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Methods for

Analysis and testing of coal and coke —

Part 108: Tests special to coke —

Section 108.6 Determination of critical
air blast value

Committees responsible for this British Standard

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British Cement Association
 British Coal Corporation
 British Gas plc
 British Steel Industry
 Electricity Industry in United Kingdom
 GAMBICA (BEAMA Ltd.)
 Institute of Petroleum
 Power Generation Contractors' Association (BEAMA Ltd.)

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Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
<hr/>	
0 Introduction	1
1 Scope	1
2 References	1
3 Definition	1
4 Principle	1
5 Apparatus	1
6 Preparation of test sample	2
7 Procedure	4
8 Expression of results	4
9 Precision	4
10 Test report	5
<hr/>	
Figure 1 — Heating element	1
Figure 2 — Alternative assemblies for measuring air flow	3
Figure 3 — Alternative assemblies of dome and combustion chamber	3
<hr/>	
List of references	Inside back cover
<hr/>	

Foreword

This Section of BS 1016 has been prepared under the direction of the Solid Mineral Fuels Standards Policy Committee. Part 108 is a revision of the 1980 edition of BS 1016-13, which is withdrawn. This Section supersedes clause 9 in BS 1016-13:1980, to which it is technically equivalent and which is deleted by amendment.

Part 108 is a further Part numbered under a scheme for rationalizing and restructuring BS 1016. The new series, when complete, will begin with Part 100, which will include a general introduction. The earlier series of Parts is as follows, with the new Part numbers (which will be given to revisions when they are published) in parentheses.

- *Part 1: Total moisture of coal;* (Part 101)
- *Part 2: Total moisture of coke;* (Part 102)
- *Part 6: Ultimate analysis of coal;* (Part 106)
- *Part 7: Ultimate analysis of coke;* (Part 106)
- *Part 8: Chlorine in coal and coke;* (Part 106)
- *Part 9: Phosphorus in coal and coke;* (Part 106)
- *Part 10: Arsenic in coal and coke;* (Part 106)
- *Part 11: Forms of sulphur in coal;* (Part 106)
- *Part 14: Analysis of coal ash and coke ash;* (Part 114)
- *Part 15: Fusibility of coal ash and coke ash;* (Part 113)
- *Part 16: Methods for reporting results;* (Part 100)
- *Part 17: Size analysis of coal;* (Part 109)
- *Part 18: Size analysis of coke;* (Part 110)
- *Part 20: Determination of Hardgrove grindability index of hard coal;* (Part 112)
- *Part 21: Determination of moisture-holding capacity of hard coal.* (Part 103)

The following Parts in the new series have been published.

- *Part 104: Proximate analysis;*
- *Part 105: Determination of calorific value;*
- *Part 107: Caking and swelling properties of coal;*
- *Part 108: Tests special to coke;*
- *Part 111: Determination of abrasion index of coal.*

Part 108 is divided into six Sections as follows.

- *Section 108.1: Determination of shatter indices;*
- *Section 108.2: Determination of Micum and Irsid indices;*
- *Section 108.3: Determination of bulk density (small container);*
- *Section 108.4: Determination of bulk density (large container);*
- *Section 108.5: Determination of density and porosity;*
- *Section 108.6: Determination of critical air blast value.*

There is no corresponding International Standard for this Section of BS 1016.

WARNING. This British Standard does not necessarily detail all the precautions necessary to comply with the requirements of the Health and Safety at Work etc. Act 1974 [1] or the Control of Substances Hazardous to Health Regulations 1988 [2]. Attention should be paid to any appropriate precautions and the method should be operated only by trained personnel.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 6, 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.

0 Introduction

The critical air blast value is a measure of the reactivity of coke to air. The more reactive the coke the lower is its critical air blast value. Typical values are 0.4 l/min for low temperature coke and 1.8 l/min for high temperature coke.

1 Scope

This Section of BS 1016 describes a method for the determination of the critical air blast value of coke.

2 References

2.1 Normative references

This Section of BS 1016 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this Section of BS 1016 only when incorporated in it by updating or revision.

