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Hard coal — Size analysis by sieving

Houille — Analyse granulométrique par tamisage

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Foreword

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The committee responsible for this document is ISO/TC 27, *Solid mineral fuels*, Subcommittee SC 1, *Coal preparation: Terminology and performance*.

This third edition cancels and replaces the second edition (ISO 1953:1994), of which it constitutes a minor revision.

Introduction

Size analysis involves the separation of a sample of coal into size fractions having defined limits. In the methods described in this International Standard the results are expressed in terms of the percentage mass of coal remaining on sieves of different aperture sizes. This information can be of use in a number of applications, including the following: assessing the yields of products from run-of-mine coals; providing design data for coal preparation plants; checking that products from screening plants are within the required limits; assessing the performance of coal-crushing plants; and selecting coals for particular processes and equipment.

Hard coal — Size analysis by sieving

1 Scope

This International Standard specifies reference methods for the size analysis of coal by manual sieving (wet or dry), using test sieves of aperture sizes between 125 mm and 45 µm. A guide to sampling is given in Annex A.

This International Standard is applicable to all hard coals. It is not applicable to coke or other manufactured fuels.

In the case of pulverized coal which has been ground so that a high proportion passes through the test sieve of smallest aperture size, the methods described in this International Standard will determine only the percentage oversize.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1213-1, *Solid mineral fuels — Vocabulary — Part 1: Terms relating to coal preparation*

ISO 1213-2, *Solid mineral fuels — Vocabulary — Part 2: Terms relating to sampling, testing and analysis*

ISO 13909 (all parts), *Hard coal and coke — Mechanical sampling*

ISO 18283, *Hard coal and coke — Manual sampling*

ISO 3310-1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1213-1 and ISO 1213-2 apply.

4 Apparatus

4.1 For all methods

4.1.1 Test sieves, exclusively round-hole or exclusively square-hole, complying with ISO 3310-1 or ISO 3310-2, as appropriate.

The recommended series of test sieves for general purposes is 125 mm, 90 mm, 75 mm, 63 mm, 50 mm, 45 mm, 31,5 mm, 22,4 mm, 16 mm, 11,2 mm, 8 mm, 5,6 mm, 4 mm, 2 mm and 1 mm nominal aperture sizes, square-hole, or the same sizes of round-hole sieves. If this series is inadequate for the sizing of graded coals, sieves from the supplementary sizes 100 mm, 80 mm, 40 mm, 25 mm, 20 mm, 12,5 mm, 10 mm and 6,3 mm may be included. For samples greater than 125 mm, single square-hole gauges of the required dimensions may be used for the larger pieces. Test sieves of nominal aperture size 4 mm and less should be of metal wire cloth; the recommended series of nominal aperture sizes is 4 mm, 2,8 mm, 2 mm, 1,4 mm, 1 mm, 710 µm, 500 µm, 355 µm, 250 µm, 180 µm, 125 µm, 90 µm, 63 µm and 45 µm.

When a complete size analysis is required, it is preferable, subject to the range of sieve aperture sizes available, that the mass of coal in any size fraction does not exceed 30 % of the total mass of sample being sieved. The largest aperture size sieve should be that on which not more than 5 % mass fraction of the sample is retained and the smallest aperture size sieve should be that through which not more than 5 % mass fraction of the sample passes.

It is important to check the sieves from time to time, by the methods described in ISO 3310-1 and ISO 3310-2, to ensure that the aperture dimensions are within the specified tolerances. Worn or damaged sieves can give rise to serious errors in size analysis and should be discarded.

4.1.2 **Receivers**, for collecting material passing through the sieves.

4.1.3 **Weighing scale**, capable of measuring the mass of the sample to be sieved to the nearest 0,1 %.

4.1.4 **Trays**, smooth, of non-corrodible material, of at least 400 mm × 400 mm, depending on the mass of sample and number of analysis required.

4.1.5 **Watch-** or **clock-glasses**.

4.2 For dry sieving

4.2.1 **Lids**, to fit the test sieves.

4.2.2 **Flat brush**, for cleaning the sieves and for brushing dust from the trays.

