

Methods for

Analysis and testing of coal and coke —

Part 108: Test special to coke —

Section 108.1 Determination of shatter
indices

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee SFI/3, Analysis and testing coal and coke, upon which the following bodies were represented:

British Cement Association
 British Coal Corporation
 British Gas plc
 British Steel Industry
 Electricity Association
 GAMBICA (BEAMA Ltd.)
 Power Generation Contractors' Association [PGCA (BEAMA Ltd.)]

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National foreword

This British Standard has been prepared SFI/3 and is identical to ISO 616:1995 *Coke — Determination of shatter indices*, published by the International Organization for Standardization (ISO) and in the preparation of which the United Kingdom played a full part.

This British Standard is a revision of BS 1016-108.1:1992 which is withdrawn. Main changes in this edition are in the sizes of test sieves used and the repeatability data.

BS 1016-108.1 is part of a rationalized and restructured BS 1016. The Parts numbered from 1 to 21 are gradually being withdrawn and replaced by Parts in the new series. The full list of Parts in the series, together with corresponding numbering of the old series and related ISO standards is given in BS 1016 *Analysis and testing of coal and coke — Part 100:1994 General introduction and methods for reporting results*.

Cross-references

International standard	Corresponding British Standard
ISO 579:1981	BS 1016 <i>Methods for analysis and testing of coal and coke</i> Part 2:1973 <i>Total moisture of coke</i> (Technically equivalent) Part 110 <i>Size analysis of coke</i>
ISO 728:1995	Section 110.1:1996 <i>Nominal top size greater than 20 mm</i> (Identical)

The Technical Committee has reviewed the provisions of ISO 2309 and ISO 3310-2 to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

A British Standard related to ISO 2309:1980 is BS 1017 *Sampling of coal and coke Part 2:1994 Methods for sampling of coke*. ISO 2309 is being revised in conjunction with ISO 1988 *Hard coal — Sampling*, ISO 9411 *Solid mineral fuels — Mechanical sampling from moving streams — Part 1: Coal* and — Part 2: *Coke*. This revision will be published in eight Parts, and it is intended to implement these Parts as identical British Standards, superseding BS 1017.

A British Standard related to ISO 3310-2:1990 is BS 410:1986 *Specification for test sieves*.

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 and ii, 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.

Introduction

The shatter index of coke can be determined for one test sieve or for each of a number of test sieves of different sizes of holes (e.g. 80 mm and 40 mm). The higher the shatter index, the greater the resistance of the coke to breakage into pieces which are smaller than the stated size.

The mean size of the coke before and after the shatter test may also be determined to give additional information about the strength of the coke.

1 Scope

This International Standard specifies a method for determining the strength of coke by the shatter test.

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 579:1981, *Coke — Determination of total moisture content*.

ISO 728:1995, *Coke (nominal top size greater than 20 mm) — Size analysis by sieving*.

ISO 2309:1980, *Coke — Sampling*.

ISO 3310-2:1990, *Test sieves — Technical requirements and testing — Part 2: Test sieves of perforated metal plate*.

3 Definition

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

3.1 shatter index

percentage of a specially prepared sample of coke remaining on a test sieve of stated size of openings after the sample has been subjected to a specified dropping test

4 Principle

A test portion taken from the coke above a specified size is dropped under standard conditions. The mass of coke which is then retained on a test sieve, or on each of two or more test sieves of different sizes of holes, is determined.

5 Apparatus

5.1 Shatter test apparatus (see Figure 1), mounted on a solid base and consisting of the following parts.

5.1.1 Base unit, comprising a steel base plate with further plates fitted on all sides to prevent loss of coke during the test. The base plate shall be not less than 12 mm thick, 1 220 mm long and 970 mm wide. Each of the other plates shall be not less than 200 mm high and 10 mm thick. The back plate (see note 1) and the side plates shall be rigidly fixed and the front plate shall be removable (see note 2), so as to facilitate shovelling the coke from the base unit into the box (**5.1.4**) after each drop.

NOTE 1 For the purposes of describing the apparatus, it is viewed from the “front” when the counterweight appears to the right (as depicted in Figure 1).

NOTE 2 For convenience, the front plate may be hinged and fitted with latches.

The rigidity of the base plate shall be ensured by one of the following means, of which the first is the simpler.

