

BRITISH STANDARD 3841 : 1972

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**METHOD FOR THE
MEASUREMENT OF SMOKE
FROM MANUFACTURED
SOLID FUELS FOR
DOMESTIC OPEN FIRES**

BRITISH STANDARDS INSTITUTION

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BRITISH STANDARDS INSTITUTION

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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 5000, fully indexed and with a note of the contents of each, will be found in the British Standards Yearbook, which may be purchased from BSI Sales Department. It may also be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

BS 410. Test sieves.

BS 1016. Methods for the analysis and testing of coal and coke.

Part 1. Total moisture of coal.

Part 2. Total moisture of coke.

Part 13. Tests special to coke.

BS 1251. Specification for open-fireplace components

BS 3142. Manufactured solid smokeless fuels for household use.

Part 2. Cokes for domestic closed appliances.

Part 3. Specially reactive fuels for all types of domestic open fire.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following BSI references relate to the work on this standard:
Committee reference SFE/29 Draft for approval 70/37945

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CO-OPERATING ORGANIZATIONS

The Solid Fuel Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

- Association of Consulting Engineers
- British Cast Iron Research Association
- British Coke Research Association
- *British Ironfounders' Association
- British Mechanical Engineering Confederation
- British Steel Industry
- Chamber of Coal Traders
- Chemical Industries Association
- *Coal Utilisation Council
- Coke Oven Managers' Association
- Combustion Engineering Association
- Council of Ironfoundry Associations
- *Domestic Solid Fuel Appliances Approval Scheme
- *Department of the Environment
- Department of Trade and Industry
- Electricity Council, the Central Electricity Generating Board and Area Boards in England and Wales
- *Gas Council
- Heating and Ventilating Contractors' Association
- Institute of British Foundrymen
- *Institute of Fuel
- Institution of Gas Engineers
- Institution of Heating and Ventilating Engineers
- Institution of Mechanical Engineers
- Iron and Steel Institute
- *Low Temperature Coal Distillers' Association of Great Britain, Ltd.
- *National Coal Board
- *Society of British Gas Industries
- Water-tube Boilermakers' Association
- Women's Advisory Council on Solid Fuel

The Government department and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this standard:

- Association of Municipal Corporations
- Greater London Council
- Ministry of Technology
- Royal Society for the Promotion of Health
- Solid Smokeless Fuels Federation
- Urban District Councils Association

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BRITISH STANDARD METHOD FOR
THE MEASUREMENT OF SMOKE
FROM MANUFACTURED SOLID FUELS FOR
DOMESTIC OPEN FIRES

FOREWORD

The Clean Air Act, 1956, empowers the Minister* to make regulations declaring specific fuels to be 'authorized fuels' for the purposes of the Act. In Section 11 of the Act it is stated that, in proceedings for an offence under the Subsection which prohibits the emission of smoke from the chimney of any building in a smoke control area, 'it shall be a defence to prove that the emission of smoke was not caused by the use of any fuel other than an authorized fuel'. In 1956 various classes of solid smokeless fuels, both natural and manufactured, were declared to be authorized fuels.

With the subsequent development of new types of manufactured solid smokeless fuels for domestic purposes it became apparent that there was a need for a standard procedure by which such fuels could be tested to give a measure of their smoke emission characteristics. Such a test procedure would have two main purposes. Firstly, it would yield information on the basis of which the Minister* could decide whether or not the fuel should be declared to be an authorized fuel. Secondly, it would be used as a reference method by fuel manufacturers for checking the validity of any simpler methods used by them for the testing of samples taken from bulk production, to ensure that the requisite degree of smokelessness was being maintained.

In 1957 the British Standards Institution, acting at the request of the then Ministry of Housing and Local Government, set up a new Technical Committee SFE/29 for the purpose of assessing smoke emission from domestic chimneys. In February, 1961, the terms of reference of this Technical Committee were extended to include the formulation of a British Standard defining methods of test for solid smokeless fuels. As the experimental investigations proceeded it became apparent that it would be difficult, and perhaps impossible, to ensure that one form of test would be equally applicable to all types of fuel. The procedure described in this British Standard has consequently been designed to deal with manufactured solid smokeless fuels intended for use in domestic open fires. It is not necessarily suitable for the evaluation of other types of solid fuel which may have different burning characteristics, such as natural fuels and fuels developed particularly for use in closed types of domestic appliances.

