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## Coke (greater than 20 mm in size) — Determination of mechanical strength

*Coke (dimension supérieure à 20 mm) — Détermination de la  
cohésion*

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ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*, Subcommittee SC 3, *Coke*.

This second edition cancels and replaces the first edition (ISO 556:1980), which has been technically revised. The main changes compared to the previous edition are as follows:

- a) The sample of coke used for Micum and Irsid tests may be analysed with a bottom size greater than 20 mm (e.g. 40 mm or 60 mm) and should the starting bottom size of coke used be different from 20 mm, it is to be stated in the test report.
- b) Addition of a new set of tables specifying:
  - 1) Sample, test conditions and results for Micum and Irsid tests.
  - 2) Dimensions of the cylindrical steel drum for Micum and Irsid tests.
  - 3) Suitable set of sieves.
- c) In reporting coke Micum and/or Irsid results, it is required to specify if a single determination or a duplicate determination was made and if a full or half Micum drum was used.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

# Coke (greater than 20 mm in size) — Determination of mechanical strength

## 1 Scope

This document specifies a method for the determination of the mechanical strength of coke having a particle size greater than 20 mm.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

ISO 13909-6, *Hard coal and coke — Mechanical sampling — Part 6: Coke — Preparation of test samples*

## 3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

## 4 Principle

A sample of coke greater than 20 mm in size (Micum and Irsid tests) and of known size distribution is subjected to mechanical stresses in a rotating drum. If desired, a sample of coke may also be analysed with a bottom size greater than 20 mm (e.g. 40 mm or 60 mm). Should the starting bottom size of coke used be different from 20 mm, it shall be stated in the test report.

The degree of breakdown of the coke is evaluated by a process of sieving and size analysis after 100 drum revolutions (Micum test) and, if desired, after a total of 500 drum revolutions (Irsid test). Micum and Irsid tests may be performed on the same coke sample.

[Table 1](#) lists sample and test conditions as well as results in conducting Micum, Irsid and half Micum/half Irsid tests.

**Table 1 — Sample, test conditions and results for Micum and Irsid tests**

| Indicator | Index    | Unit of measurement | Test Method   |               |                          |
|-----------|----------|---------------------|---------------|---------------|--------------------------|
|           |          |                     | Micum         | Irsid         | Half Micum or Half Irsid |
| Sample    | Size     | mm                  | >20, >40, >60 | >20, >40, >60 | >20, >40, >60            |
|           | Amount   | kg                  | 50 ± 0,5      | 50 ± 0,5      | 25 ± 0,25                |
|           | Moisture | %                   | <3            | <3            | <3                       |

**Table 1** (continued)

| Indicator | Index              | Unit of measurement | Test Method |            |                            |
|-----------|--------------------|---------------------|-------------|------------|----------------------------|
|           |                    |                     | Micum       | Irsid      | Half Micum or Half Irsid   |
| Test      | Revolutions        | no.                 | 100         | 500        | 100 (Micum) or 500 (Irsid) |
|           | Rotation Frequency | r/min               | $25 \pm 1$  | $25 \pm 1$ | $25 \pm 1$                 |
| Results   |                    | %                   | >40 mm      | >40 mm     | >40 mm                     |
|           |                    |                     | >20 mm      | >20 mm     | >20 mm                     |
|           |                    |                     | <10 mm      | <10 mm     | <10 mm                     |

NOTE Sieves of 10 mm, 20 mm, and 40 mm are mandatory. Other sieves with different apertures are optional (see Table 3).

## 5 Apparatus

**5.1 Cylindrical steel drum**, having the following dimensions (see Table 2 and Figure 1):

**Table 2 — Dimensions of cylindrical steel drum for Micum and Irsid tests**

| Indicator | Index              | Unit of measurement | Test Method               |                           |                           |
|-----------|--------------------|---------------------|---------------------------|---------------------------|---------------------------|
|           |                    |                     | Micum                     | Irsid                     | Half Micum or Half Irsid  |
| Apparatus | Inner Length       | mm                  | $1\ 000 \pm 5$            | $1\ 000 \pm 5$            | $500 \pm 5$               |
|           | Inner Diameter     | mm                  | $1\ 000 \pm 5$            | $1\ 000 \pm 5$            | $1\ 000 \pm 5$            |
|           | Thickness of drum  | mm                  | 6                         | 6                         | 6                         |
|           | Lifter             | no.                 | 4                         | 4                         | 4                         |
|           | Lifter Angle       | mm                  | $100 \times 50 \times 10$ | $100 \times 50 \times 10$ | $100 \times 50 \times 10$ |
|           | Opening width      | mm                  | 500                       | 500                       | 500                       |
|           | Opening length     | mm                  | 500 - 1 000               | 500 - 1 000               | 300 - 500                 |
|           | Rotation Frequency | r/min               | $25 \pm 1$                | $25 \pm 1$                | $25 \pm 1$                |

NOTE If lifter angles ( $100 \times 50 \times 10$ ) mm are not available, it is possible to use ( $100 \times 50 \times 8$ ) mm instead.

