

BS ISO 12900:2015



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Hard coal — Determination of abrasiveness

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National foreword

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Hard coal — Determination of abrasiveness

Houille — Détermination de l'abrasivité



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Foreword

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The committee responsible for this document is ISO/TC 27, *Solid mineral fuels*, Subcommittee SC 5, *Methods of analysis*.

This second edition cancels and replaces the first edition (ISO 12900:1997), of which it constitutes a minor revision.

Introduction

The abrasiveness of coal is recognized as a factor in coal operations, from mining to utilization, requiring a standard method of measurement and evaluation, as some coals are more abrasive than others.

The interaction between coal and conveying, storage, and crushing equipment results in component wear. In particular, higher contact pressures in some coal pulverizers result in significant wear.

For the ranking or relative comparison of the abrasiveness of coals, a test was developed^[1] which standardized the following equipment variables:

- a) test equipment dimensions and tolerances;
- b) speed of rotation of wearing components;
- c) properties of the wearing components;
- d) mass of the test portion;
- e) top particle size of the test portion;
- f) duration of the test.

The abrasiveness of coal is generally a function of two factors: the physical properties of the coal, in particular, moisture content, mineral content, and mineral characteristics;^{[1] [2] [3] [4] [5] [6]} the mechanics of the operations to which the coal is subjected.

NOTE Moisture contents over 10 % in the test sample after air-drying and laboratory equilibration might give anomalous results; the reason for this has not been established.

Wear on coal-pulverizing elements in industrial mills is influenced by the physical characteristics of the coal and its mineral constituents, the mechanical characteristics of the mill, including the milling pressures, alloy material properties and coal feed flow, and the operation of the mill. Abrasiveness as determined by this International Standard has been demonstrated to provide initial empirical estimates of specific wear rates in certain types of industrial tube-ball mills, vertical spindle mills, and high-speed hammer mills,^{[3] [6]} with different coefficients for each mill type.

Abrasiveness as determined by this International Standard might be of value in providing an initial estimate of the likely wear in other applications, giving the relative effect of different coals.

Hard coal — Determination of abrasiveness

1 Scope

This International Standard describes a method for determining the abrasiveness of hard coal.

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 589, *Hard coal — Determination of total moisture*

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

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 13909-2, *Hard coal and coke — Mechanical sampling — Part 2: Coal — Sampling from moving streams*

ISO 13909-3, *Hard coal and coke — Mechanical sampling — Part 3: Coal — Sampling from stationary lots*

ISO 13909-4, *Hard coal and coke — Mechanical sampling — Part 4: Coal — Preparation of test samples*

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

3 Principle

Four standard steel blades are rotated under specified conditions in a 2 kg mass of prepared coal in a test machine. The abrasiveness is calculated from the mass of steel lost during the test.

4 Apparatus

4.1 Abrasion test machine, comprising the following components:

4.1.1 Blades, of the following types:

- a) **A set of four reference blades**¹⁾, having a Vickers hardness of 160 ± 15 when tested in accordance with ISO 6507-1. When new, the blades, machined with the bar rolling direction parallel to the line of the bolt holes, from a bar of carbon steel, shall have the shape, dimensions, and surface finish shown in [Figure 1](#). To reduce the extent of varying hardness near the surface, care should be taken during machining to minimize surface distortion and heating of the blades. The blades shall be marked for identification.

A new set of blades shall be “run in” by carrying out a number of abrasiveness determinations on 2 kg test portions of the same coal until constant results (within the limits of repeatability, see [Clause 9](#)) are obtained.

When blades are not in use, they should be wrapped in a cloth containing a rust-preventive solution and stored in a desiccator. Immediately prior to use, the blades should be cleaned with a suitable solvent, e.g. methylated spirits, and allowed to air-dry in a desiccator.

1) Suitable blades are available from Mitsui Babcock Energy Ltd., Technology Centre, Renfrew, U.K.

The reference set of blades shall be discarded when any of the following conditions occurs:

- the wear on the leading edge or corners is greater than 3 mm;
- the blades cannot be correctly adjusted in the jig.