- a) The base plate is supported solidly on a concrete raft, and the side and back plates and the vertical supports (**5.1.2**) are welded to it.
- b) The base plate is supported above a solid floor, on a lower framework of 75 mm × 75 mm × 10 mm angle-iron to which it is welded or riveted; the side and back plates are welded or riveted to this framework and also to a vertical piece of angle-iron at each of the two back corners.

5.1.2 Main vertical supports, fastened to the outside of the side plates of the base unit. If the base plate is supported on a framework of angle-iron, the vertical supports shall be riveted or welded to the angle-iron to increase rigidity. The two vertical supports shall be constructed in one of the following ways.

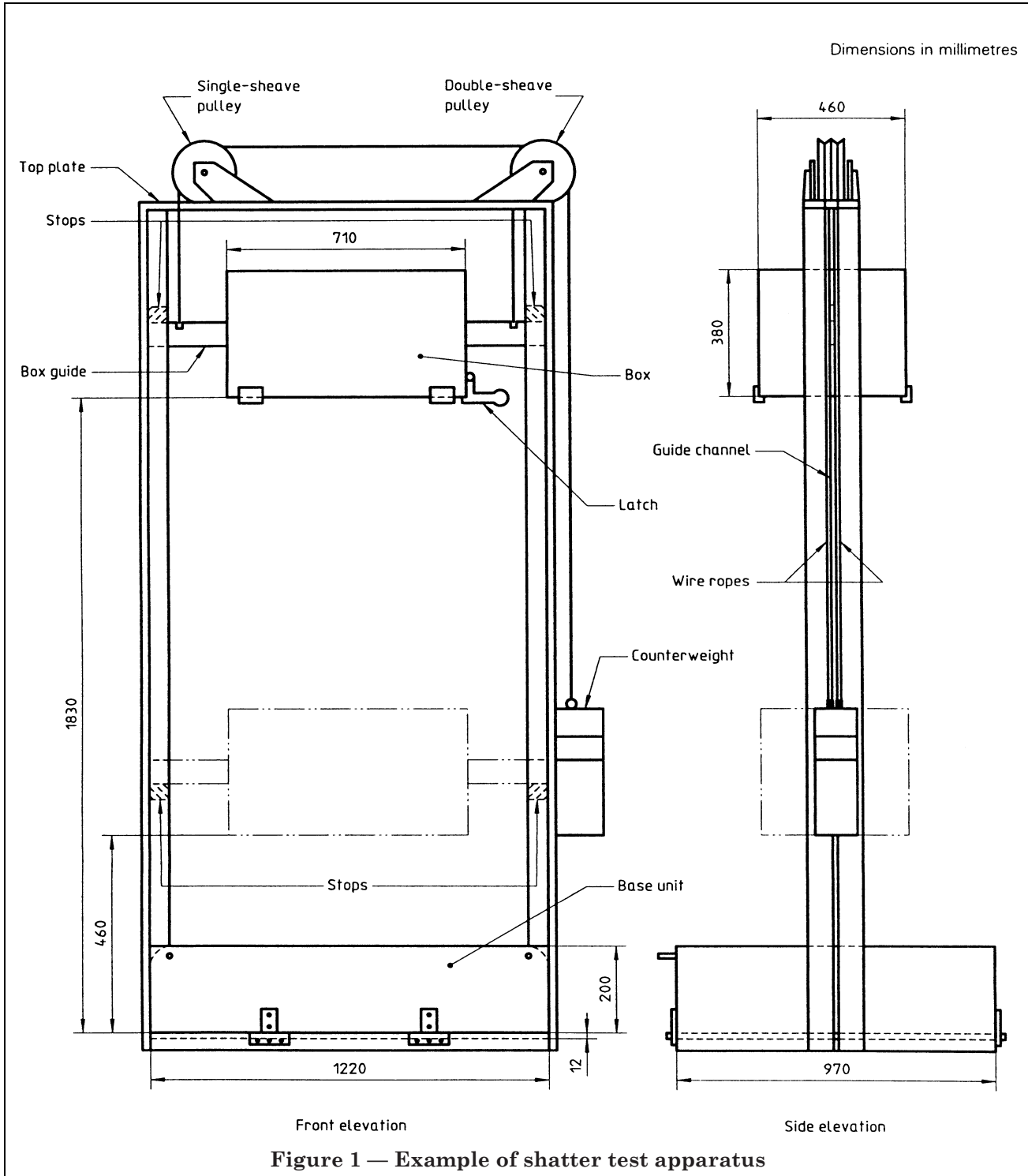
- a) Each support consists of a T-section 150 mm wide with a 60 mm web.

