
**Carbonaceous materials used in the
production of aluminium — Baked
anodes and cathode blocks —**

Part 2:
**Determination of apparent density
and of open porosity using a
hydrostatic method**

*Produits carbonés utilisés pour la production de l'aluminium —
Anodes cuites et blocs cathodiques —*

*Partie 2: Détermination de la masse volumique apparente et de la
porosité ouverte par une méthode hydrostatique*





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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).

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

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 226, *Materials for the production of primary aluminium*.

This second edition cancels and replaces the first edition, ISO 12985-2:2000, of which it constitutes a minor revision.

A list of all parts in the ISO 12985 series can be found on the ISO website.

Carbonaceous materials used in the production of aluminium — Baked anodes and cathode blocks —

Part 2: Determination of apparent density and of open porosity using a hydrostatic method

1 Scope

This document specifies a hydrostatic method for the determination of the apparent density and the open (to water) porosity of carbonaceous products used in the production of aluminium.

This hydrostatic method was developed principally to determine the open porosity but can also be used to measure the apparent density. This document is especially applicable to samples of complex or irregular geometry (due to drilling difficulties).

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 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*

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

The apparent density of a material is defined as the ratio of its dry mass to its volume. The volume is determined by the measurement of the Archimedes force (the mass of the displaced liquid) applied to the sample saturated with water after boiling. The open porosity is simply measured by calculating the ratio of the mass (volume) of water which has penetrated into the sample after boiling to the mass (volume) of the displaced water measured with the hydrostatic balance.

5 Reagents

5.1 Distilled water, or water of equivalent purity.

6 Apparatus

6.1 Heating plates, to hold a beaker containing the samples for boiling.

6.2 Beaker, with a height 2 to 2,5 times the height of the samples.

6.3 Thermometer, for measuring room temperature with a range of 10 °C to 40 °C, and capable of measuring to the nearest 0,5 °C.

6.4 Hydrostatic balance (one plate), capable of measuring to the nearest 0,1 % of the measured mass, for example $\pm 0,1$ g for mass of 100 g.

6.5 Drying cabinet, capable of maintaining a temperature of 110 °C.

7 Sampling

Sample the cathode blocks and baked anodes in accordance with ISO 8007-1 and ISO 8007-2, respectively. Remove any dust or loosely attached pieces which are likely to break off during the test.

To ensure that the sample is mechanically stable during the test, it should not exceed 100 mm in any dimension.

To ensure that the precision given in [Clause 9](#) is achieved, a sample volume of approximately 100 cm³ is necessary.

8 Procedure

8.1 Determination of dry sample mass

Dry the test specimen at (110 ± 5) °C until constant mass is reached for a minimum of 2 h or until consecutive weightings at 5 min intervals differ by less than 0,1 %. Cool to room temperature in a desiccator and weigh the mass (m_1) of the test specimen to the nearest 0,1 g, if the mass is greater than 100 g, or to the nearest 0,01 g if the mass is 100 g or less.

8.2 Determination of the volume

Place the sample in the beaker ([6.2](#)) and fill it with water until the test specimen is covered by 50 mm of water above the top of the test specimen. Place a glass cover on the beaker. Heat the beaker rapidly and allow the water to boil for 1 h. Refill, if necessary, to replace evaporated water then cool to room temperature (20 ± 2) °C.

After placing the hydrostatic balance on the water bath, hang the basket on the balance hook by a wire. Immerse the basket completely. Adjust the balance to zero and put the test specimen in the basket.

Immerse the test specimen completely and read the mass (m_2) over the balance with the same precision as defined in [8.1](#).

Take the test specimen out of the basket, blot it with a moistened sponge and weigh it rapidly (m_3).

9 Calculation

The apparent density ρ_a , expressed in grams per cubic centimetre, is given by Formula (1)

$$\rho_a = \frac{m_1}{m_3 - m_2} \times \rho_w \quad (1)$$

and the open porosity accessible by the water ε_w , expressed as a percentage by mass, is given by Formula (2)

$$\varepsilon_w = \frac{m_3 - m_1}{m_3 - m_2} \times 100 \quad (2)$$

where

m_1 is the dry mass, expressed in grams;

m_2 is the immersed mass, expressed in grams;

m_3 is the mass, expressed in grams, after saturation by boiling;

ρ_w is the density of water, expressed in grams per cubic centimetre, at the actual temperature.

Report the results to the third decimal place.

10 Precision

10.1 Apparent density

10.1.1 Repeatability

The difference between the values of duplicate determinations, carried out in rapid succession by the same operator using the same apparatus on the same test sample, shall not exceed the repeatability limit, r , as follows:

$$r = 0,003 \text{ g/cm}^3$$

10.1.2 Reproducibility

The difference between the values of the average of duplicate determinations obtained by two laboratories using this method for the analysis of the same laboratory sample is not expected to exceed the reproducibility limit, R , as follows:

$$R = 0,008 \text{ g/cm}^3$$

10.2 Open porosity

10.2.1 Repeatability

The difference between the values of duplicate determinations, carried out in rapid succession by the same operator using the same apparatus on the same test sample, shall not exceed the repeatability limit, r , as follows:

$$r = 0,3 \%$$

10.2.2 Reproducibility

The difference between the values of the average of duplicate determinations obtained by two laboratories using this method for the analysis of the same laboratory sample is not expected to exceed the reproducibility limit, *R*, as follows:

$$R = 0,5 \%$$

11 Test report

The test report shall include the following information:

- a) an identification of the sample;
- b) the International Standard used (including its year of publication);
- c) the method used (if the standard includes several);
- d) the date of the test;
- e) the result(s), including a reference to the clause which explains how the results were calculated;
- f) any deviations from the procedure;
- g) any unusual features observed.

Bibliography

- [1] ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*
- [2] ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*
- [3] ISO 5725-3, *Accuracy (trueness and precision) of measurement methods and results — Part 3: Intermediate measures of the precision of a standard measurement method*
- [4] ISO 5725-4, *Accuracy (trueness and precision) of measurement methods and results — Part 4: Basic methods for the determination of the trueness of a standard measurement method*
- [5] ISO 5725-5, *Accuracy (trueness and precision) of measurement methods and results — Part 5: Alternative methods for the determination of the precision of a standard measurement method*
- [6] ISO 5725-6, *Accuracy (trueness and precision) of measurement methods and results — Part 6: Use in practice of accuracy values*

