INTERNATIONAL STANDARD

ISO 12985-2

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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

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 12985 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 12985-2 was prepared by Technical Committee ISO/TC 47, *Chemistry*, Subcommittee SC 7, *Aluminium oxide, cryolite, aluminium fluoride, sodium fluoride, carbonaceous products for the aluminium industry*.

ISO 12985 consists of the following parts, under the general title *Carbonaceous materials used in the production of aluminium — Baked anodes and cathode blocks*:

— *Part 1: Determination of apparent density using a dimensions method*

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

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 part of ISO 12985 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 part of ISO 12985 is especially applicable to samples of complex on irregular geometry (due to drilling difficulties).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 12985. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 12985 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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 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 Archimede's 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.

4 Reagents

4.1 Distilled water, or water of equivalent purity.

5 Apparatus

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

5.2 Beaker, having a height 2 to 2,5 times the height of the samples.

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

5.4 Hydrostatic balance (one plate), capable of measuring to the nearest 0,1 % of the measured mass, for example ± 0,1 g for a mass of 100 g.

5.5 Drying cabinet, capable of maintaining a temperature of (110 ± 5) °C.

6 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.

NOTE 1 To ensure that the sample is mechanically stable during the test, it should not exceed 100 mm in any dimension.

NOTE 2 To ensure that the precision given in clause 9 is achieved, a sample volume of approximately 100 cm^3 is necessary.

7 Procedure

7.1 Determination of the 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 weighings 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.

7.2 Determination of the volume

Place the sample in the beaker (5.2) 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) on the balance with the same precision as defined in 7.1.

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

8 Calculation

The apparent density ρ_a, expressed in grams per cubic centimetre, is given by the formula

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

and the open porosity accessible by the water ε_w, expressed as a percentage by mass, is given by the formula

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

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 second decimal place.

9 Precision

9.1 Apparent density

9.1.1 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:

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

9.1.2 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:

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

9.2 Open porosity

9.2.1 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:

$r = 0{,}3$ %

9.2.2 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 %

10 Test report

The test report shall include the following information:

a) an identification of the sample;

b) the method used by reference to this part of ISO 12985, i.e. ISO 12985-2:2000;

c) the date of the test, the results and the method of expression used;

d) any unusual features noted during the determination;

e) any operation not included in this part of ISO 12985 or in the International Standards to which reference is made, or regarded as optional.

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.*