The web shall be removed where it is fastened to the side plate of the base unit.

- b) Each support consists of two 75 mm × 75 mm angles set 13 mm apart.

5.1.3 Top plate, 150 mm to 200 mm wide and 6 mm thick, fastened to the main vertical supports, with a single-sheave pulley mounted at the left-hand end and a double-sheave pulley at the right-hand end.

5.1.4 Box, of internal dimensions 710 mm long, 460 mm wide and 380 mm deep.



The bottom of the box shall consist of two doors, hinged lengthwise and provided with a latch or other fastening capable of rapid opening. The doors shall be made of 6 mm steel plate and shall swing open rapidly, so as not to impede the fall of the coke. The fastening shall be designed so that it can be released without causing the box to move (see, for example, the arrangement shown in Figure 1).

The sides of the box shall be made of steel plate not less than 3 mm thick.

5.1.5 Box guides, approximately 250 mm long, fitted to the end plates of the box, to engage with the main vertical supports.

If the main vertical supports consist of T-sections, each box guide shall be double to run on either side of the web of the T-section.

If the main vertical supports consist of 75 mm × 75 mm angles, each box guide shall consist of 6 mm plate which can move in the channel between the two angles.

5.1.6 Wire ropes and counterweight, for supporting the box. A wire rope shall be fastened to each box guide (5.1.5) near the side support, so as to interfere as little as possible with the reloading of the box after each drop. The two wire ropes shall pass over the pulleys and a counterweight shall be suspended from the other ends of the ropes. The counterweight shall consist of a fixed weight, of mass equal to that of the box, and two 12,5 kg removable weights which are slotted onto a rod which passes through the centre of the fixed weight.

5.1.7 Box stops, to restrain the box, on either side, at the top and bottom of its run. The upper stops shall be located so that the highest position to which the box can be raised is where the inside of the bottom of the box is 1 830 mm above the surface of the base plate. The lower stops shall be located to prevent the box from travelling below the position where the distance between the bottom of the box and the base plate is 460 mm.

If the main vertical supports consist of 75 mm × 75 mm angles, the stops shall consist of plates filling the slot between the two angles.

If the main vertical supports consist of T-sections, the lower stops shall consist of plates fixed to the web of the sections. The upper stops shall be provided by means of similar plates or, alternatively, the distance pieces fixing the width of the slots between the double guides shall be extended vertically to form stops against the top plate.

5.2 Test sieves, of perforated plate, square hole, complying with ISO 3310-2 and of nominal sizes of holes 125 mm, 100 mm, 80 mm, 63 mm, 50 mm, 40 mm, 25 mm and 12,5 mm. The sieve plates shall be 600 mm square and shall be mounted in hardwood frames armoured with angle plates to reduce wear. When the wear on any hole exceeds 2 % of its nominal size, the hole shall be blanked off or the test sieve changed.

NOTE 3 For the larger sizes of foundry coke, single-hole gauges may be used instead of test sieves.

5.3 Weighing machine, with a capacity of not less than 25 kg, capable of weighing to the nearest 10 g.

6 Sampling and size analysis

Take two gross samples for physical testing in accordance with ISO 2309:1980, *Coke — Sampling*¹⁾ Prepare one of these samples for the determination of moisture content in accordance with ISO 2309 and carry out the determination in accordance with ISO 579. If the moisture content is higher than 5 % (*m/m*), dry the other sample sufficiently to reduce the moisture content to lower than 5 % (*m/m*). Use this second sample for the remainder of the test.

Carry out a size analysis in accordance with ISO 728 on the sample using a set of test sieves (5.2) of successive nominal size of holes, the sieve with the largest size of holes being that on which not more than 5 % (*m/m*) of the sample remains. Place the coke by hand on the sieves of nominal size of holes down to and including 40 mm. For the smaller hole sizes, carry out sieving manually by holding the sieve in the hands, or suspending it freely, and shaking it horizontally to and fro with a displacement of about 75 mm. Complete fifty such oscillations (each consisting of one movement to and fro) in a period of about 30 s. If the amount of coke remaining on the sieve is then such that it covers more than 75 % of the sieve area, divide it into two or more portions and manually shake each portion separately.

