
International Standard



556

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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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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 556 was developed by Technical Committee ISO/TC 27, *Solid mineral fuels*, and was circulated to the member bodies in August 1979.

It has been approved by the member bodies of the following countries :

Australia	France	South Africa, Rep. of
Austria	Germany, F. R.	Spain
Belgium	Hungary	Turkey
Canada	India	United Kingdom
Chile	Japan	USA
China	Netherlands	USSR
Egypt, Arab Rep. of	Poland	

No member body expressed disapproval of the document.

This International Standard cancels and replaces ISO Recommendation R 556-1967 and International Standard ISO 1881-1973, of which it constitutes a technical revision.

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

1 Scope and field of application

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

2 References

ISO 728, *Coke size analysis (nominal top size greater than 20 mm)*.

ISO 565, *Test sieves – Woven metal wire cloth and perforated plate – Nominal sizes of apertures*.

3 Principle

A sample of coke greater than 20 mm in size and of known size distribution is subjected to mechanical stresses in a rotating drum. 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 500 drum revolutions (Irsid test).

4 Apparatus

4.1 Cylindrical steel drum, having the following dimensions (see the figure) :

Length 1 000 ± 5 mm

Diameter 1 000 ± 5 mm

Minimum thickness 5 mm

The drum shall be replaced if the thickness falls below 5,0 mm due to wear. Inside the drum, parallel to its axis and dividing the wall into four equal areas, shall be fixed four angle sections (or lifting flights). Each lifting flight, equal in length to the length of the drum and constructed of 100 mm × 50 mm × 10 mm thick mild steel angle, shall be fixed rigidly to the full length of the internal curved surface of the drum, 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. 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 sup-

ported 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 by hand in either direction to facilitate emptying. Suitable mechanical means shall be available 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 can be pre-set to stop the drum after any desired number of revolutions.

The drum shall have an opening on the cylindrical surface through which the coke may be charged and discharged. The opening shall be at least 600 mm long and 500 mm wide to facilitate cleaning and emptying. The opening shall be fitted with a cover, the inner portion of which shall be of 10 mm mild 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 may with advantage be fitted around the cover to minimize loss of dust.

4.2 Tray, approximately 1 500 mm × 1 100 mm and 200 mm deep, constructed from a suitable abrasion- and wear-resistant material (1,22 mm galvanized sheet has been found suitable), for receiving the coke on discharge. One end wall of the tray shall be inclined outwards at 45° to facilitate emptying.

4.3 Weighing machine, preferably of the platform type, of maximum capacity 100 kg and such that the weighing error does not exceed 0,1 kg.

4.4 Round-hole test sieves, comprising a series of perforated plates with circular apertures that will enable a complete size analysis of the coke under examination to be determined.

Test sieves with apertures of diameter 10, 20 and 40 mm shall be included. Others in the series may be (for example) 31,5, 63, 80 and 100 mm. When wear causes the diameter of any of the apertures to exceed its nominal diameter by more than 2 %, the aperture shall be blanked off or the test sieve shall be replaced. Not more than 25 % of the available apertures of any of the test sieves shall be blanked off.

4.5 Series of light containers, the largest of which is capable of holding 50 kg of coke (i.e. capacity of at least 0,12 m³).

5 Sampling

A gross sample shall be taken consisting of at least 200 kg of coke. 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 7.2). This sample shall be subjected to a size analysis according to ISO 728. It is recommended that the coke should be separated into the following fractions :

- a) 20 mm to 31,5 mm
- b) 31,5 mm to 40 mm
- c) 40 mm to 63 mm
- d) 63 mm to 80 mm
- e) 80 mm to 100 mm
- f) greater than 100 mm

If necessary continue to size 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.

Each test portion shall consist of $50 \pm 0,5$ kg of coke greater than 20 mm and shall contain the same proportion of coke within the individual size fractions as determined from the size analysis of the gross sample.

A nomogram may be used for this calculation. 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.

Duplicate determinations shall be made, each on a separate 50 kg test portion constituted from the gross sample, (but see 8.1.2).

6 Procedure

6.1 Micum test (100 revolutions)

6.1.1 Test procedure

For each of the determinations to be made, prepare a test portion consisting of $50 \pm 0,5$ kg of coke taken as described in clause 5 and charge it into the clean and empty drum, taking care to avoid breakage of the coke during charging. Secure the cover on the drum. Rotate the drum at a constant rotational frequency of $25 \pm 1 \text{ min}^{-1}$ for 100 rev. Allow the dust to settle for 1 min, remove the door and empty the contents of the drum into the tray. Using the appropriate test sieves so that a full size analysis is obtained, sieve all the contents of the tray using hand-placing or mechanical sieving. If the test portion is to be sieved by mechanical sieving, ascertain first that this procedure gives results that are not biased with respect to those obtained by the normal method of hand-placing. In all cases, use the sieves of aperture diameter 10, 20 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.