After a number of tests, the wearing surface of the blades might become rough, in which case each blade should be gently polished with a finegrained emery paper and reconditioned prior to further use.

Dimensions in millimetres

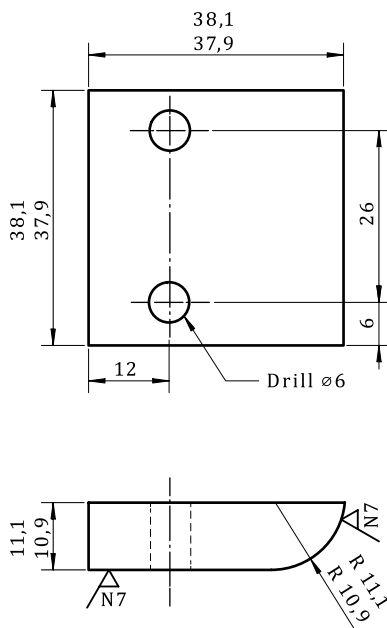


Figure 1 — Blades

- b) **A set of four working blades**, conforming to the requirements of 4.1.1 and checked successively against the reference blades when their original mass has decreased by 2 %, 3 %, 4 %, or more frequently if required.

The working set of blades shall be discarded when the results obtained on a sample using the working set differ, after a minimum of three determinations, by more than the limit of repeatability from the value obtained using the reference set.

After a number of tests, the wearing surface of the blades might become rough, in which case each blade should be gently polished with a finegrained emery paper and reconditioned prior to further use.

4.1.2 Mill mortar, having dimensions as shown in Figure 2 and fitted with a dust-tight cover. The lower sections of the walls may be recessed to accommodate a replaceable liner. Hardened metal or hard metal plate is recommended for the mill mortar (or liner if fitted). The mill mortar shall be discarded (or a new liner fitted) when the tolerance shown in Figure 2 is exceeded.

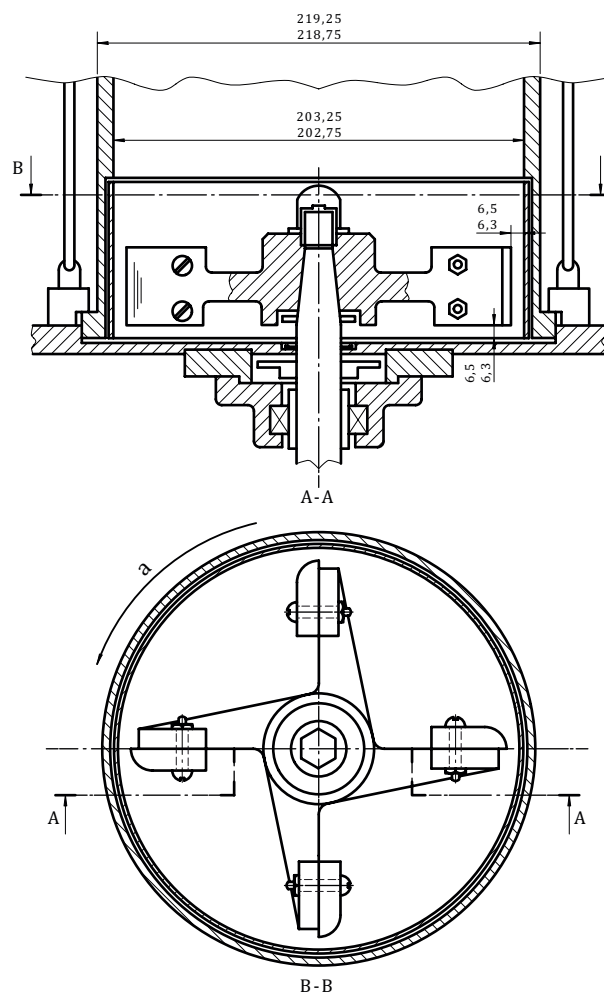
4.1.3 Quadrant, having four arms with elongated bolt holes for attachment and adjustment of the blades using round-head bolts, nuts, and spring washers. The quadrant shall be capable of being removed from the mill mortar (see [Figure 2](#)).