The drum shall have an opening on the cylindrical surface through which the coke is charged and discharged. The opening shall be fitted with a cover, the inner portion of which shall be of 10 mm steel plate of the same curvature as the drum, and which shall be of the same size as the opening so that when the cover is secured, the inside face is substantially level with the internal surface of the drum. A rubber gasket should be fitted around the cover to minimize loss of dust.

Inside the drum, parallel to its axis and dividing the wall into four equal areas, four angle sections (or lifting flights) shall be fixed. Each lifting flight (for dimensions see Table 2), equal in length to the length of the drum, shall be fixed rigidly to the full length of the internal curved surface of the drum. The position of the lifting flights is parallel to the axis of the drum in such a way that the flange of width 100 mm points towards the axis of the drum, and the narrower flange, in contact with the curved surface of the drum, points in the direction opposite to that of rotation of the drum.

Drum wall thickness and lifting flight thickness should be measured after every 500 tests to ensure conformity to specifications. The drum shall be replaced if the wall thickness falls below 5 mm due to wear. The angle sections (or lifting flights) shall be replaced when they wear to 95 mm.

The drum shall be carried on two stub-axes, at least 250 mm in length, rotating in horizontal journal bearings which are supported in a framework mounted at either side of the drum. The clearance

below the drum shall be not less than 230 mm and not more than 300 mm to enable the drum to be conveniently emptied. The drum shall be capable of being rotated in either direction to facilitate emptying. An electric motor shall be used to set the drum in motion at a constant rotational frequency of  $(25 \pm 1) \text{ min}^{-1}$  and the drum shall be fitted with a revolution counter and relay system, which may be pre-set to stop the drum after any desired number of revolutions.

**5.2 Tray**, >1 000 mm × >900 mm × 200 mm deep, constructed from a suitable abrasion-resistant and wear-resistant material for receiving the coke on discharge. One end wall of the tray shall be inclined outwards at 45° to facilitate emptying.

NOTE 1 Trays of approximately 1 500 mm × 1 100 mm × 200 mm deep were found to be suitable.

NOTE 2 1,22 mm galvanized sheet has been found suitable for the tray.

**5.3 Weighing machine**, preferably of the platform type, of maximum capacity 100 kg (50 kg for half Micum or half Irsid test) and such that the weighing error does not exceed 0,1 kg (0,05 kg for half Micum or half Irsid test).

**5.4 Round-hole test sieves**, comprising a series of perforated plates with circular apertures (ISO 3310-2) that will enable a complete size analysis of the coke under examination to be determined.

Test sieves with apertures of diameter 10 mm, 20 mm and 40 mm shall be included. Others in the series may be, for example, 31,5 mm, 60 mm, 80 mm and 100 mm.

It is important to check the sieves from time to time (e.g. after 500 sievings) using the methods described in ISO 3310-2, to ensure that the hole dimensions are within the specified tolerances. Worn or damaged sieves could give rise to serious errors in size analysis and shall be discarded.

**5.5 Series of light containers**, the largest of which shall be capable of holding 50 kg of coke (i.e. capacity of at least 0,12 m<sup>3</sup>) for the handling and collection of all different sieve fractions.

## 6 Sample preparation

A gross sample shall be taken consisting of approximately 100 kg of coke according to ISO 18283 or ISO 13909-6. The lower size limit shall be not less than 20 mm, but where the lower nominal size of the coke sample is greater than 20 mm, this lower nominal size may be used for the preparation of a Micum test portion (see 8.2). This sample shall be subjected to a size analysis according to ISO 728. In Table 3 a set of suitable sieves is given. Sieves of 10 mm, 20 mm, and 40 mm are mandatory for bottom sizes >40 mm, >20 mm and sievings after test. Other sieves are optional.