2.2 Informative references

This Section of BS 1016 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definition

For the purposes of this Section of BS 1016 the following definition applies.

critical air blast value

the minimum rate of air flow through ignited, closely graded coke, in a bed of specified dimensions, which will maintain combustion

4 Principle

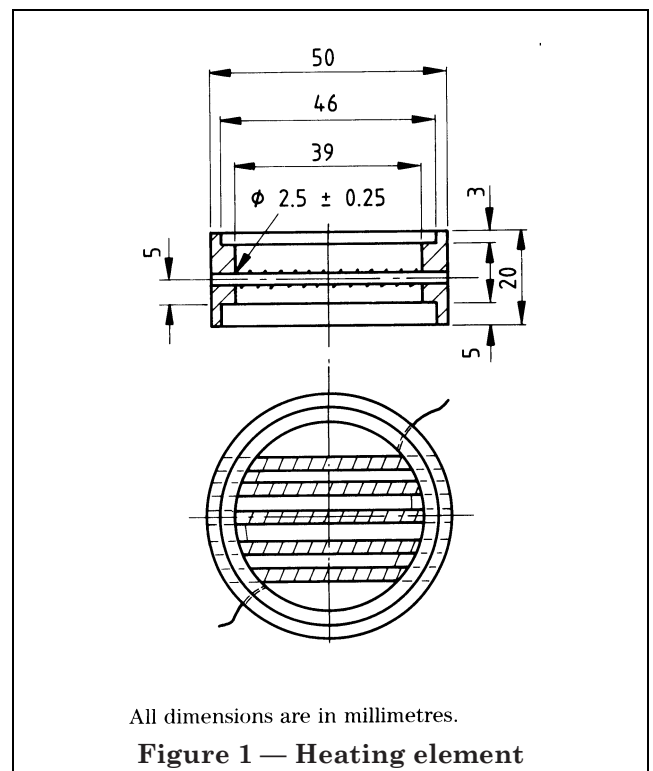
A bed of graded coke is ignited electrically in a specified combustion chamber, with dry air passing through the bed at a rate of 4.25 l/min. When the coke is fully ignited the rate of air flow is reduced to a preselected value for 20 min and then raised to the original value to attempt resuscitation. This procedure is repeated with fresh portions of the coke and with other rates of air flow until the critical value is found.

5 Apparatus

5.1 Combustion chamber, comprising a tube of transparent silica or heat-resisting glass of length 200 mm, inside diameter 40 mm \pm 1 mm and wall thickness 1 mm to 2 mm. The inside of the wall of the tube shall have three projections around the circumference, produced by reshaping the glass or by fusing-on lugs, at a distance of 35 mm to 41 mm from one end. A continuous line shall be marked round the circumference at a distance of 10 mm to 12 mm from the same end. The tube shall be closed at the other end by a rubber stopper which carries a silica or heat-resisting glass tube, of inside diameter 5 mm to 6 mm, bent at right angles.

5.2 Metal gauze disc, made from wire mesh, of aperture size 0.4 mm to 0.6 mm, to fit inside the combustion chamber and rest on the projections.

5.3 Heating element (see Figure 1), comprising a heating wire, wound round silica rods which are held in a cylindrical frame.



The cylindrical frame shall be made of an insulating and heat-resisting material, with outside diameter 50 mm, inside diameter 39 mm and height 20 mm. It shall be recessed on the underside so as to rest on the top of the combustion chamber. The diameter of this recess shall be 1 mm to 4 mm greater than the outside diameter of the combustion chamber. The top of the frame shall be recessed to a diameter of approximately 46 mm and to a depth of 3 mm. This recess shall be fitted with a porcelain or quartz disc with at least 50 holes of diameter not greater than 2 mm and not less than 0.5 mm. Five silica rods, with outside diameter $2.5 \text{ mm} \pm 0.25 \text{ mm}$, shall be fitted into holes drilled through the walls of the frame.

The heating wire shall be of 0.3 mm nickel-chromium resistance wire, welded at its ends to 1 mm leads of the same alloy. It shall be wound helically round, and supported by, the five silica rods in the frame. The resistance of the wire (when new), as measured between the leads, which shall not exceed 50 Ω in length, shall be not greater than 40 Ω and not less than 30 Ω .

5.4 Air supply, capable of providing an air flow through the combustion chamber of up to 4.25 l/min, controlled to within ± 0.05 l/min. Air supplied either from a cylinder of compressed air or direct from a compressor is suitable.

NOTE If the air is supplied from a compressor, a large reservoir should be included in the supply line to damp out pulsations and, if necessary, a filter should be included to remove oil mist. The rate of air flow through the apparatus should be controlled by a needle valve or screw clip placed after some form of pressure regulator such as a water seal (up to 300 mm deep) or a gas governor.