Some test machines have quadrants which are not removable. For these machines, the blades should be adjusted using suitable gauges so that the trailing and bottom edges are positioned $(6,4 \pm 0,1)$ mm from the wall and bottom of the mill mortar.

4.1.4 Drive, for driving the quadrant at $24,5 \text{ s}^{-1} \pm 0,5 \text{ s}^{-1}$ either directly or indirectly by a constant-speed electric motor. The shaft shall be fitted with a revolution counter and automatic cut-off switch.

NOTE A 2,5 kW motor is suitable. The drive can be above or below the mill mortar.

Dimensions in millimetres



Key

a Direction of rotation.

Figure 2 — Mill mortar and quadrant assembly

4.1.5 Jig, metal, (see [Figure 3](#)) to assist in attaching and adjusting the blades to the quadrant arms. The jig dimensions shall be such that, when the blades are secured on the quadrant arms so that they are touching the walls and bottom of the jig, they will have the correct clearances when the quadrant is replaced in the mill mortar. The clearance (6,3 mm to 6,5 mm) between the blades and the mill mortar shall be checked periodically using a limit gauge.

4.2 Balance, capable of weighing a mass of not less than 2 kg to within 1 g or better.

4.3 Balance, capable of weighing the blades to within 0,1 mg.

4.4 Jaw crusher, capable of reducing coal particles to less than 6,7 mm with minimum production of fines.

4.5 Test sieves, having apertures 6,7 mm, 16 mm, and 31,5 mm and conforming to the requirements of ISO 3310-1.

4.6 Fine brass brush, for cleaning blades.

5 Sample preparation

The test sample shall be of 6,7 mm nominal top size and shall have a fines content of not more than 30 % less than 1 mm.

The sample shall be taken in accordance with ISO 18283, ISO 13909-2, or ISO 13909-3 and be prepared in accordance with ISO 13909-4.

A suitable procedure, as shown in the flow diagram in [Figure 4](#), is as follows.

The sample is prepared to give 55 kg or more of material having a nominal top size of 31,5 mm. It is then air-dried.

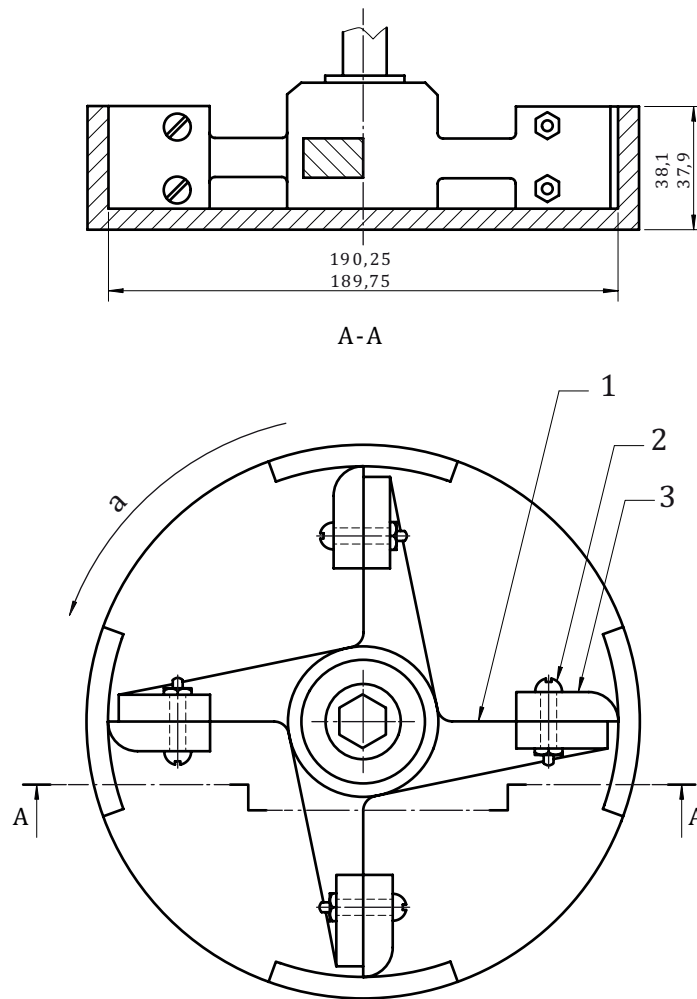
The air-dried sample is sieved using a 16 mm sieve. The fraction passing this sieve is set aside and the retained material is crushed (in one or more steps) to pass a 16 mm sieve.