Table 3 — Suitable set of sieves

| Sieve<br>mm | Foundry coke <sup>a</sup> | Blast furnace coke (before the test) |                       |                       | Coke after the test |
|-------------|---------------------------|--------------------------------------|-----------------------|-----------------------|---------------------|
|             |                           | Bottom size<br>>60 mm                | Bottom size<br>>40 mm | Bottom size<br>>20 mm |                     |
| 150         | x                         |                                      |                       |                       | x <sup>b</sup>      |
| 120         | x                         | x <sup>b</sup>                       | x <sup>b</sup>        | x <sup>b</sup>        | x <sup>b</sup>      |
| 100         | x                         | x                                    | x                     | x                     | x                   |
| 80          | x                         | x                                    | x                     | x                     | x                   |
| 60 (63)     |                           | x                                    | x                     | x                     | x                   |

Sieve sizes in bold = mandatory for bottom sizes >40 mm, >20 mm, and all sievings after test.

<sup>a</sup> Depending on the bottom size.

<sup>b</sup> If necessary (desired).

Table 3 (continued)

| Sieve<br>mm                                                                                   | Foundry coke <sup>a</sup> | Blast furnace coke (before the test) |                       |                       | Coke after the test |
|-----------------------------------------------------------------------------------------------|---------------------------|--------------------------------------|-----------------------|-----------------------|---------------------|
|                                                                                               |                           | Bottom size<br>>60 mm                | Bottom size<br>>40 mm | Bottom size<br>>20 mm |                     |
| 31,5                                                                                          |                           |                                      | x                     | x                     |                     |
| <b>40</b>                                                                                     |                           |                                      | <b>x</b>              | <b>x</b>              | <b>x</b>            |
| <b>20</b>                                                                                     |                           |                                      |                       | <b>x</b>              | <b>x</b>            |
| <b>10</b>                                                                                     |                           |                                      |                       |                       | <b>x</b>            |
| Sieve sizes in bold = mandatory for bottom sizes >40 mm, >20 mm, and all sievings after test. |                           |                                      |                       |                       |                     |
| <sup>a</sup> Depending on the bottom size.                                                    |                           |                                      |                       |                       |                     |
| <sup>b</sup> If necessary (desired).                                                          |                           |                                      |                       |                       |                     |

If necessary, continue to filter the coke on sieves of larger aperture, e.g. 120 mm, 150 mm, until less than 5 % of the total mass of coke remains on the sieve of largest aperture.

For a full Micum and full Irsid test, each test portion shall consist of  $(50 \pm 0.5)$  kg of coke greater than 20 mm (or greater than 40 mm or 60 mm for a full Micum test) and shall contain the same proportion of coke within the individual size fractions as determined from the size analysis of the gross sample.

For a half Micum and half Irsid test, each test portion shall consist of  $(25 \pm 0.25)$  kg of coke greater than 20 mm (or greater than 40 mm or 60 mm for a half Micum test) and shall contain the same proportion of coke within the individual size fractions as determined from the size analysis of the gross sample (see 7.1).

The moisture content of the sample shall not exceed 3 %. If the moisture content of the sample exceeds 3 %, the coke shall be oven-dried.

If a sufficient amount of >20 mm coke (or >40 mm or >60 mm, Micum only) coke is produced from a carbonization test, duplicate determinations shall be made, each on a separate 50 kg test portion constituted from the gross sample (see 9.1.1). If an insufficient amount of >20 mm (or >40 mm or >60 mm, Micum only) coke is produced from a carbonization test, a single determination shall be made on a 25 kg test portion constituted from the gross sample (see 9.1.1). Micum and Irsid tests may be performed on the same coke sample.

Note that in reporting coke Micum and/or Irsid results, it shall be specified if a single determination or duplicate determination was made and if a full or half Micum drum was used.

## 7 Procedure

### 7.1 Test procedure

Specify which test will be executed (Micum, Irsid, half Micum, half Irsid, Micum and Irsid, or half Micum and half Irsid).

Table 4 lists conditions for conducting the tests.

Table 4 — Test conditions

| Indicator | Index  | Unit of measurement | Test method   |               |                          |
|-----------|--------|---------------------|---------------|---------------|--------------------------|
|           |        |                     | Micum         | Irsid         | Half Micum or Half Irsid |
| Sample    | Size   | mm                  | >20, >40, >60 | >20, >40, >60 | >20, >40, >60            |
|           | Amount | kg                  | $50 \pm 0,5$  | $50 \pm 0,5$  | $25 \pm 0,25$            |

Table 4 (continued)

| Indicator | Index       | Unit of measurement | Test method |       |                            |
|-----------|-------------|---------------------|-------------|-------|----------------------------|
|           |             |                     | Micum       | Irsid | Half Micum or Half Irsid   |
| Test      | Revolutions | no.                 | 100         | 500   | 100 (Micum) or 500 (Irsid) |

For each of the determinations to be made, prepare a test portion from the amount given in Table 4 and charge it into the clean and empty drum, taking care to avoid breakage of the coke during charging. Secure the cover to the opening on the drum. Rotate the drum at a constant rotational frequency of  $(25 \pm 1) \text{ min}^{-1}$  for the number of revolutions as given for the chosen test in Table 4. Allow the dust to settle for 1 min, remove the opening and empty all the contents of the drum into the tray.

