
**Carbonaceous materials for the
production of aluminium —
Cathode blocks and baked anodes
— Determination of compressive
strength**

Produits carbonés utilisés pour la production de l'aluminium — Blocs cathodiques et anodes cuites — Détermination de la résistance à la compression



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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).

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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 226.

This second edition cancels and replaces the first edition (ISO 18515:2007), of which it constitutes a minor revision.

Carbonaceous materials for the production of aluminium — Cathode blocks and baked anodes — Determination of compressive strength

1 Scope

This International Standard specifies a method to determine the compressive strength of solid carbon and graphite materials at room temperature.

NOTE ISO 18515 is based on DIN 51910.

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 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 8007-1, *Carbonaceous materials used in the production of aluminium — Sampling plans and sampling from individual units — Part 1: Cathode blocks*

ISO 8007-2, *Carbonaceous materials used in the production of aluminium — Sampling plans and sampling from individual units — Part 2: Prebaked anodes*

ISO 8007-3, *Carbonaceous materials used in the production of aluminium — Sampling plans and sampling from individual units — Part 3: Sidewall blocks*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 compressive strength

σ_{dB}

ratio of the maximum force ($F_{\max}$) during a compressive experiment leading to fracture and the initial cross-section, A , of the specimen

Note 1 to entry: The compressive strength is calculated as the quotient of the maximum force at fracture of the specimen under the conditions of the compressive strength method.

$$\sigma_{dB} = \frac{F_{\max}}{A}$$

where

$F_{\max}$ is the maximum force in newton;

A is the initial cross-section, in meter squared.

Note 2 to entry: The compressive strength is expressed in Mega Pascal (MPa).

Note 3 to entry: Generally, the maximum force displayed on the test machine and the force at fracture is similar, if they are different, the term refers to the maximum force displayed.

4 Principle

The compressive strength is determined using cylindrical or cubic test specimens. A test specimen with plane parallel end planes is pressed between the pressure plates of a testing machine. The compressive strength is calculated from the maximum force and the initial cross-section of the test specimen.

5 Apparatus

5.1 Compression-testing machine, which meets at least the demands of class 2, in accordance with ISO 7500-1.

5.2 Measuring device, with two pressure plates.

The device shall ensure a uniform load over the surface by cardanic suspension.

5.3 Measuring device (e.g. vernier calliper, in accordance with ISO 13385-1), capable of measuring the linear dimensions of the test specimens with an accuracy of $\pm 0,5$.

6 Test specimen

6.1 Sampling and sample preparation

Sampling shall be in accordance with the appropriate method, i.e. ISO 8007-1, ISO 8007-2, ISO 8007-3, or be agreed with the applicant. The number of specimens shall be defined with respect to the homogeneity of the material to be tested.

6.2 Size geometry

Cylindrical cubic test specimens of any size can be used, subject only to the requirement that the smallest dimension shall be at least three times the diameter of the largest structural constituent (e.g. maximum grain size) of the material to be tested, but not smaller than 5 mm. When cylindrical test specimens are used, their height shall be equal to the diameter (isometrical cylinders). Similarly, when using hollow cylinders, the height shall be equal to the outer diameter.

7 Procedure

7.1 Perform all measurements at room temperature, i.e. in the range 10 °C to 35 °C.

7.2 Choose the measuring range of the testing machine, such that the expected maximum force is at least 1/10 of full scale. Centre the test specimen on the support.

Increase the force uniformly and shock-free at a rate (velocity of the force bearing) of about 5 mm/min until the test specimen fractures. Determine the maximum force.

8 Calculation and expression of results

The compressive strength, σ_{dB} , expressed in MPa, is calculated according to Formula (1):

$$\sigma_{dB} = \frac{F}{A} \quad (1)$$

where

F is the maximum force, expressed in N;

A is the initial cross-section, expressed in mm².

9 Precision

A round robin was carried out with participants from 10 laboratories who submitted results for two materials, with four parallels for each. The precision calculation is according to document ISO/TC 226 N 1515.

The precision is given at the 95 % confidence level.

Repeatability, $r = 5,7$ MPa.

Reproducibility, $R = 9,8$ MPa (between laboratories).

NOTE The test samples had similar material averages and it was not possible to determine the dependence on the material average.

Repeatability: Given a number of anodes, all with a compression strength of 42,0 MPa, measured by the same operator in the same laboratory, the difference between two measurements will be within the range 42,0 MPa $\pm$ 5,7 MPa in 95 out of 100 instances.

Reproducibility: Given a number of anodes, all with a compression strength of 42,0 MPa, measured by different laboratories, the difference between two measurements will be within the range 42,0 MPa $\pm$ 9,8 MPa in 95 out of 100 instances.

10 Test report

The test report shall contain the following information:

- a) a reference to this International Standard, (i.e. ISO 18515:2014);
- b) type, position, and orientation of test specimens during the sampling procedure;
- c) designation of the test specimens;
- d) number of test specimens;
- e) linear dimensions of test specimens, in millimetres;
- f) compressive strength, σ_{dB} , in MPa, rounded to the nearest 0,1 MPa, individual values and mean value;
- g) additionally agreed conditions deviating from this International Standard;
- h) test date.

Bibliography

- [1] ISO 13385-1, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 1: Callipers; Design and metrological characteristics*
- [1] DIN 51910, *Testing of carbonaceous materials — Determination of compressive strength — Solid materials*

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