If required, the sample of coal less than 16 mm may be divided, but to no less than 20 kg.

The sample is then sieved using a 6,7 mm sieve. The fraction passing this sieve is set aside and the retained material is crushed (in one or more steps) to pass a 6,7 mm sieve.

All the minus 6,7 mm coal is collected together and thoroughly mixed.

Dimensions in millimetres



Key

- 1 quadrant arm
- 2 retaining bolt
- 3 blades with curved edges
- a Direction of rotation.

Figure 3 — Jig and location of blades

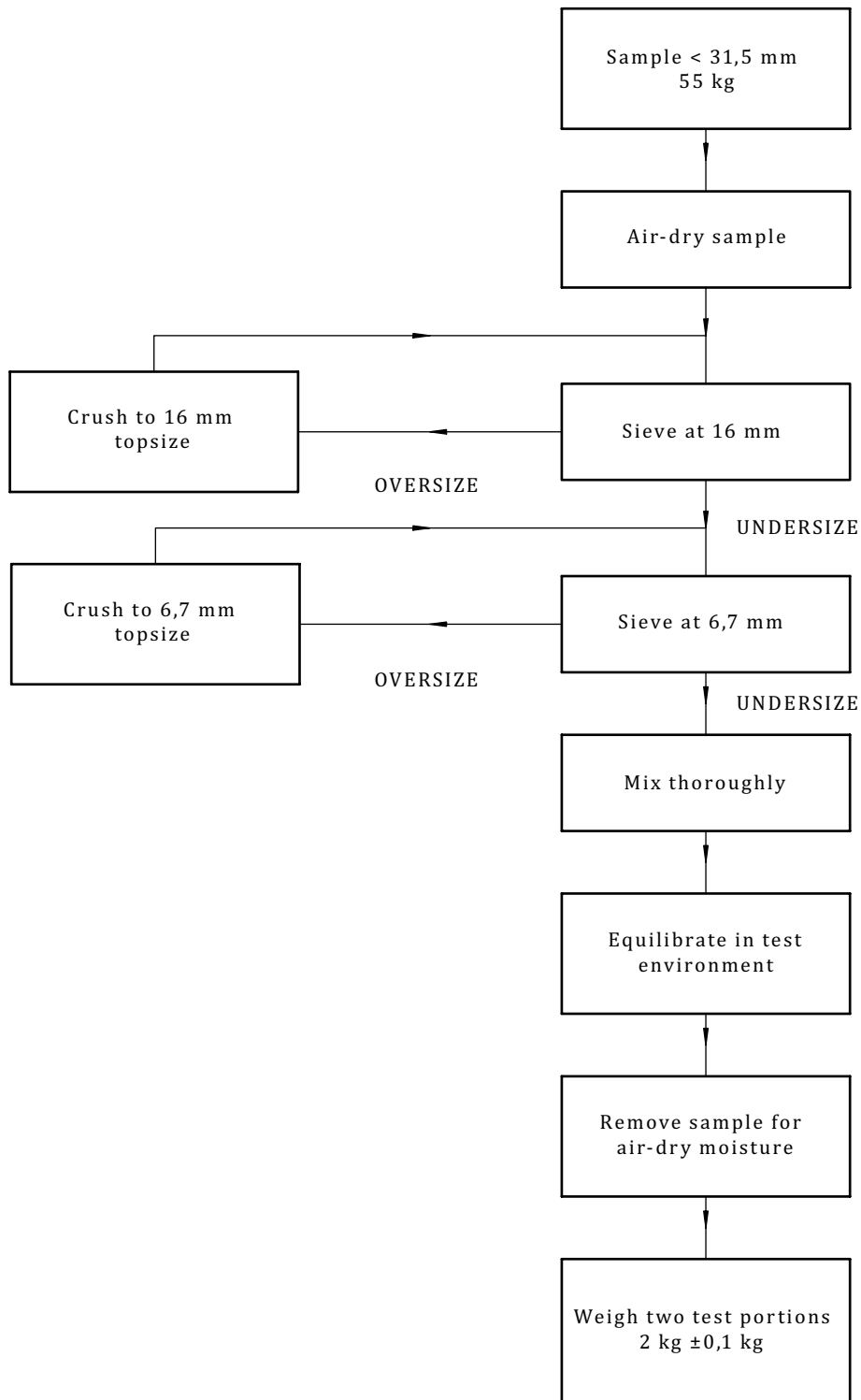


Figure 4 — Sample preparation: flow diagram

The sample is exposed in a thin layer for the minimum time necessary for the moisture content to reach equilibrium with the laboratory atmosphere.

6 Procedure

Inspect the mill mortar, quadrant arms, and blades and, if necessary, clean with a suitable solvent. Dry in a desiccator and weigh each blade to the nearest 0,1 mg.

NOTE 1 A suitable solvent is methylated spirits.

Position the quadrant in the jig. Attach the blades to the quadrant using roundhead bolts, nuts, and spring washers. Ensure that the blades are just touching the walls and bottom of the jig and that the blades are mounted with the curved edges facing the direction of rotation. Tighten the nuts securely and check the adjustment. If necessary, adjust the blades.

Weigh out a $1,5 \text{ kg} \pm 0,01 \text{ kg}$ sample and determine the total moisture content in accordance with ISO 589. Carry out the moisture determination concurrently with the abrasiveness determination.

Weigh out a $2 \text{ kg} \pm 0,1 \text{ kg}$ test portion. Place the quadrant and blades in the mill mortar. Place the 2 kg test portion in the mill mortar and level the surface.

Fit and secure the cover. Set the automatic counter, start the motor, and allow it to trip at a quadrant speed of $24,5 \text{ s}^{-1} \pm 0,5 \text{ s}^{-1}$.

Remove the cover and the coal from the mill mortar. Remove the quadrant assembly and check that the blades are correctly positioned by replacing the quadrant and blades in the jig. If the blades have moved, repeat the entire test procedure with fresh test portions of coal, ensuring that the blades are firmly secured.