5.5 Air flow measurement system, comprising one of the following.

- a) Two flowmeters, one capable of measuring flow rates up to 3 l/min to an accuracy of ± 0.03 l/min and the other to read 4.25 l/min to the same accuracy [see Figure 2 a)].
- b) An inclined capillary flow gauge, a gas meter indicating 2.5 litres per revolution and a suitable manometer [see Figure 2 b)].

5.6 Dome, comprising one of the following.

- a) A dome of heat-resisting glass, of inside diameter $75 \text{ mm} \pm 15 \text{ mm}$ and height $190 \text{ mm} \pm 10 \text{ mm}$ [see Figure 3 a)].
- b) A tube, of similar material and dimensions, closed at its upper end with a rubber stopper carrying the air inlet tube [see Figure 3 b)].

In either case the lower end shall be closed with a rubber stopper, carrying a pair of 3 mm diameter brass or copper leads which are connected to the leads of the heating element when the apparatus is assembled. In the case of **5.6 a)**, the stopper shall also be fitted with the air inlet tube.

5.7 Drying tower, of diameter 50 mm and height 300 mm, with the outlet tube filled with self-indicating silica gel.

5.8 Funnel, for charging the coke, made by rolling a sheet of paper or metal foil into a cone with an outlet at the apex of about 10 mm in diameter.

