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Guide for

Assessing coke screening plant

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Cooperating organizations

The Solid Fuel Standards Committee, under whose direction this British Standard was prepared, consists of representatives from the following:

Association of British Solid Fuel Appliances Manufacturers
Association of Consulting Engineers
British Carbonization Research Association*
British Cast Iron Research Association
British Ironfounders' Association
Chamber of Coal Traders
Chartered Institution of Building Services
Coke Oven Managers' Association*
Combustion Engineering Association
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National Coal Board*
Society of British Gas Industries
Solid Smokeless Fuels Federation
Women's Solid Fuel Council

The organizations marked with an asterisk in the above list were directly represented on the Technical Committee entrusted with the preparation of this British Standard.

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Contents

Foreword

This British Standard has been prepared under the direction of the Solid Mineral Fuels Standards Committee and supersedes the 1969 edition, which is therefore withdrawn. The main technical change from the previous edition concerns the efficiency of screening and the opportunity has been taken to align it with BS 1016-18, which has superseded BS 1293 and BS 2074.

This standard gives guidance on the testing of new coke screening plants or plants where major alterations have been carried out, and to show the effectiveness with which the specified coke is separated into the required size fractions. In coke screening practice, the required size fractions or grades refer to coke at the outlet of storage hoppers or at the end of a boom loader or at other such points where coke is finally discharged from the plant, and therefore the tests will normally include the effect on the coke of the passage through the hopper. The procedure of sampling directly underneath the screens may be permitted as long as the fact is noted and its implications realized.

For the purposes of this standard, main screening plants are considered to consist of the screens, storage hoppers, anti-breakage devices and debreezing screens, together with inter-connecting conveyors and chutes. Mobile screening plants are those which are commonly used to remove undersize material from graded coke after ground storage.

Clause **4** gives guidance on methods of assessing the effectiveness with which a screen separates coke into the required sizes. Clause **5** gives a description of how the test is to be carried out and clause **6** some procedures for obtaining the required technical data for evaluating the plant. Appendix A shows the number of increments to be collected for moisture determination, Appendix B sets out the way in which the results should be recorded and Appendix C gives a method for calculating input data when testing mobile plant.

This standard requires frequent reference to BS 1016-18 and BS 1017-2 and it is based on the assumption that the relevant requirements of these standards are complied with.

This standard is intended for application at coke ovens but would be equally applicable to any coke producing plant or manufactured fuel works.

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 10, 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 provides guidance on assessing coke screening plants, both new and those to which major alterations have been carried out, including mobile plants. It describes methods that can be used to satisfy buyer and seller that the plant is capable of meeting the requirements agreed between them and to indicate the effectiveness of separation of the specified coke into required fractions.

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 British Standard the following definitions apply:

3.1 Sampling terms[1)]

3.1.1
sample

a number of increments grouped together for analysis and testing to provide information about the unit of coke from which the increments are taken

3.1.2
subsample

part of a sample when the sample has been collected in two or more parts, each part being analysed separately. Each subsample is composed of evenly-spaced increments

3.1.3
increment

the quantity of coke collected by a single operation of a sampling instrument

3.2 Coke terms[1)]

3.2.1
screening; screens

the commercial operation of separating coke into sizes or grades, using screens for that purpose

3.2.2
sieving; sieves

the laboratory or test operation of size analysis, using sieves for that purpose

NOTE All references in this standard to sieves and sieving should be interpreted as references to sieves which comply with the requirements of BS 410.

3.2.3
grading

see *screening*

3.2.4
size analysis

the size characteristics of a sample of coke as determined by a laboratory sieving procedure

3.2.5
graded coke (sized coke)

coke that has been separated between specified size limits by screening

3.2.6
oversize

the percentage by mass of coke whose size is larger than a specified upper size limit

3.2.7
undersize

the percentage by mass of coke whose size is smaller than a specified lower size limit

3.2.8
large coke

coke that does not pass through the largest screen in use

3.2.9
breeze

coke that will pass through the smallest screen in use

3.2.10
input coke

the coke fed to a commercial screen or a series of screens

3.2.11
rated input

the quantity (t/h) for which a screen or series of screens is designed

3.2.12
throughput

the quantity (t/h) fed to a screen or series of screens during a specified period

3.2.13
output coke or product

the coke obtained from a screen or a series of screens

[1)] When BS 1017-2:1960 is revised, it is intended to adopt the terms in that revision.