4.2.3 **Hardwood block**, about 150 mm long with a 10 mm × 10 mm cross-section, for tapping the sieves.

4.2.4 **Shovel** or **scoop**.

4.2.5 **Vibratory sieve shaker for mechanical sieving**.

4.3 For wet sieving

4.3.1 **Pressure filter**.

4.3.2 **Buchner funnel** and **Buchner flask**.

4.3.3 **Filter paper**.

4.3.4 **Oven**, capable of being controlled to ± 5 °C in the range 30 °C to 110 °C.

5 Sampling of test sample

The sample shall be taken in accordance with ISO 13909 or ISO 18283, subject to the following provision:

a) the number of increments and the increment masses, for both manual and mechanical sampling, should comply with the requirements of ISO 13909 or ISO 18283.

   or

b) the minimum mass of the gross sample should comply with Table 1.

Table 1 — Minimum mass of sample for size analysis

Nominal top size of coal mm	Minimum mass for a precision of 1 % kg	Minimum mass for a precision of 2 % kg
300	54 000	13 500
200	16 000	4 000
150	6 750	1 700
125	4 000	1 000
90	1 500	400
75	950	250
63	500	125
50	280	70
45	200	50
38	130	30
31,5	65	15
22,4	25	6
16,0	8	2
11,2	3	0,70
10,0	2	0,50
8,0	1	0,25
5,6	0,50	0,25
4,0	0,25	0,25
2,8	0,25	0,25
2,0	0,25	0,25
1,0	0,25	0,25
< 0,5	0,25	0,25

Preparation of test sample

5.1 General

Drying is necessary if the coal is wet and dry sieving is to be performed. The gross sample may be divided if its mass greatly exceeds the value given in Table 1. If the gross sample is to be dried and divided, the division shall be carried out first whenever practicable. If no preparation is necessary, the test sample is the gross sample.

5.2 Drying

Air-dry the sample either at ambient temperature or at an elevated temperature not exceeding 40 °C. Cool, if necessary, and allow the moisture content to come to equilibrium with the laboratory atmosphere.

If caking or swelling tests are to be carried out subsequently on the sample, the drying temperature should not exceed 40 °C.

5.3 Division (other than wet coal of nominal top size less than 4 mm)

Divide the sample by means of a suitable mechanical sample divider or riffle avoiding size degradation and loss of dust. For sample that contains larger pieces of particle size greater than say 50 mm, where a suitable mechanical sample divider or riffle is not available, use either the flattened heap method,

the strip mixing and splitting method described in ISO 13909-4 and ISO 18283. Weigh all the coal not included as part of the test sample and retain it until all analyses and calculations are complete.

5.4 Division of wet coal of nominal top size less than 4 mm

Spread the gross sample on a clean flat surface, form into a cake 15 mm to 25 mm thick and extract a 2 kg sample by taking not less than 50 increments, evenly spread over the cake, using an appropriate sampling scoop and bump plate. If further division is necessary, air-dry the divided sample first, as described in 6.2 and then proceed as described in 6.3.

6 Procedure

6.1 General

The analysis shall be carried out by dry sieving (7.2) or by wet sieving (7.3).

In general, dry sieving is suitable for most types of coal but wet sieving should be used if particles tend to agglomerate.

NOTE 1 A combination of wet sieving (to remove fine material) and dry sieving can be appropriate and an example is given in Annex B.

NOTE 2 When sieving coals, wet sieving may produce different results compared to dry sieving because the coals may contain percentages of clay and/or shales which may be soluble in water.

The range of sieves used will depend on the type of coal and the purpose of the test. For example, a complete size analysis may be required for a run-of-mine coal or, in the simplest case, the amount of undersize in a graded product may be required. If the results are to be presented graphically, the range of sieves should comprise at least five different aperture sizes.

During sieving it may be convenient either to weigh separately each container with its size fraction and to subtract the mass of the empty container or to weigh one container with the fraction corresponding to the largest aperture size and to add successively all the other fractions, noting the cumulative mass after each addition. The first technique is preferred for samples having a maximum particle size of 4 mm, so that the end point of sieving may be checked. The second technique is normally used for samples containing pieces having a particle size greater than 4 mm. However, if a detailed analysis of the individual size fractions is required, it is essential to use the first technique.

