameter of the Walton-Beckett graticule	µm
D_F	Diameter of the exposed area of filter	mm
d	Diameter of the filter nozzle	mm
f	Fibres (see 3.1)	
K	Calibration factor for Pitot-static tube	
k	Simplified calibration factor for Pitot-static tube	
N	Total number of fibres counted	
n	Number of graticule areas examined	
P	Absolute pressure	Pa
δp	Differential pressure (Pitot-static readings)	Pa
R	Sampling rate	m^3/min
T	Absolute temperature	K
t	Temperature of the duct gases	°C
v	Gas velocity at a sampling point	m/s
V	Volume of sampled gas	m^3
ρ	Density of duct gas	kg/m^3
Θ	Duration of sampling	s

Table 2 — Subscripts

Subscript	Meaning
S	Standard conditions of 1,013 bar and 0 °C
F	Filter
G	Graticule
I	Integrating meter
T	Total

5 Principle

The apparatus is inserted into a moving gas stream and a known volume is withdrawn isokinetically. The sampled gas is passed through a filter medium which removes particulate matter (including fibres) from the gas stream. The filter is treated to make it transparent when viewed under a microscope, and the number of fibres are counted, in a precise number of fields viewed using a phase-contrast optical microscope.

Knowing the volume of gas sampled, the cross-sectional area of the filter, the number of "regulated" fibres counted, and the cross-sectional area of each field, the concentration of fibres in the moving gas stream can then be calculated.

6 Summary of method

The method specifies the apparatus and the way in which it is to be used to take a sample, in order that the concentration of fibres emitted in a gas stream from an asbestos process can be determined by measurement and calculation. This enables an assessment to be made of the effectiveness of the measures being taken to prevent pollution.

The sampling train shown schematically in figure 1, consists of the following:

— probe with nozzle and fibre collector;

— flow regulation equipment;

— volume measurement apparatus;

— pump.

The analytical equipment consists of:

— a phase contrast microscope;

— filter "clearing" equipment;

— flow and temperature measurement apparatus.

This is a sensitive method which requires small samples and relatively short sampling times, which enables several samples to be taken, thus improving the precision of the method. In practice, a preliminary sample and two definitive samples will normally be taken.

Initially, before sampling can begin, it will be necessary to take note of all plant operating parameters and dimensions at the sampling plane. Then, the flow rate and temperature of the gases in the duct are measured and the atmospheric pressure is noted.

Once these preliminaries have been dealt with, the sampling train is assembled, selecting the appropriate nozzle to ensure that isokinetic sampling can be carried out.

The sampling probe is inserted in sequence into the access holes in the duct and a sample is withdrawn isokinetically from the four points at the centre of four equal areas. The sample volume is then recorded. The sample, which is collected on a membrane filter, is transported to a laboratory where it is treated to enable the counting of the fibres under a phase-contrast microscope.

From the recorded data, the concentration of fibres in the duct can be calculated.

7 Apparatus

7.1 General

Use a sampling train for sampling regulated fibres as shown in figure 1. The apparatus to be used is listed in table 3. The items of apparatus provided shall be constructed of materials (e.g. stainless steel) capable of withstanding the conditions under which they will be used, shall be portable or transportable, and shall be capable of sampling isokinetically (see 12.3) at a steady rate.

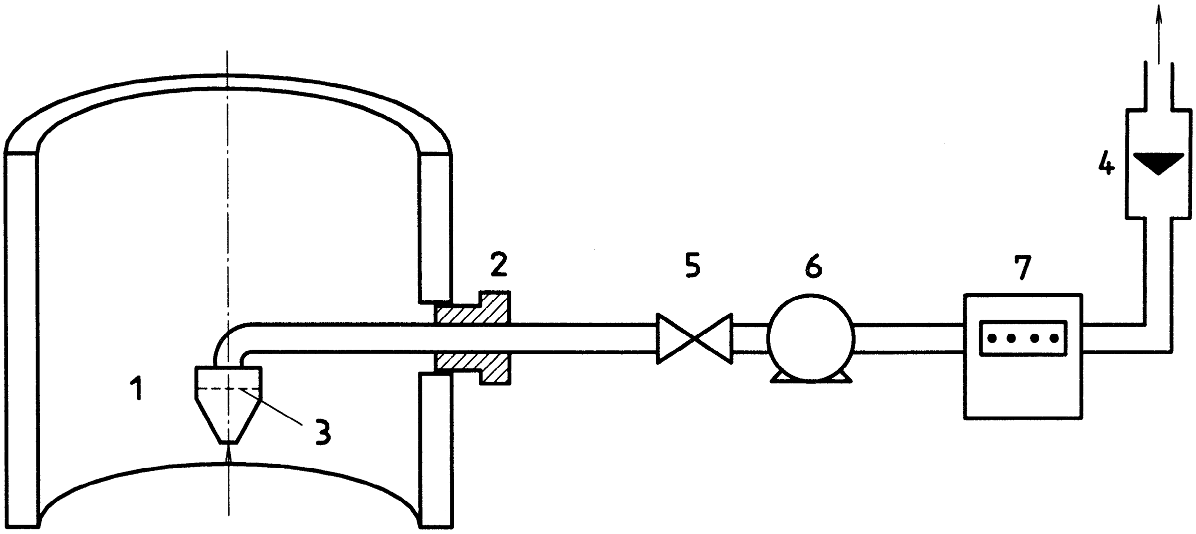
NOTES

4 Access ports on the duct will be needed to enable sampling to take place.

5 A well established and accepted laboratory to undertake analytical work will be required. The laboratory should be part of a quality control system.