Use the same set of test sieves as for the preparation of the sample, so that a full-size analysis from all contents of the tray will be obtained. In all cases, use at least the sieves of aperture diameter 10 mm, 20 mm and 40 mm. Cumulatively weigh the size fractions of 10 mm and above, noting the mass of each individual size fraction. Weigh separately the fraction of size less than 10 mm and add this fraction also to the cumulatively weighed fractions.

Micum and Irsid tests may be performed on the same coke sample. In this case the sample which is taken out after 100 revolutions, sieved into fractions and weighed shall be retained completely in the drum and treated with an additional 400 revolutions. Check the loss of the test portion after the Micum test is carried out. If it is larger than specified in 8.1, stop further testing. If this combined test (Micum and Irsid test) is executed, it shall be specified in the test report.

## 8 Expression of results

### 8.1 Calculation

Calculate the percent mass fraction for each cumulative mass (determined as specified in 7.1) in relation to the initial test portion mass [i.e. of  $(50 \pm 0,5) \text{ kg}$ , or of  $(25 \pm 0,25) \text{ kg}$ , as per specifications in Table 4].

Add the loss of mass to the weighed mass of the fraction of size less than 10 mm, provided that the following conditions apply:

- If the procedure specified in 7.1 starting with 50 kg of coke has been followed, the difference between the total of the masses of the individual fractions and the mass of the original test portion does not indicate a loss of more than 0,35 kg.
- If the procedure specified in 7.1 starting with 25 kg of coke has been followed, the difference between the total of the masses of the individual fractions and the mass of the original test portion does not indicate a loss of more than 0,15 kg.

Round off each percentage to the first decimal place.

### 8.2 Micum indices

If Micum tests are carried out on coke of a lower size limit different from 20 mm, report the lower size limit of the test portion.

Express the results of Micum indices as follows:

- Index  $M_{40}$  is the percentage of the test portion remaining on the 40 mm aperture test sieve after 100 drum revolutions.
- Index  $M_{20}$  is the percentage of the test portion remaining on the 20 mm aperture test sieve after 100 drum revolutions.

- c) Index  $M_{10}$  is the percentage of the test portion passing the 10 mm aperture test sieve after 100 revolutions. This is obtained from the mass of the fraction of size less than 10 mm to which is added the loss of mass, provided that this is not greater than 0,35 kg (50 kg starting coke mass) or 0,15 kg (25 kg starting coke mass) (see 8.1). This value is therefore the complement to 100 of the percentage of the test portion remaining on or over the 10 mm aperture test sieve.
- d) Other Micum indices may be reported but they are not covered by the precision statement in this document.

Round off the reported values of the Micum indices to the first decimal place. For each index, express as the result of a single determination or the arithmetic mean of the individual values obtained from the two determinations (see 9.1.1). An example of the mode of calculation and reporting the results is given in Annex A.

### 8.3 Irsid indices

Express the results as Irsid indices ( $I_{40}$ ,  $I_{20}$ ,  $I_{10}$ , etc.) in a manner similar to that described in 8.2, but using the percentages determined after 500 drum revolutions. Round off the reported values of the Irsid indices to the first decimal place.

For each index, express as the result of a single determination or the arithmetic mean of the individual values obtained from the two determinations (see 9.1.1). A similar type of report to that given in Annex A shall be used.

## 9 Precision of the method

### 9.1 Repeatability

The results of duplicate determinations, carried out in the same laboratory by the same operator with the same apparatus within a short interval of time on representative portions taken from the same gross sample, shall not differ by more than the values given in Table 5.

**Table 5 — Repeatability limit**

| $M_{40}$ | $M_{10}$ | $I_{40}$ | $I_{20}$ | $I_{10}$ |
|----------|----------|----------|----------|----------|
| 3,0      | 1,0      | 5,0      | 2,5      | 2,0      |

The repeatability limits in Table 5 apply to determinations carried out in either the Micum or half-Micum drum.