*In England and Wales the Minister of the Department of the Environment, in Scotland the Minister of State.

INTRODUCTION

The Report of the Committee on Air Pollution (Cmd. 9322) defined smoke as 'suspended particles or droplets of carbonaceous matter, grit and dust arising from the combustion of fuel'. It is well established that the smoke from a domestic fire cannot be judged solely in terms of its 'optical density' since this parameter depends not only on the quantity of the particulate matter which constitutes the smoke but also on its nature and on the volume flow rate of the flue gases carrying it. This British Standard therefore requires the smoke to be determined gravimetrically by collection and weighing in an electro-precipitator through which all the flue gases are passed. The procedure is based on the measurement of the smoke produced when a standard charge of fuel is burnt on an open fire. The test is carried out at one specified condition, in which the average radiant output of the fire is adjusted to a particular level chosen to be reasonably characteristic of normal domestic usage. The result is expressed as the mass of smoke produced per unit time.

This British Standard does no more than describe a reference procedure for making a smoke emission measurement on a manufactured solid smokeless fuel for use in domestic open fires. Because of the inherent difficulties of the procedure it is impossible to say at the present how many tests would have to be carried out, in any particular case, before a representative figure for the smoke emitted from the fuel could be quoted. It is intended that the standard should be reviewed in the light of practical experience of its application and, if it appears desirable, should then be revised and amplified. It may be useful, however, briefly to set out some of the difficulties which are likely to be encountered in the application of this standard and how they may possibly be dealt with, it being understood that nothing which is stated in the following three paragraphs has any mandatory force.

When a new manufactured solid smokeless fuel intended as an authorized fuel for use in domestic open fires has been developed to the stage of readiness for bulk production, it would be necessary for the smoke emission of a representative sample of it to be determined by the procedure of this British Standard. More than one determination would be necessary, the number required being decided in part by good scientific practice and in part by the closeness with which the smoke emission of the fuel was found to approach the permitted limit. The results of the tests would be averaged and the average value of smoke emission compared with any limiting standard which had been laid down.

When the fuel was put into bulk production it would be necessary, except where the process was such that the smokiness of the fuel would be consistently very low, for the manufacturer to institute a quality control procedure to ensure that the requisite degree of smokelessness was maintained. The test method described in this British Standard has been kept as simple as possible.

nevertheless it takes a long time to carry out and involves precise measurements with relatively elaborate equipment. In consequence it would not be regarded as eminently suitable for day-to-day quality control. It would be expected that the manufacturer would make every effort to find some simpler method which could be used in his plant for this particular purpose. Such a simpler method would not necessarily involve making a direct measure of smoke, provided that it gave a result which had a reasonable relationship with the smoke as measured by the reference method of this standard, and the relationship would need to be checked and calibrated periodically by this method. It follows that it would probably be so arbitrarily linked with the particular fuel and process which it was designed to serve, that there would be little likelihood of it having a wider application or becoming the subject of a British Standard.

The extent, if at all, to which any quality control procedure, whether using the test described in this British Standard or some simpler method, would be required to be used by the fuel manufacturer would depend primarily on the average level and the consistency of the smoke emission of his product and on the degree of control which it was possible to exercise at the plant. If a simpler method were to be used to monitor the plant output, then the extent of use of the quality control procedure would also depend in some measure on the efficacy and reliability of the simpler method itself, which in turn would dictate the frequency with which it would be necessary to check and calibrate it by the reference method of this British Standard. The measured results from the monitoring tests would have to be assessed by some quality control procedure based on statistical principles. This procedure would have to be designed so as to ensure that the requisite standard of smokelessness was being maintained in bulk production. Relevant, though not identical, questions relating to fuel quality and consistency are dealt with in BS 3142, which could therefore be usefully studied in this connection to see where there was common ground.

The standard originally prepared was published in 1965 and is now superseded by the present metric version, without modification.

METHOD

0. SCOPE

This British Standard specifies the procedure by which a smoke emission test is made on a sample of a manufactured solid fuel intended for use in domestic open fires.

NOTE. The titles of the British Standards referred to in this standard are listed on page 2.