4 General

No screen is completely effective in performing its object of removing the whole of the material which is below the aperture size. Consequently, the coke that does not pass through a screen always includes some material which is below the aperture size. The proportion of such undersize may be appreciable and is likely to increase with throughput. On the other hand, the wear of a screen increases the amount of oversize in the grade below it.

The screen apertures are selected, therefore, to give the desired product, allowing for the limitations of the screening operation and for breakage in the hopper.

The effectiveness of such a screen to separate coke should be assessed by the ratio of the mass of coke below the desired size which passes through the screen to the total mass of such coke. Similarly, the ability of a pair of screens to produce a grade should be assessed by the proportion of coke within the desired size limits.

The different methods of assessment are as follows.

1) *Efficiency*. The *efficiency of screening* is the ratio of the mass of undersize coke passing through the screen to the mass of such coke passing over and through the screen.

2) *Performance*

a) The *performance of a screen* is the proportion by mass in the coke which has passed over a screen and is above the required size.

b) The *performance of a screen plant*, in relation to a pair of screens, is normally the percentage by mass of the fraction in a graded coke which is between the required size limits.

It is apparent that, although each approach will give an assessment of the effectiveness with which the plant is working, the results will be different. Each approach has its own application and it is necessary to decide which should be adopted. Thus, *efficiency* measures the effectiveness with which a screen removes material below the screen apertures in size. *Performance*, however, measures the effectiveness with which a screen or a pair of screens will produce coke of the desired sizes.

If interest is centred more directly on the ability of a screen to separate coke, then method 1 should be used and samples taken at the outlet of the screen or at some adjacent point before the coke enters a hopper. This method may also be usefully employed to assess the choice of aperture size to give a product of desired size.

The ability of a screen or screening system to produce coke of a desired size can be assesed by method 2, which is normally used for marketing control purposes. Samples will normally be taken at the dispatch loading point and the assessment may include the effect of breakage on conveyors and in hoppers, and the effect of debreezing screens at hopper outlets. The results obtained from such samples will therefore assess the ability of the plant as a whole to produce coke to a given size.

A combination of these methods will give a comprehensive assessment of the behaviour of the whole plant, which may be desirable for special investigations.

When methods for the performance of a screen and a screen plant or a screen plant alone are followed, the results may be recorded as shown in Appendix B.

5 Description of methods

5.1 Types of plant. This standard is applicable to the following two types of plant.

a) *Main screening plant*. This forms a fixed unit which may be attached to a carbonization plant; it receives its input from conveyors, dispatching its output to discharge points for bulk loading, or into bunkers and thence into sacks.

b) *Mobile screening plant*. A mobile plant is used to remove undersize material from graded coke after ground storage or to regrade coke drawn from stock. Such a plant often consists of a receiving hopper fed by a mobile stacker, crane, mechanical shovel or similar device, and a single deck screen or multi deck screen with facilities for bulk or sack loading or both.

The principles of testing these two types of plant are the same, but in actual operation some differences of practice are unavoidable; these are described as they arise.

5.2 Importance of sampling. The usefulness of the test is dependent on the collection of satisfactory samples. It is essential to collect samples that are free from bias and are representative of the input and output coke.

NOTE For general comments on the avoidance of bias see section 6 of BS 1017-2:1960.

5.3 Quality of product. The main factors that vary and affect the quality of the product are as follows:

a) throughput;

b) moisture content;

c) bulk density;

d) size distribution of input coke (which may affect the feed to each individual screen);

e) the height through which the coke may fall in the screening operation.