Weigh each size fraction, to the nearest 10 g, and place each fraction in a separate pile or container. Record the masses retained on the individual sieves as cumulative percentages.

¹⁾ In due course, ISO 2309 will be replaced by ISO 13909-6, *Hard coal and coke — Sampling — Part 6: Coke — Preparation of test samples*.

7 Preparation of test portion

Constitute a $25 \text{ kg} \pm 0,1 \text{ kg}$ test portion containing all fractions of coke greater than 63 mm in size, in approximately the same proportions as they are present in the gross sample. Prepare the test portion by taking at random from each of the separate size fractions of coke (see clause 6), down to and including the 63 mm to 80 mm fraction, an appropriate mass, weighed to the nearest 10 g using the weighing machine (5.3).

NOTE 4 The simplest way of achieving this is to calculate the cumulative mass of coke required in each of these size fractions in the test portion, so as to correspond to the proportions in the gross sample. Then, starting with the fraction with the largest particle size, select pieces of coke and place them in a weighed container until the required cumulative mass for each size fraction has been obtained.

8 Procedure

8.1 Determination

Transfer the test portion (see clause 7) carefully into the box (5.1.4) of the shatter test apparatus (5.1), by removing the coke from its container and placing it in the box by hand.

Place the two 12,5 kg weights on the counterweight (5.1.6) and raise the box to its highest position (see 5.1.7). Close and fasten the front plate of the base unit (5.1.1). Release the bottom doors of the box to allow the coke to fall onto the base plate.

WARNING — To avoid the possibility of injury, it is important that the operator should stand to one side before the doors of the box open.

Close and secure the doors of the box. Remove the two 12,5 kg weights and lower the box to the lower stop (see 5.1.7). Drop the front plate and carefully shovel the coke from the base plate into the box. Return all the coke to the box in this manner but without sweeping the base plate at this stage. Do not stand on the coke to perform this operation.

WARNING — To avoid the possibility of injury, it is important that the operator should stand to one side before the front plate falls.

Repeat the process until a total of four drops have been made.

NOTE 5 Some form of indicator is helpful to avoid an error in the number of drops.

If the mean size before and after the test is to be determined, assemble a set of test sieves (5.2) so that a full size analysis can be carried out.

Otherwise, use only the sieves corresponding to the shatter indices to be determined. Transfer all the coke, sweeping the dust from the base plate, to the top sieve (with the largest size of holes) and sieve it by placing the coke by hand on the sieves of nominal size of holes down to and including 40 mm and by shaking manually for the smaller hole sizes.

Cumulatively weigh the size fractions, to the nearest 10 g, noting the mass corresponding to each size.

8.2 Validity of determination

For the determination to be valid, the total mass of the size fractions (see 8.1) shall not differ from the original mass of the test portion by more than 100 g. If the difference exceeds this limit, repeat the determination.

9 Expression of results

The shatter index S_x , corresponding to a sieve of nominal size of holes x mm, is given by the following equation:

$$S_x = \frac{m_1}{m_2} \times 100$$

where

- m_1 is the cumulative mass of coke retained, after dropping, on all sieves of nominal size of holes equal to or greater than x mm;
- m_2 is the total mass of the test portion when weighed after the test.

Report the result to the nearest 0,1 unit.

If the mean size before and after the test is to be determined, calculate it in accordance with ISO 728.

10 Precision

10.1 General

The precision of the test can vary considerably depending on the index determined and the actual strength of the coke. The values for repeatability quoted in 10.2 are given only as examples.

10.2 Repeatability limit

The results of duplicate determinations of S_{40} and $S_{12,5}$, carried out at different times in the same laboratory, by the same operator with the same apparatus, on representative portions constituted from the size fractions of the same gross sample, should not differ by more than 4,0 units and 1,0 units respectively.

10.3 Reproducibility

No value for reproducibility can be quoted for determinations carried out in different laboratories, since the transport of coke samples involves the risk of breakage and thus alteration of the size distribution and the shatter indices.

11 Test report

The test report shall include the following information:

a) the method used by reference to this International Standard;

- b) a complete identification of the sample;
- c) the date of the test;
- d) the results expressed in accordance with clause 9;
- e) any unusual features noted during the determination;
- f) any operation not included in this International Standard, or regarded as optional.

List of references

See national foreword.

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