

Methods for

Measurement of air pollution —

Part 11: Determination of a black smoke
index in ambient air

UDC 614.715:543.275.3:531.082.531

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- British Cement Association
- British Coal Corporation
- British Gas plc
- Combustion Engineering Association
- Department of the Environment (Her Majesty's Inspectorate of Pollution)
- Department of Health
- Department of Trade and Industry (Laboratory of the Government Chemist)
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This British Standard, having been prepared under the direction of the Environment and Pollution Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 September 1993

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The following BSI references relate to the work on this standard:
Committee reference EPC 35
Draft for comment 91 51945 DC

ISBN 0 580 22506 2

Amendments issued since publication

Amd. No.	Date	Comments

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National foreword

This Part of BS 1747 has been prepared under the direction of the Environment and Pollution Standards Policy Committee. It is identical with ISO 9835:1993 *Ambient air — Determination of black smoke index*, published by the International Organization for Standardization (ISO) with the active participation and approval of the UK.

This Part of BS 1747 is one of a series relating to air quality arising from UK participation in the work of ISO/TC 146. Methods for the determination of particular constituents of ambient air will be published as further Parts of this British Standard. Topics relating to air quality characteristics will be published as Parts of BS 6069 *Characterization of air quality*.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8 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 International Standard specifies a method for measuring the black smoke index of an ambient air sample. The method is based on the staining effect of particles which is produced when a sample of air is drawn through a filter paper.

The method is intended for the measurement of a black smoke index in the range 6 to 375 in the ambient atmosphere. It is based on the measurement of reflectance. The method does not measure the mass concentration of particles directly.

2 Definition

For the purposes of this International Standard, the following definition applies.

2.1

black smoke

strongly light-absorbing, particulate material suspended in the ambient atmosphere

NOTE 1 The major contributor to black smoke is soot particles; i.e. particles containing carbon in its elemental form.

3 Principle and theory

Air is drawn through a filter paper and the reflectance of the stain produced is measured. If it is assumed that reflected light from the surface of the filter paper has passed through the layer of light absorbent particles twice, reflectance from the filter surface is analogous to the absorption of light by particles suspended in air in accordance with the equation

$$R = R_0 \exp\left(-\frac{2aV}{A}\right) \quad \dots (1)$$

where

- R is the intensity of reflected light from the surface of a stained paper;
- R_0 is the intensity of reflected light from the surface of a clean paper;
- A is the area of the stain on the filter paper, in square metres;
- V is the volume sampled, in cubic metres;
- a is the absorption coefficient, in reciprocal metres.

Thus, rearranging equation (1):

$$a = \frac{A}{2V} \times \ln\left(\frac{R_0}{R}\right) \quad \dots (2)$$

The method specified in this International Standard can be used to measure the absorption coefficient on any filter material, but the conversion of absorption coefficient or extinction coefficient to what is, by convention, known as the black smoke index, is purely an arbitrary operation which is carried out by reference to tables or graphs. For further explanations, see Annex A.

4 Apparatus

4.1 Sampling equipment. The sampler shall be designed for daily operation, or it shall be of an automatic type for continuous operation. Flow diagrams of alternative arrangements of sampling equipment are shown in Figure 1. Details of the sampling equipment are given in 4.1.1 to 4.1.6.

4.1.1 Air intake, a conical funnel of 30 mm to 50 mm diameter that is constructed of polyvinylchloride. The funnel shall be mounted vertically with the mouth downwards at a height of not less than 2,5 m and not greater than 5 m above the ground. The inlet shall be located at least 1 m horizontally from any external walls.

4.1.2 Connection tubing, constructed of polyvinylchloride, of internal diameter $8 \text{ mm} \pm 1 \text{ mm}$ and not greater than 6 m in length. Bends shall be avoided if possible but, if unavoidable, shall have a radius greater than 50 mm.

4.1.3 Filter unit. The filter holder shall be constructed of an electrically conducting and chemically inert material (with respect to the atmosphere likely to be encountered). The area of the aperture shall be $5 \text{ cm}^2 \pm 5 \%$. The leakage across the filter and valves (if used) shall not exceed 2 % of the total flow rate. The filter holder should be of a design which will provide a homogeneous particle layer on the surface of the filter medium.

The homogeneity of the particle layer can be checked by measuring the reflectance at several points across the diameter of the stain produced by sampling particles using the filter holder. The variation in reflectance across the stain shall not exceed 1 percentage unit of reflectance.

4.1.4 Filter material. The filter membrane shall have a collection efficiency of as close to 100 % as possible in the 0,1 micron to 5 micron particle size range. Variations in reflectance across the whole surface area shall not exceed 1 reflectance unit. In addition, the filter material shall be suitable for a flow rate of $2 \text{ m}^3/\text{d}$.

NOTE 2 The reflectance of unused filters may vary from batch to batch, and it is therefore necessary to check and adjust for the variability of the filters before use.