The size analysis of coke fed to the plant is influenced by:

1) the type of carbonizing plant;

2) the carbonizing conditions;

3) the caking properties;

4) the size of coal carbonized.

5.4 Operation of screening plant. During the period of the test, the throughput should be at or near the rated input, but the average throughput should not exceed that originally specified.

NOTE Although the throughput to the plant should be constant the loading on the individual screens may vary.

The amount of undersize in the input should not exceed that originally specified by the purchaser. The use of a coke cutter or breaker alters the size analysis of the feed and, where one is incorporated, tests should be carried out both with and without it in operation.

The screens should be cleaned at the end of each shift and the number of particles removed from each screen recorded. This does not apply to debreezing screens at hopper outlets.

If it is desirable to obtain additional information about the behaviour of the screen under a range of conditions, it is necessary to carry out tests with input cokes of different size analyses and with varying throughput.

5.5 Duration of test

5.5.1 *Main screening plant.* Where a feed hopper precedes the screening plant, the height of coke in the hopper varies throughout the period of the test. The test period should be of such duration as to cover the full range of hopper conditions that are likely to arise. It is recommended that for plants operating throughout the 24 h, the minimum period of test should be three days and for plants operating on day shifts only, the minimum period of test should be the working week of at least five days.

5.5.2 *Mobile screening plant.* In any single test, at least 10 t of coke should be passed on to the screen, preferably in a continuous flow. If it is possible, the required number of increments should be collected in a single day; otherwise the test should be extended over a sufficient number of days to permit the required number of increments to be collected. The increments should be spread evenly over the loading period.

5.6 Samples required

5.6.1 *Main screening plant.* It is necessary to collect one sample for size analysis and one for moisture determination from the input coke, and one for size analysis and one for moisture determination from the output coke from each hopper discharge point or screen.

5.6.2 *Mobile screening plant.* In most cases it is impracticable to obtain a sample of the input coke or to measure its throughput. Consequently, the test method recommended is such that it permits the indirect calculation of input data from an analysis of coke passing *over* and *through* the screen. It is realized that the size analysis of input coke calculated in this way is subject to some error, since breakage occurs in the screening process. The error should, however, be small and for the purpose of this test can be ignored.

NOTE An example showing the calculation of input data is given in Appendix C.

It is therefore necessary to collect one sample for size analysis and one for moisture determination from the coke passing over the screen, and a similar pair of samples from the coke passing through the screen. If it is possible to sample the input coke, then samples should be taken in the same way as for a main screening plant.

5.7 Collection of samples. Each sample should be formed by the collection of the specified number of increments of the specified mass (see **5.8** and **5.9**). The increments should be collected over the days during which the test is carried out and should be spread evenly over the loading periods. The increments collected on a single day should be put together to form a subsample, each subsample being analysed separately.

5.8 Number of increments

5.8.1 *Size analysis.* In order to achieve the standard of precision given in Table 4 of BS 1016-18:1981, the number of increments given in section 5 of BS 1017-2:1960 is required.

5.8.2 *Moisture determination.* It is recommended that the number of increments collected corresponds to a precision of 1.0 %. The number of increments required to give this degree of precision is given in Table 1.

NOTE This table is taken from BS 1017-2:1960.

5.9 Mass of increments. The recommended minimum mass of increments for each sample is given in section 5 of BS 1017-2:1960 for size analysis and moisture determination.

5.10 Collection of increments

NOTE The sampling implement used for collecting the increment should be of the type described in Table 5 of BS 1017-2:1960.

5.10.1 *General.* To ensure that the results are of the expected precision, the specified number of increments are collected at regular intervals spread evenly over the whole of the loading period and not taken rapidly one after another over a short period of time. Descriptions of the methods of collecting the increments from falling streams or stopped belts are given in BS 1017-2. It cannot be emphasized too strongly that unless adequate care is taken at this stage the whole test may be rendered useless and the work wasted.