#### 9.1.1 Number of determinations

If an insufficient amount of >20 mm coke (or >40 mm, or >60 mm, Micum only) is produced from a carbonization test to perform more than one determination, a single determination is acceptable and shall be made on a 25 kg test portion constituted from the gross sample when doing a half Micum or half Irsid test. If a sufficient amount of >20 mm coke (or >40 mm or >60 mm, Micum only) is produced from a carbonization test, a duplicate determination shall be made, each on a separate 50 kg test portion constituted from the gross sample where doing a Micum or Irsid test.

If duplicate determinations are carried out, the figure reported shall be the mean of the results.

In reporting coke Micum and/or Irsid results, it shall be specified if a single determination or duplicate determination was made and if a full or half Micum drum was used.

## 9.2 Reproducibility

No tolerance is quoted for determinations carried out in different laboratories because the transport of a coke sample involves the risk of breakage and thus alteration of the size distribution and hence the resulting Micum and Irsid indices.

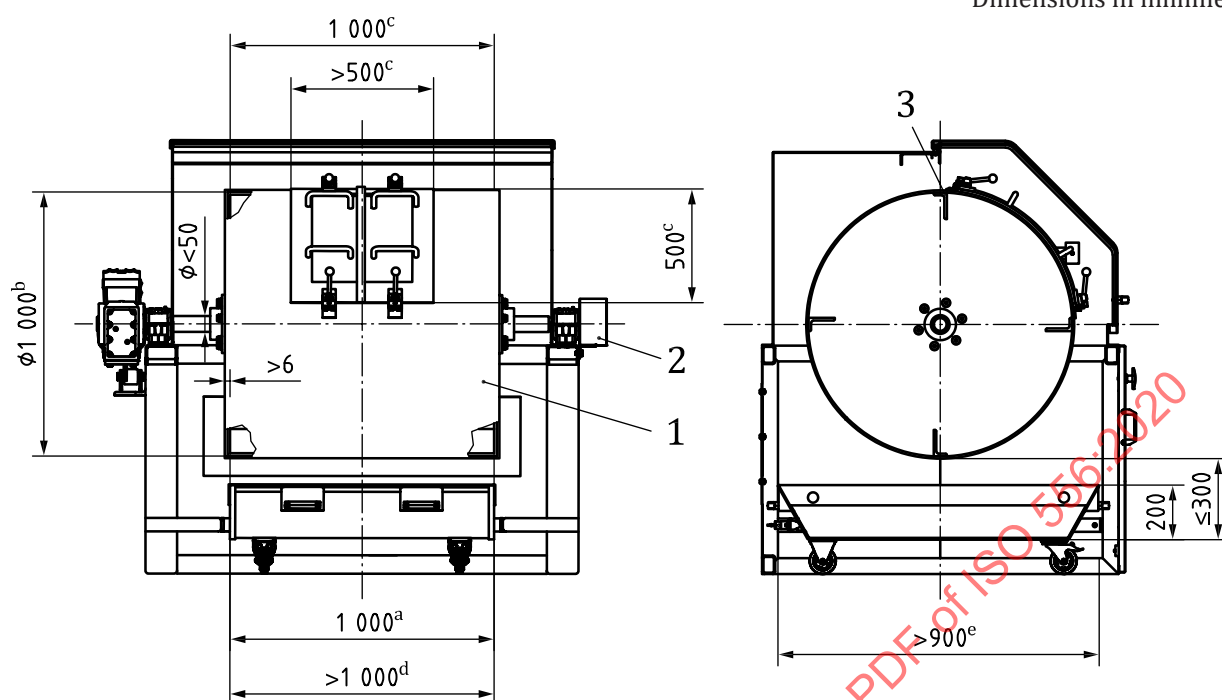
## 10 Test report

The test report shall include the following particulars:

- a) reference to this document, e.g. ISO 556:2020;
- b) identification of the sample tested;
- c) starting bottom size of coke;
- d) combination of Micum and Irsid tests (if any);
- e) results of the determination(s);
- f) any deviations from the procedure;
- g) any unusual features observed;
- h) the date of the test.

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Dimensions in millimetres

**Key**

- 1 drum
- 2 revolution counter
- 3 angle sections (100 × 50 × 10) mm
- a Internal drum length.
- b Internal drum diameter.
- c Drum opening.
- d Width of receiving tray.
- e Length of receiving tray.

**Figure 1 — Full Micum/Irsid drum**