6.1.2 Validity of results

For the results to be valid, the total mass of the size fractions (see 6.1.1) shall not differ from the original mass of the test portion by more than 0,35 kg. If, through loss of material or errors, the total mass lies outside these limits, the result of the determination shall be rejected.

6.2 Irsid test (500 revolutions)

6.2.1 Test procedure

Carefully return all the size fractions of coke to the drum, replace the door and rotate the drum at a rotational frequency of $25 \pm 1 \text{ min}^{-1}$ for a further 400 rev. Repeat the sieving process and the weighing of the size fractions as described in 6.1, using the appropriate sieves and in all cases the sieves of 10, 20 and 40 mm aperture diameter.

6.3 Special test using a half-Micum drum and 25 kg of coke

6.3.1 Introduction

There is considerable experimental evidence available to show that the mechanical strength of coke can be determined with a precision equal to that obtained in the larger drum (using 50 kg of coke, as described in 6.1 and 6.2) by using a drum 500 mm in length and 1 000 mm in diameter and a test portion of 25 kg. There is no bias between the results obtained under the two different test conditions. The necessary modifications to the procedure are described in 6.3.2, 6.3.3 and 6.3.4.

6.3.2 Apparatus

The apparatus shall be as described in clause 4, except for the following differences :

- a) **Cylindrical steel drum.** The length of the drum shall be 500 ± 5 mm.
- b) **Weighing machine.** The weighing machine shall have a maximum capacity of 50 kg and the weighing error shall not exceed 0,05 kg.

6.3.3 Sampling

Proceed as described in clause 5, but prepare test portions of mass $25 \pm 0,25$ kg.

6.3.4 Test procedure

Proceed as described in 6.1 and 6.2, but with the following modifications :

- a) **Test portion.** Use a test portion of $25 \pm 0,25$ kg.
- b) **Validity.** For the result to be valid, the total mass of the size fractions after the first 100 rev (see 6.1.2) shall not differ from the original mass of the test portion by more than 0,15 kg. If the total mass lies outside these limits, the results of the determination shall be rejected.

7 Expression of results

7.1 Calculation

Express each cumulative mass (determined as described in 6.1.1) as a percentage of the initial test portion mass (i.e. of $50 \pm 0,5$ kg, or of $25 \pm 0,25$ kg if the modified procedure described in 6.3 has been followed).

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 described in 6.1 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 modified procedure described in 6.3 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.

7.2 Micum indices

If Micum tests are carried out on coke of lower size limit greater than the lowest of 20 mm, report the lower size limit of the test portion.

Express the results of Micum indices as follows :

- Index M_{40} .** The percentage of the test portion remaining on or over the 40 mm aperture test sieve after 100 drum revolutions.
- Index M_{20} .** The percentage of the test portion remaining on or over the 20 mm aperture test sieve after 100 drum revolutions.
- Index M_{10} .** 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 allowed in 6.1.2 or 6.3.4 b) (see 7.1). 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.
- Other Micum indices.** Proceed similarly for other Micum indices, e.g. M_{30} (corresponding to the 31,5 mm aperture test sieve), M_{60} (corresponding to the 63 mm aperture test sieve), M_{80} , M_{100} .

Round off the reported values of the Micum indices to the first decimal place. For each index, express as the result the arithmetic mean of the individual values obtained from the two, three or four determinations (see 8.1.2). An example of the mode of calculation and reporting the results is given in the annex.

7.3 Irsid indices

Express the results as Irsid indices (I_{40} , I_{30} , I_{20} , I_{10} , etc.) in a manner similar to that described in 7.2, 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 the arithmetic mean of the individual values obtained from the two, three or four determinations (see 8.1.2). A similar type of report to that given in the annex shall be used.

8 Precision of the method

8.1 In the same laboratory

8.1.1 Repeatability

The range of the results relating to 95 % probability carried out within the same laboratory are given in the following table for two, three and four tests (see 8.1.2).

Number of determinations	95 % tolerance limits for				
	M_{40}	M_{10}	I_{40}	I_{20}	I_{10}
2	3,0	1,0	5,0	2,5	2,0
3	3,6	1,2	6,0	3,0	2,4
4	4,0	1,3	6,6	3,3	2,6

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

8.1.2 Number of determinations

Two, three or four determinations shall be made, each on a separate 50 kg test portion constituted from the gross sample (see clause 5).