There is no essential difference between taking increments from bagging points and bulk loading points except for the inherent difficulty of collection in the first case, where it may be necessary to take a 50 kg sack as an increment. The sample then becomes impracticably large. However, in such cases it is generally possible to set up a temporary arrangement to enable the increments to be taken. On many plants the fixing of a chute to the outlet of the debreezing screen enables the coke to be discharged in a continuous flow and at a throughput which is normally associated with bag loading. An increment may be taken from the end of the chute during the discharge of about 100 kg to 150 kg. This procedure is then repeated at regular intervals throughout the duration of the test, in order to accumulate the required number of increments for the sample.

5.10.2 *Mobile screening plant.* Increments may be collected conveniently during bulk loading if the sampler stands on a platform by the side of the lorry or wagon. If sack loading facilities only are available, it is recommended that the procedure given in **5.10.1**, of fixing a chute to the outlet of the screen, should be followed.

5.11 Method of analysis

5.11.1 *Size analysis.* The method described in BS 1016-18 should be used for the size analysis of samples. It is essential that the sieves used for the analysis of output coke include at least those sizes which are equal to the nominal size of the grade produced. In the case of input coke it is recommended that the size analysis should be as detailed as possible but sizes at least equal to the apertures used on the screening plant should be included.

NOTE The analysis should be recorded as a percentage by mass and may be given separately or cumulatively.

5.11.2 *Moisture content.* The method described in BS 1016-2 should be used for the determination of moisture content.

5.11.3 *Shatter test.* If a sample is needed for the shatter test, it should be extracted from the sample for size analysis and tested in accordance with BS 1016-13.

5.11.4 *Micum test.* If a sample is needed for the Micum test, it should be extracted from the sample for size and tested in accordance with BS 1016-13.

5.11.5 *Bulk density.* If required, a bulk density determination may be carried out on the sample collected for size analysis. This should be done after the completion of the size analysis but care should be taken to reconstitute and mix thoroughly the separated size fractions. The determination should be carried out in accordance with BS 1016-13.

6 Provision and presentation of technical information

6.1 General. A typical method of displaying the required information is given in Appendix B, but it may not be necessary to record these particulars in all cases (see **6.2** to **6.7**).

6.2 Mass of coke. Where possible the input coke should be weighed. Where this is impossible its mass should be obtained from the mass of the output coke and the mass of samples removed.

If this method is impracticable, the following indirect method may be used for the main screening plant.

In the case of coke ovens, the mass of coal charged is normally known and is checked at frequent intervals by coal intake and stocks. With continuous vertical retorts the throughput of coal per retort per day is also usually known and regularly checked. Proximate analysis of this coal and normal works records regarding the gross mass of coals (making allowances for moisture content) permit the calculation of a figure for the gross mass of coke discharged.

This indirect method may be used except in cases where a large proportion of the coke is removed prior to the screening plant. In such cases the method of direct weighing should be adopted. If the large coke is weighed, a combination of this known mass and the indirect method can be used to assess the mass of the input coke.

6.3 Throughput

6.3.1 *Main screening plant.* The average throughput is calculated on the basis of the time when coke is flowing over the screen and should not include time when the screen is "running empty".

The rate of feed to each screen is calculated from the mass, if known, of each grade produced.

6.3.2 *Mobile screening plant.* Lorries or wagons of known mass should be positioned at points to collect the coke passing over and through the screen. The throughput is obtained by weighing the lorries or wagons at the end of the test, adding together the mass of coke in each, and observing the time taken to complete the test. If the flow of coke is interrupted during the test, then the time noted should be for that period when coke is flowing over the screen.

The mass of coke taken as samples should be included in the determination of throughput.

6.4 Type of carbonizing plant. A record should be made of the type of carbonizing plant, the number, size and capacity of ovens, the type of firing, the rated daily throughput, etc.

6.5 Coal blend carbonized. The type of coal blend carbonized should be stated as fully as possible, giving the size, the designation (e.g. the National Coal Board coal rank code number) and the source of the coals, together with any other information such as swelling number and caking power.