A preliminary sieving on the smallest aperture size sieve is recommended when the sample contains a large proportion of very fine material.

6.2 Dry sieving

6.2.1 Sample of maximum particle size greater than 22,4 mm

The following procedure applies:

a) Weigh the sample to be sized to the nearest 0,1 % of the mass of the sample.

b) Position the 22,4 mm aperture size sieve (4.1.1) over an empty receiver (4.1.2) so that the free fall of coal passing through the sieve into the receiver does not exceed 150 mm.

c) Place the coal on the sieve and move the coal by hand. Hand place each piece of coal in turn and if in some position and without forcing, it passes through the sieve opening, it is designated as passing 22,4 mm. Alternatively a mechanical sieve shaker can be used to assist this process.

d) Re-sieve the oversize by hand placing from the 22,4 mm aperture size sieve, on the larger aperture size sieves in the set (4.1.1), starting with the largest aperture size and working down to the

smallest. Collect each size fraction in a weighed empty receiver and reweigh to obtain the mass of each individual fraction.

e) Sieve the undersize from the 22,4 mm aperture size sieve as described in 7.2.2 or 7.2.3.

NOTE "Hand placing" refers to the operation defined in ISO 1213-2.

6.2.2 Sample of maximum particle size between 4 mm and 22,4 mm—manual method

The following procedure applies:

a) Weigh the sample to the nearest 0,1 % of the mass of the sample.

b) Position the largest aperture size sieve in the set (4.1.1) over an empty receiver (4.1.2). Move the sieve horizontally to and fro, with the displacement not exceeding 100 mm in either direction, so as to cause the pieces of coal to tumble or roll on the sieve.

c) Continue the sieving motion until eight movements in each direction (a total of 16 movements) have taken place after the last undersize piece passes through the sieve. Avoid any impact when stopping the motion.

d) Place the coal remaining on the sieve in a weighed receiver and reweigh to obtain the mass of the size fraction.

e) Resieve the undersize by repeating the above process for each sieve down to and including the 4 mm aperture size sieve. If analysis of the undersize from the 4 mm aperture size sieve is required, proceed as described in 7.2.3.

NOTE When using square-hole sieves, the sides of the holes should be parallel to the direction of the sieving motion.

6.2.3 Sample of maximum particle size less than 4 mm—manual method

The following procedure applies:

a) Weigh the sample to the nearest 0,1 % of the mass of the sample.

b) Place the smallest aperture size sieve in the set (4.1.1) on a receiver (4.1.2), brush the sample onto the sieve, fit the lid (4.2.1) and sieve continuously for 5 min, as described in Item c) below, to remove the undersize. If the sample is large, sieve it as separate portions so that not more than 75 % of the area of the sieve is covered at the end of each sieving operation.

c) Hold the receiver, fitted with the sieve and its lid, in the left hand so that the surface of the sieve is inclined downwards towards the left at an angle of about 30° to the horizontal. Tap the higher side of the sieve frame six to eight times with the hardwood block (4.2.3). While maintaining the inclination of the sieve, shake the assembly to and fro several times, also rotating it in the plane of the sieving surface through an angle of approximately 60°.

d) Continue the operations of tapping and shaking alternately for 5 min.

e) At the end of the 5 min sieving period allow the suspended dust to settle for 2 min, carefully remove the lid and lift the sieve from the receiver. Invert the sieve over a tray (4.1.4) tap the side of the frame with the hardwood block and carefully brush the uppermost surface of the inverted sieve with the flat brush (4.2.2). Turn the sieve the right way up and add any loose particles dislodged during brushing to the oversize on the tray.

f) Invert the receiver over a second tray (4.1.4) tap the receiver with the hardwood block and brush out any adherent dust.

g) If fine dust is still visible in the oversize, replace the sieve on the receiver, transfer the oversize from the first tray to the sieve, replace the lid and re-sieve for a further 5 min. Separate the sieve