Duplicate determinations shall be carried out, and both results shall be accepted, unless the difference between the results exceeds the tolerance limit appropriate to two determinations (see 8.1.1), in which case a further determination shall be carried out.

If the spread of the three results does not exceed the tolerance limit for three determinations (see 8.1.1), all three may be accepted, otherwise a fourth determination shall be carried out.

If the spread of the four results is not greater than the tolerance limit for four determinations (see 8.1.1), all may be accepted.

If the spread exceeds this value and three of the four results lie within the limits for three determinations, these three may be accepted and the fourth rejected.

If neither of these conditions apply, the four results shall be accepted, but a special investigation should be made into all aspects of the sampling, apparatus and testing.

The figure finally reported shall be the mean of all the accepted results.

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

8.2 In different laboratories

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 the Micum indices.

Dimensions in millimetres

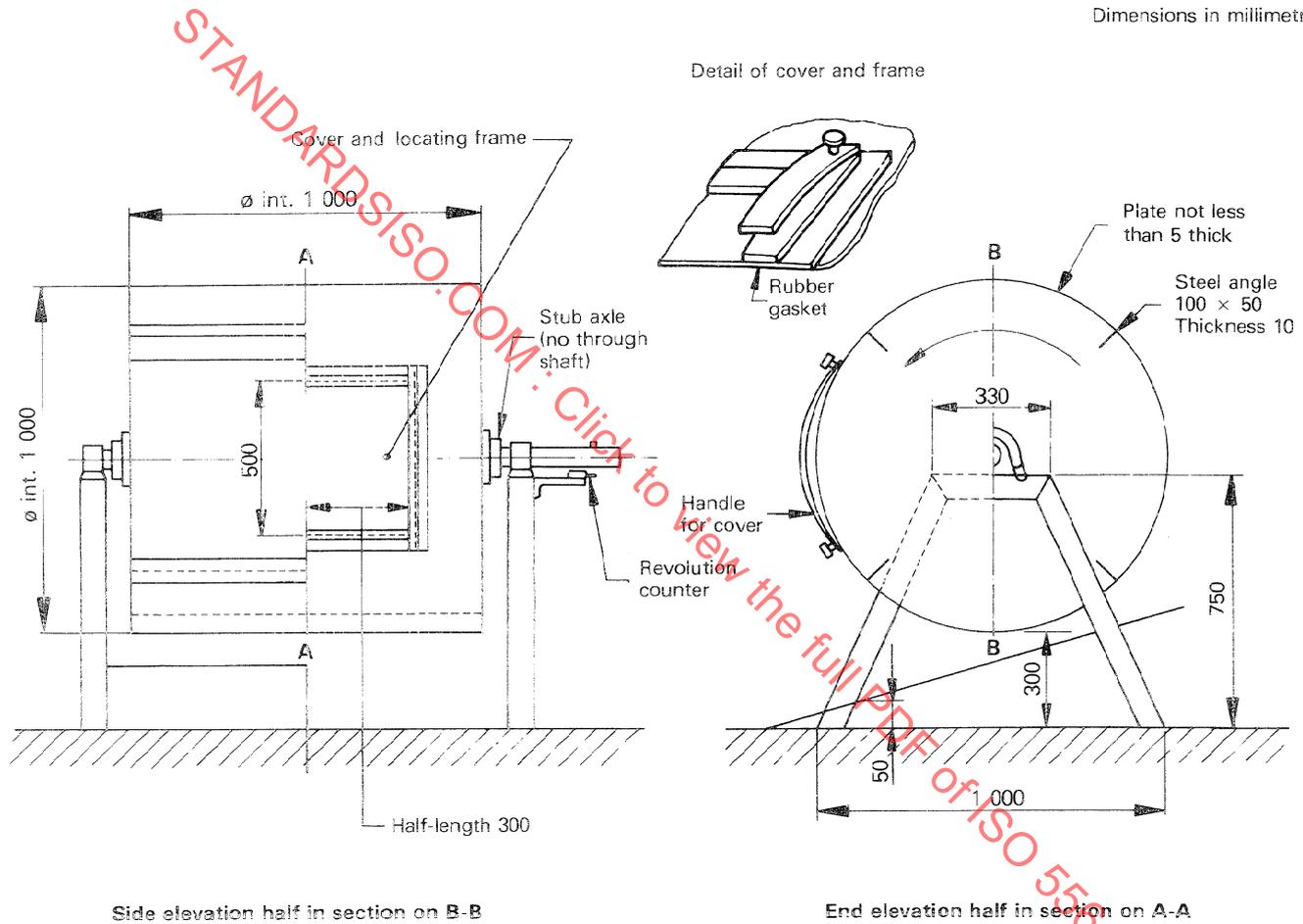


Figure — Micum drum