1. EQUIPMENT

1.1 CHIMNEY AND SETTING

The test chimney and setting shall be freestanding and all the brickwork shall be of common clay brick. The chimney and setting shall be so sited that, when the BCURA* cage radiometer is in position for a test, radiation cannot fall on the cold junctions and the radiometer is not exposed to intense draughts (see B.3).

The test setting shall be as shown in Fig. 1. The brickwork on either side of the fireplace opening shall be not less than 230 mm thick to a height of at least 1 m above the finished hearth level and shall be not less than 115 mm thick behind the fireplace opening. The setting shall be surmounted by a chimney with a 230 mm by 230 mm flueway, constructed of 115 mm brickwork and lined with lime mortar. The chimney shall terminate within the test laboratory at a height of 4.6 m above the finished hearth level. The setting shall incorporate a throat-forming lintel complying with the requirements of the relevant section of BS 1251.

The fireback shall be non-fluted and in accordance with the requirements of BS 1251, the number of parts of the fireback being left to individual choice. The space behind the fireback shall be insulated by filling with broken brick (40 mm down) bound with a slurry of lime and sand, the proportions being: broken brick 16, lime 2, sand 1. An expansion joint, consisting of strawboard or thin corrugated cardboard, shall be provided behind the lower part of the fireback.

The rear surface of the throat shall be formed above the fireback in the manner shown in Fig. 1, i.e. without a smoke shelf. The line of the upper surface of the fireback shall be followed for approximately 100 mm and the throat then sloped off at an angle of approximately 45° to meet the brickwork at the rear of the chimney, yielding a throat width of approximately 115 mm. This may be done by the use of either brick with a lime mortar lining or precast concrete.

The tiled surround shall be in accordance with the requirements of BS 1251, with overall dimensions 1 m by 1 m and with the fireplace opening $410 -5 +10$ mm wide and $560 +0 -5$ mm high. The surround shall be flat, i.e. one in which both the back and the front of the surround are at the same level around the fireplace opening as they are at the periphery. The tiles shall be light-coloured and 10 mm thick on a concrete backing 40 mm thick.

The hearth shall be formed of a 50 mm concrete base at least 1 m long by 0.45 m wide. It shall be tiled with light-coloured tiles similar to those used in the surround.

* British Coal Utilisation Research Association.

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1.2 OPEN FIRE AND GAS IGNITION BURNER

The open fire shall be the London/Fulham Mark II 400 mm (nominal) inset fire fitted with a cast iron bottomgrate having air spaces of 16 ± 1 mm between the bars and with integral gas ignition burner. The general design of this appliance is illustrated in Fig. 2. It shall be used without deepening bar or deepening plate, but with its ashpan in position.

A special air inlet plate constructed as shown in Fig. 3 shall be used instead of the normal ashpit cover, to enable the amount of combustion air to be more accurately set and reproduced.

The fire shall be set back as far as possible in the fireplace opening. The firefront shall be rigidly fixed to the hearth and its vertical sides sealed against the front edges of the fireback by means of non-combustible non-asbestos tap ~~or string~~, the string being clamped tightly and faced off with refractory cement. The sealing strip along the bottom of the firefront shall be sealed to the hearth with refractory cement.



1.3 GAS SUPPLY TO IGNITION BURNER

The gas ignition shall be town gas or coke oven gas having a calorific value between 16.8 and 20.8 MJ/m³. The gas shall be supplied at a rate corresponding to approximately 7.5 kJ/s.

1.4 POKER

The diameter of the poker used for de-ashing the fire shall not be more than 10 mm at the end which is inserted into the fire.

1.5 ELECTRO-PRECIPITATOR

The electro-precipitator shall be so designed and operated as to be capable of collecting at least 95 % of the smoke emitted during each test; any precipitator which can be demonstrated to have this efficiency of operation shall be deemed acceptable for the purposes of this British Standard. Appendix A describes a design of precipitator which was developed by the British Coal Utilisation Research Association and which has been shown to meet the above requirement. Appendix A also describes suitable ancillary equipment, safety devices and methods of operation.

1.6 DESICCATING CANISTER

An airtight desiccating canister shall be provided for drying the electro-precipitator before and after each test. A design suitable for use with the BCURA type of precipitator is illustrated in Fig. 4. On each occasion that the canister