

Method for the

Measurement of the concentration of particulate material in ducts carrying gases

UDC 628.53:662.965:620.113

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Cement Makers' Federation	Department of Energy: Electricity
Combustion Engineering Association	Hevac Association

This British Standard, having been prepared under the direction of the Mechanical Engineering Standards Committee, was published under the authority of the Executive Board on 31 August 1978

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First published April 1940
First revision August 1978

The following BSI references relate to the work on this standard:
Committee reference MEE/48
Draft for comment 75/74380 DC

ISBN 0 580 10129 0

Amendments issued since publication

Amd. No.	Date of issue	Comments
3001	May 1979	Indicated by a sideline in the margin

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Foreword

This British Standard, prepared under the direction of the Mechanical Engineering Standards Committee, is a revision of BS 893:1940 and provides methods to be used in the measurement of the concentration of particulate materials in ducts carrying gases.

The standard contains details of the equipment and apparatus required, its technical characteristics, instructions for its assembly and the weighing of particles and instructions for the regulation of the “isokinetic” state according to the type of probe used.

The standard is, in principle, in agreement with BS 3405 with respect to terminology, the preparation for sampling, the test apparatus and the procedure to be followed in carrying out the tests. However, this standard and BS 3405, while essentially dealing with the same subject, are intended for different applications. The procedure described in BS 3405 may be considered suitable and economical, in circumstances where a lesser degree of accuracy is required; this may often be the case with comparatively small installations. If a higher degree of accuracy is required, however, the procedure described in this standard should be followed; this will usually be the case where the largest installations are concerned, e.g. electrical power stations and, in certain circumstances, e.g. as a referee test, may be considered advisable even with a smaller installation. It should be noted, however, that the accuracy of the method depends on the plant conditions being maintained at a constant level.

Appendix A gives the meaning of symbols used in the calculations and Appendix B includes methods and rules for determining the position of sampling points in circular and rectangular ducts.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard specifies methods for the measurement of the concentration of particulate matter in ducts carrying gases.

This standard provides for a higher order of precision than BS 3405. See Appendix C.

2 References

The titles of the publications referred to in this standard are listed on the inside back cover.

3 Definitions

For the purposes of this standard, the following definitions apply.

3.1 site

works or plant where sampling is to be carried out

3.2 duct

an enclosed structure through which gases travel from one point to another

3.3 sampling position

a place in a duct where sampling is carried out

3.4 sampling plane

the cross section of the duct in which all sampling is carried out

3.5 sampling line

the line across the sampling plane on which the sampling points are located

3.6 sampling point

a specific location on a sampling line at which an individual sample is extracted

3.7 access hole

a hole in the duct, at the extremity of a sampling line, through which sampling is undertaken

3.8 isokinetic sampling

sampling at such a rate that the average velocity of the gas entering the sample nozzle is the same as that of the gas in the duct at the sampling point

3.9 normal temperature and pressure (NTP)

15 °C and 101 325 N/m²

3.10 particulates

solid matter, in a gas stream, that is solid at normal temperature and pressure

3.11 gas

a mixture of gaseous compounds or elements flowing in a duct, carrying particulate matter

4 Equipment

4.1 List of equipment for measurement of particulate content. The following list summarizes the equipment which may be necessary for the measurement of particulate content (see Figure 1).

- 1) Entry nozzle (see 4.3).
- 2) Probe tube (see 4.4).
- 3) Particle separator(s) (see 4.5).
- 4) Sampling flow rate measuring device (see 4.6).
- 5) Flow rate control device (see 4.7).
- 6) Exhauster (see 4.8).
- 7) Thermometer for measuring the temperature t_1 in the duct.
- 8) Thermometer for measuring the temperature t_2 of the gas sample upstream of the flow rate measuring unit.
- 9) Instrument for measuring the humidity of the gases in the duct.
- 10) Instrument for measuring the static pressure p_1 in the duct.
- 11) Instrument for measuring the static pressure p_2 upstream of the flow rate measuring device.
- 12) Sensitive differential instrument connected to the pitot tube 14).
- 13) Sensitive differential instrument for measuring the pressure difference Δp_4 in the flow rate measuring device.
- 14) Pitot tube (or, when conditions permit, a hot wire anemometer or other equally suitable device).
- 15) Barometer for measuring the local atmospheric pressure p_{at} .
- 16) Device for recovering any particulates which are retained in the entry nozzle or in the probe tube.
- 17) Containers for transporting the particulates.
- 18) Timing device.
- 19) Accessory particle separators (cyclone, microcyclone, cloth filter bag etc.).
- 20) Provision for heating or cooling the probe tube and particle separator or separators.
- 21) Instrument for analysing composition of gas.