Remove the blades, allow them to cool, and carefully clean them using the brass brush and a suitable solvent. Dry the blades and store in a desiccator until ambient temperature is reached. Re-weigh each blade to the nearest 0,1 mg.

NOTE 2 If the loss of mass of one blade repeatedly deviates by 20 % relative or more from the average loss of mass of all blades, the test should be discarded and the reason investigated.

Repeat the test using a duplicate test portion.

7 Calculation

The abrasiveness of the coal, A , in milligrams of metal lost per kilogram of coal, is calculated using Formula (1):

$$A = \frac{(m_1 - m_2) \times 10^3}{m_3} \quad (1)$$

where

m_1 is the total initial mass, in grams, of the four blades;

m_2 is the total final mass, in grams, of the four blades;

m_3 is the mass, in kilograms, of the test portion.

8 Reporting of results

Report the result as the mean of duplicate determinations to the nearest whole number.

9 Precision of the determination

The numerical values for repeatability and reproducibility should not exceed those given in [Table 1](#).

Table 1 — Precision data for the determination of the abrasiveness of hard coal

Abrasiveness observed	Repeatability <i>r</i>	Reproducibility <i>R</i>
≤20	2	See Note
>20	10 % of mean	See Note

NOTE As the test result is a function of the air-dried moisture in the test portion (among other factors), a value for reproducibility cannot be quoted. A series of international interlaboratory tests have failed to generate highly reproducible results for this test.

10 Test report

The test report shall contain the following information:

- a) identification of the sample;
- b) a reference to this International Standard and its year of publication, i.e. ISO 12900:2015;
- c) date of the test;
- d) the test result;
- e) the moisture content of the sample after air-drying and laboratory equilibration;
- f) any unusual features noted during the determination;
- g) any operation not included in this International Standard or regarded as optional.

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