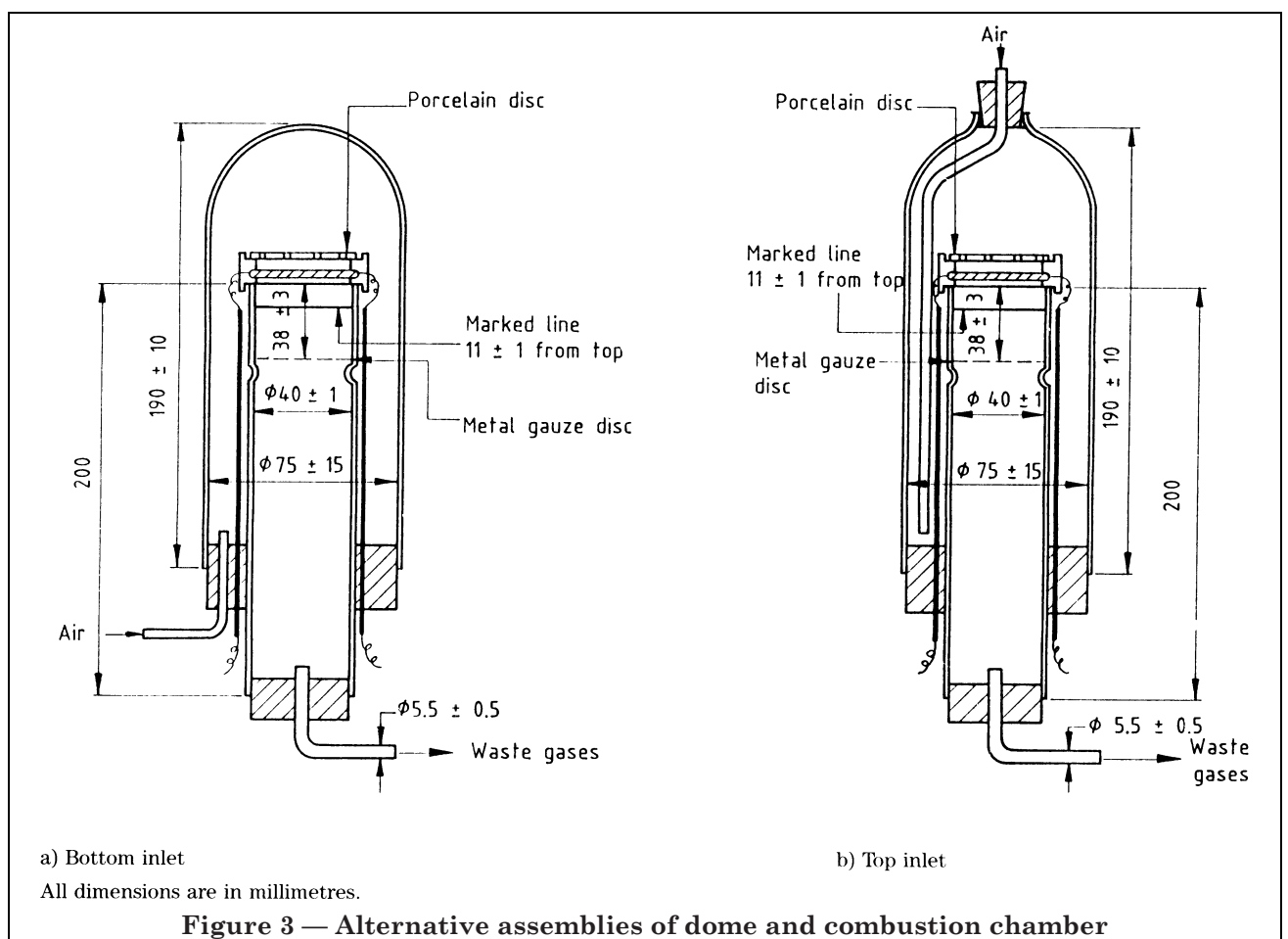
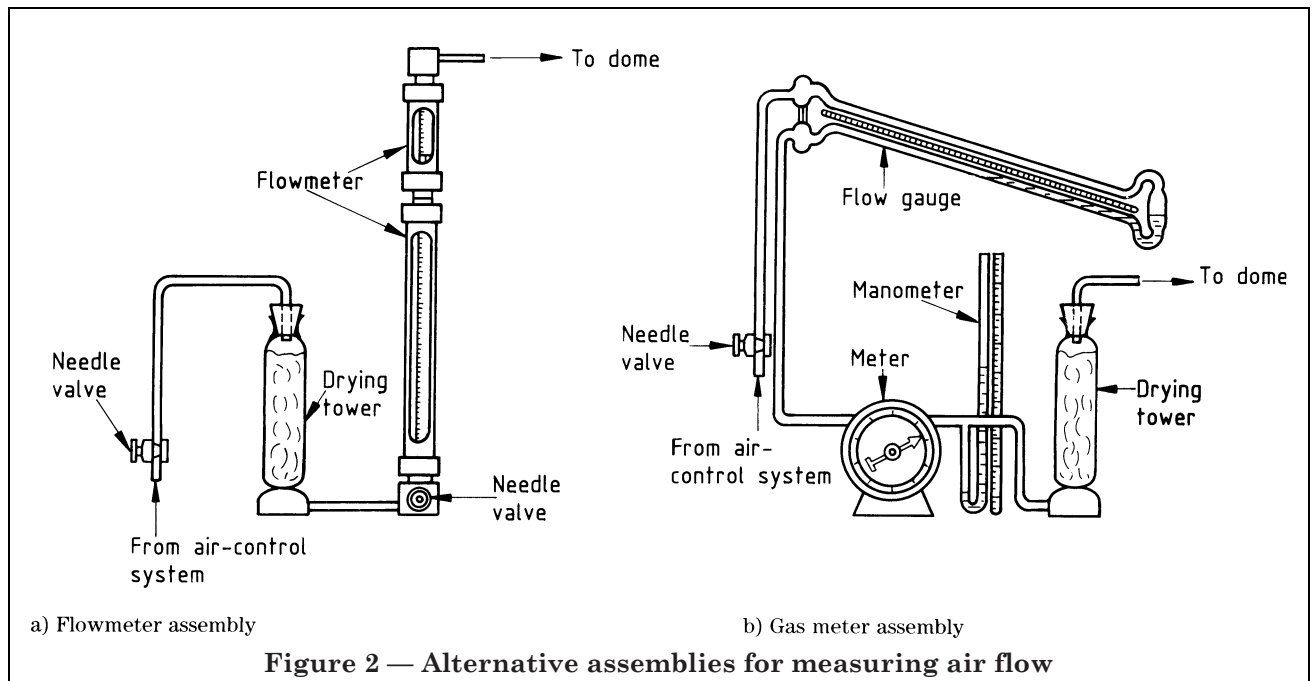
5.9 Former, of cork, felt-covered wood or aluminium, of a diameter slightly less than that of the combustion chamber.

5.10 Test sieves, of nominal aperture sizes 1.18 mm and 600 μm , conforming to BS 410:1986.

5.11 Air oven, capable of maintaining a temperature within the range 105 °C to 110 °C.

6 Preparation of test sample

Prepare a test sample, in accordance with **A.5** of BS 1017-2:1960, which passes the 1.18 mm test sieve (**5.10**) and is retained on the 600 μm test sieve. Dry the test sample in a shallow tray in the oven (**5.11**) at a temperature within the range 105 °C to 110 °C and re-sieve it on the 600 μm test sieve immediately before use.