6.6 Coke feed. Any further information regarding the characteristics of the coke feed, such as bulk density, shatter and Micum indices, should be recorded. For a mobile screening plant, the point of production of the coke should also be recorded.

6.7 Design features of coke screening plant. Many features in the design of the coke screening plant influence the size of the product. These include the following:

a) types of screen;

b) number of decks or screen units;

c) size of screening surface and size of aperture;

d) type of mesh;

e) dimensions of hoppers;

f) type of anti-breakage device;

g) type of cutter or breaker;

h) characteristics of the debreezing screens.

All this information should be recorded.

Appendix A Number of increments for moisture sample

Table 1 shows the number of increments needed for ± 1 % precision.

NOTE This table is taken from BS 1017-2:1960.

Table 1 — Number of increments for ± 1 % precision

Class	Moisture	Increments
	%	
1[a]	5 or less	32
	Over 5	48
2[b]	3 or less	48
	3 to 5	72
	Over 5	108
3[c]	3 or less	100
	3 to 5	150
	Over 5	225
4[d]	All moisture contents	16

NOTE *Mobile screening plant.* The number of increments required from the coke passing through the screen depends on the size of the coke aperture. For screen apertures of 25 mm square (31.5 mm round) and below, the material may be classified as class 4 and from the table it will be found that 16 increments are required. For larger screen apertures the coke should be classified as class 3.

[a] Class 1. Large or graded gas cokes from which breeze has been removed.

[b] Class 2. Large or graded oven cokes from which breeze has been removed.

[c] Class 3. Gas or oven cokes from which breeze has not been removed.

[d] Class 4. Breeze.

Appendix B Typical report

A typical report would display the following information.

General information and description of plant

1. Type of coal carbonized.
2. Type of carbonizing plant.
3. General description of coke screening plant.
   (a) Method of conveying and delivering coke to screen.
   (b) Mean height from feed point to screen.
   (c) Type of screens.
   (d) Number of decks or screening units.
   (e) Length, width and details of mesh in accordance with BS 1669 or other relevant standard. When mesh size is not covered by these standards full details should be given.
   (f) Nominal rating of screen motor or motors.
   (g) Number of hoppers and dimensions of each (height, breadth, width).
   (h) Description of anti-breakage device.
   (i) Type of debreezing screen.
   (j) Length, width and details of mesh in debreezing screen [see (e)].

NOTE A flow diagram of the plant should be attached.

4. Rated input (t/h).

5. Size of coke required at hopper outlet.

Grade A	*Grade B*	*Grade C*
. . . % above . . . mm	. . . % above . . . mm	. . . % above . . . mm
. . . % between . . . mm and . . . mm	. . . % between . . . mm and . . . mm	. . . % between . . . mm and . . . mm
. . . % below . . . mm	. . . % below . . . mm	. . . % below . . . mm

6. Maker's guaranteed tolerances.

(a) Range of rated input (t/h).

(b) Permissible range in size analysis of input coke.

Fraction	Permissible range	
	min.	max.
	%	%
Above . . . mm		
Between . . . mm and . . . mm		
Between . . . mm and . . . mm		
Below . . . mm		

Test data and report

7. Period over which test has been carried out (days).

8. Setting of screen for test, i.e. speed and amplitude of vibration, direction of throw, angle of inclination, etc.

9. Total time during which coke passed over screen (h).

10. (a) Mass of output coke grade A . . . . . t

(b) Mass of output coke grade B . . . . . t

(c) Mass of output coke grade C . . . . . t

(d) Total mass passing over screens (A + B + C, etc.) . . . . . t

11. (a) Average throughput to 1st screen . . . . . t/h

(b) Average throughput to 2nd screen . . . . . t/h

(c) Average throughput to 3rd screen . . . . . t/h

(d) Average throughput to plant . . . . . t/h

(e) Average throughput to plant as percentage of rated input . . . . . %

12. (a) Total number of particles removed from the screen mesh during test.

(b) Number of screen apertures.

(c) Percentage of screening area blind.