Table 3 — Sampling and analytical apparatus

Number (see figure 1)	Apparatus	Design	Requirements
1	Sample nozzle and filter holder	See figure 3	See 7.3 and figure 3
2	Probe tube and support	Rigid and tubular to support filter holder and sample nozzle and to seal duct	See 7.3 and figure 2
3	Fibre collector	Membrane filter (mixed esters)	Efficiency of > 98 % for 3 µm size particles
4	Flowmeter for sampling	Orifice plate, variable flow orifice	Volumetric flow rate accurate to within ± 2 %
5	Regulator for sampling	Control valve or equivalent method for adjusting flow	Capable of maintaining isokinetic sampling (see 12.3)
6	Pump	Vacuum pump or fan, or equivalent with smooth flow characteristics	Suitable for isokinetic sampling and shall be gas-tight when an integrating gasmeter is employed
7	Device for measuring sample volume	Integrating dry gasmeter or equivalent (see annex B)	Gas volume measured with an accuracy of ± 2 %
8	Device for measuring temperature (in duct)	Thermocouple or equivalent	Accurate to ± 1 % of absolute temperature
9	Device for measuring flow	Pitot-static tube (see annex B) connected to a device for measuring differential pressure	Complying with ISO 3966
10	Sample containers	Sealable	Large enough to contain filter holder
11	Optical microscope	Phase contrast	Complying with ISO 8672
12	Filter clearing apparatus	Acetone/triacetin (see figure 4)	Complying with ISO 8672
13	Timing device	Stopwatch	To read to the nearest 1 s
14	Device for measuring duct dimensions	Calibrated rod, reliable drawings or equivalent (see clause 8)	Internal dimension of duct measured to ± 1 %
15	Device for measuring atmospheric pressure	Barometer or equivalent	Accurate to ± 1 %



NOTE — The numbers in this figure correspond to items of apparatus listed in table 3.

Figure 1 — Typical sampling train

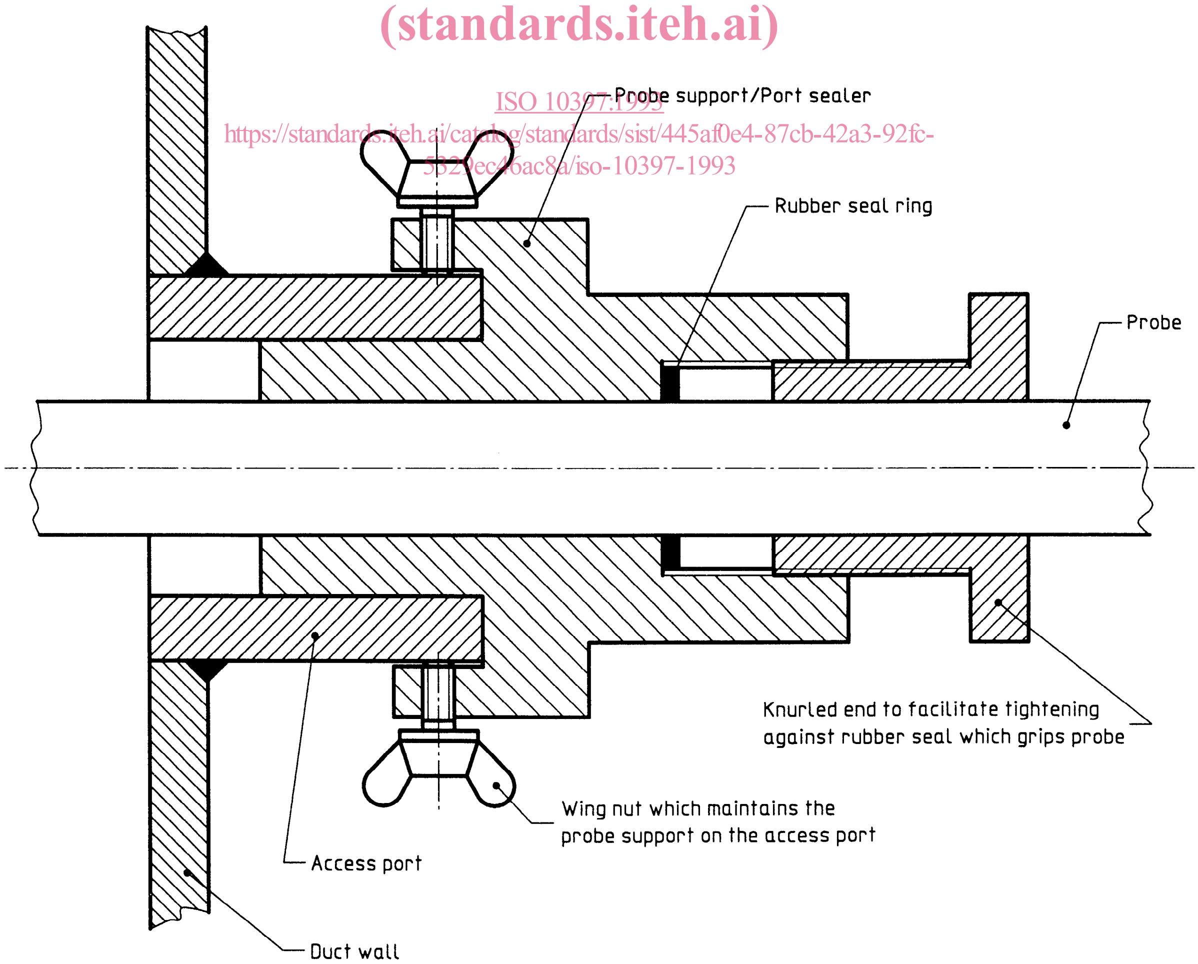


Figure 2 — Typical access port with probe support/port sealer