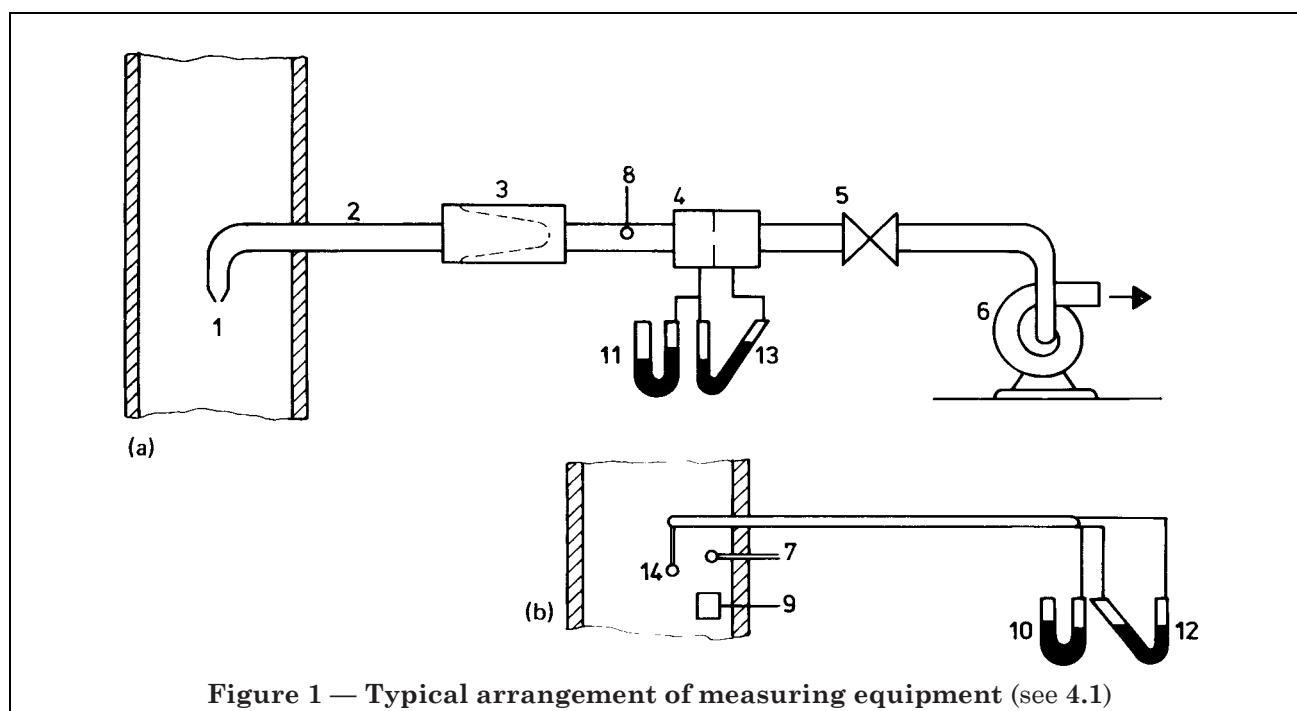


Figure 1 — Typical arrangement of measuring equipment (see 4.1)

4.2 General requirements concerning equipment.

Unless specifically agreed otherwise between the interested parties, all apparatus to be inserted into the duct shall be suitable for insertion through a hole of 109.8 mm diameter, even with thick-walled ducts. This corresponds to the bore of a socket which will accept a pipe threaded externally to series R4 of BS 21.

The apparatus required for measuring the chemical composition of the gases is not dealt with in this British Standard (see BS 1756).

Equipment shall be provided and measures shall be taken to ensure the safety of personnel, including the following:

- a) an adequate and safe working platform at each sampling position, with safe means of access to it;
- b) protection for the personnel taking the measurements, including protection from the gases in the flue, as necessary;
- c) safe means of handling the equipment in use;
- d) the safety of those below the sampling position.

4.3 Entry nozzle (see Figure 2). The entry nozzle is that part of the equipment which first admits a sample of the gas stream to be measured. The nozzle should be of a simple design, as shown in Figure 2, and should not include any encumbrances that might affect the performance of the equipment. Other designs of nozzle may be used provided that they comply with the accuracy requirements of this standard.

It is usual for a range of different internal diameter nozzles to be supplied with the equipment so that samples can be withdrawn from gas streams flowing at a wide range of velocities.

The external profile of the entry nozzle should be similar to that shown in Figure 3 or Figure 4.

No reduction should be made in the internal diameter over a distance equal to three times the diameter of the entry section. Any subsequent changes in bore diameter shall be tapered rather than stepped. Any bends in this section shall have a minimum radius of 1.5 times the nozzle bore diameter.

In order to obtain a sharp-edged entry section, the width of the annular face of the tip of the nozzle should be not greater than the dimensions shown in Figure 3 and Figure 4.

The diameter of the entry nozzle shall be not less than 10 mm.

4.4 Probe tube. The probe tube is that part of the equipment which enables the entry nozzle to be placed within the duct or chimney in order that a sample of gas may be taken. The probe tube usually connects together the different items of equipment, namely the entry nozzle, particle collector(s) and separator(s), and also the sample flow rate measuring device where this is in the duct.

Any part of the probe tube that is within the duct shall be rigid.