1st screen	2nd screen	3rd screen
(a)	(a)	(a) . . . .
(b)	(b)	(b) . . . .
(c)	(c)	(c) . . . .

13. Input sampling.

(a) Upper size of coke.

(b) Total mass of sample.

(c) Total number of increments.

(d) Description of sampling.

14. Output sampling.

	Grade A	*Grade B*	*Grade C*
(a) Total mass of sample	. . . . .	. . . . .	. . . . .
(b) Total number of increments	. . . . .	. . . . .	. . . . .
(c) Description of sampling	. . . . .	. . . . .	. . . . .

15. Average analysis of input coke.

(a) Moisture content (BS 1016-2) . . . . . %

(b) Shatter index (BS 1016-13)

(i) 38 mm . . . . . % (ii) 12.5 mm . . . . . %

or

(c) Micum test (BS 1016-13)

(i) M_{40} . . . . . % (ii) M_{10} . . . . . %

(d) Bulk density (BS 1016-13) . . . . . kg/m^3

16. Size analysis of input coke.

	Above . . . mm	**Between . . . mm and . . . mm**	**Between . . . mm and . . . mm**	**Between . . . mm and . . . mm**	**Below . . . mm**
As specified by purchaser, %					
Size analysis of input coke during test, %					

17. Performance of screen plant.

	Nominal size of coke at discharge				
	Above . . . mm	**Between . . . mm and . . . mm**	**Between . . . mm and . . . mm**	**Between . . . mm and . . . mm**	**Below . . . mm**
Aperture size of screen, mm					
(1) Total throughput in each grade, %					
Discharge joint number	1, 2, etc.	1, 2, etc.	1, 2, etc.	1, 2, etc.	1, 2, etc.
(2) Oversize in each grade, %					
(3) Undersize in each grade, %					
(4) Performance[a], %					

[a] See clause **4**.

18. General comments.

Appendix C Example of calculation of input data

This example shows a method of calculating input data when testing mobile screening plant fitted with 20 mm square apertures used for removing undersize material from coke of nominal size 20 mm to 50 mm.

Throughput

Mass of coke passing over screen + mass of sample removed = 10.15 t
Mass of coke passing through screen + mass of sample removed = 0.64 t
Total = 10.79 t

Time for test = 12.75 min

$$\text{Throughput} = 10.79 \times \frac{60}{12.75} \text{ t/h}$$

$$= 50.8 \text{ t/h}$$

Coke passing over screen as percentage of total

$$= \frac{10.15}{10.79} \times 100 = 94.1 \%$$

Coke passing through screen as percentage of total

$$= 5.9 \%$$

Size analysis

Size analysis of coke passing over screen:

Fraction, mm	%
Above 50	0.6
50 to 25	87.4
25 to 20	8.7
Below 20	3.3

The size analysis of the input coke is obtained by multiplying the above fractions by 94.1/100 and adding to the "below 20 mm" fraction the 5.9 % which has passed through the screen.

Fraction, mm		%
Above 50	0.6 × 0.941 = 0.6	0.6
50 to 25	87.4 × 0.941 = 82.2	82.2
25 to 20	8.7 × 0.941 = 8.2	8.2
Below 20	3.3 × 0.941 = 3.1 + 5.9 =	9.0
	94.1	100.0

Moisture

Moisture content of coke passing over screen = 7.0 %
Moisture content of coke passing through screen = 11.5 %
Moisture content of input coke: 7.0 × 94.1 = 658.7
11.5 × 5.9 = 67.9
726.6

$$\text{Moisture content} = \frac{726.6}{100} = 7.3 \%$$

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Publications referred to

BS 410, *Specification for test sieves.*
BS 1016, *Methods for the analysis and testing of coal and coke.*
BS 1016-2, *Total moisture of coke.*
BS 1016-13, *Tests special to coke.*
BS 1016-18, *Size analysis of coke.*
BS 1017, *Methods of sampling of coal and coke.*
BS 1017-2, *Sampling of coke.*
BS 1669, *Industrial perforated plates.*

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