7 Procedure

Assemble the air flow measurement system (5.5) and the drying tower (5.7), as shown in Figure 2, and connect them to the air supply (5.4). Assemble the combustion chamber (5.1) and the metal gauze disc (5.2) as shown in Figure 3. Prepare the coke bed by pouring coke from the test sample (clause 6) through the funnel (5.8) on to the metal gauze disc. Move the funnel around during this operation so as to form a loose, uniformly packed bed. The height of the funnel above the coke bed shall be such that the free fall of the particles does not exceed 5 mm. Fill the combustion chamber with coke up to the line. Smooth the surface of the bed with the former (5.9), manipulated so as to roll the particles over the surface rather than to press them in position. Assemble and connect the remaining apparatus, including the heating element (5.3) and the dome (5.6), as shown in Figure 2 and Figure 3, and then check for leaks.

Set the rate of air flow to 4.25 l/min, switch on the current and adjust it so that the heat dissipated is between 175 W and 185 W. Continue heating until the glowing zone has spread to all parts of the periphery of the bed surface. At the instant this is achieved, switch off the current and reduce the air flow rate to a value which is expected to be slightly above critical value¹⁾, at the same time noting the reading of the relevant flowmeter or the initial reading of the gas meter, as appropriate (see 5.5). Continue passing air at this rate for 20 min, read the gas meter again, if applicable, and increase the rate to 4.25 l/min. Continue at this rate until resuscitation (as indicated by the continuation or the reappearance of the glow) occurs or for a maximum of 20 min.

NOTE Observations are made easier by screening the combustion chamber from direct lighting.

If resuscitation takes place, repeat the operations described above using progressively lower air flow rates, with a fresh portion of the test sample for each new rate, until a rate is found from which no resuscitation occurs. Similarly, if resuscitation does not take place, repeat the sequence of operations using progressively higher air flow rates until resuscitation just occurs.

In this way, obtain two rates of air flow which differ by not more than 0.06 l/min and are such that resuscitation occurs from one but not from the other. Record the air flow rate from which resuscitation occurs.

8 Expression of results

The critical air blast value of the coke, expressed in l/min of dry air at a temperature of 15 °C and a pressure of 100 kPa, is given by one of the following formulae.

- a) For an air flow rate measured by a flowmeter:

$$\frac{11.53PV}{(273.15 + T) d} \times 10^5$$

- b) For an air flow rate measured by a gas meter:

$$\frac{11.53fV(P + a - h)}{(273.15 + T_w) d} \times 10^5$$

where

- d is the diameter of the combustion chamber (in mm);
- P is the atmospheric pressure (in kPa);
- V is the minimum rate of air flow from which resuscitation occurs (in l/min);
- T is the air temperature (in °C);
- f is the gas meter correction factor;
- a is the manometer pressure (in kPa);
- h is the aqueous vapour pressure at T_w °C (in kPa);
- T_w is the temperature of water in the gas meter (in °C).

Report the result to the nearest 0.01 l/min.

9 Precision

9.1 Repeatability

The results of duplicate determinations, carried out at different times in the same laboratory by the same operator with the same apparatus using representative portions taken from the same test sample, should not differ by more than 0.06 l/min.

9.2 Reproducibility

The means of the results of duplicate determinations, carried out in each of two different laboratories using representative portions taken from the same sample after the final stage of sample preparation, should not differ by more than 0.06 l/min.

¹⁾ A rough estimate of the critical air blast value can be obtained from the time required for ignition (see Brewin, W. and J.K. Thompson. *Fuel in Science and Practice*, 1937, 16, 361 – 365) [3].

10 Test report

The test report shall include the following:

- a) the identification of the sample;
- b) the reference to the method used,
i.e. BS 1016-108.6:1992;
- c) the results expressed in accordance with
clause 8;
- d) any unusual features noted during the
determination;
- e) any operation not specified in this standard or
regarded as optional.

List of references (see clause 2)

Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 410:1986, *Specification for test sieves*.

BS 1017, *Methods for sampling of coal and coke*.

BS 1017-2:1960, *Sampling of coke*.

Informative references

Other references

[1] GREAT BRITAIN. Health and Safety at Work etc. Act 1974. London: HMSO.

[2] GREAT BRITAIN. Control of Substances Hazardous to Health Regulations, 1988. London: HMSO.

[3] BREWIN W. and J.K. THOMPSON The critical air blast test and its significance. *Fuel in Science and Practice*, 1937, **16**, 361 – 365.

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