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Aluminium oxide primarily used for the production of aluminium — Method for the determination of tapped and untapped density

Oxyde d'aluminium principalement utilisé pour la production d'aluminium — Méthode de détermination de la masse volumique tassée ou inexploitée

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Contents

Page

Foreword

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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, *Materials for the production of primary aluminium*.

Introduction

This International Standard is based on the Australian Standard AS 2879.8.

Aluminium oxide primarily used for the production of aluminium — Method for the determination of tapped and untapped density

1 Scope

This International Standard describes methods for the determination of tapped and untapped bulk density of smelter grade aluminium oxide primarily used for the production of aluminium.

Methods using the fall of sample into a receptacle have been found to be sensitive to flow rate variations, which are caused by physical properties of the aluminium oxide.

This International Standard minimizes flow rate variations.

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 806, *Aluminium oxide primarily used for the production of aluminium — Determination of loss of mass at 300 °C and 1 000 °C*

AS 4538.2, *Guide to the sampling of alumina — Preparation of samples*

3 Principle

A test portion of the sample is allowed to fall in a narrow stream from a container onto a small metal impact plate from which the stream spreads and falls into a receiving vessel of known volume. The mass of test portion filling the vessel is determined and untapped bulk density is calculated on a moisture-free (300 °C) basis. The material in the receiver is then compacted by tapping the container while further sample is added so that tapped bulk density can be determined, again, on a moisture-free basis. The loss of mass at 300 °C is determined on a test portion of sample, this value is used in the calculation of tapped and untapped bulk density on a moisture-free basis.

4 Apparatus

4.1 Sample delivery apparatus, as shown in Figure 1, constructed entirely of an abrasion resistant material, e.g. stainless steel, brass or aluminium. The orifice plate slides a 5 mm orifice beneath the delivery vessel to begin or terminate sample flow into the delivery tube.

4.2 Receiver, a cylindrical container of volume (200 ± 10) ml, having internal length-to-diameter ratio of approximately 6:1 with the exact volume V determined accurately by temperature corrected water mass and constructed of a material that precludes permanent deformation or damage on moderate tapping of the container. Metal or plastic is preferred.

NOTE An error of 0,5 ml in the volume determination will cause an error of 3,0 kg/m^3 in the bulk density.

4.3 Laboratory top-pan balance, capable of weighing 500 g to nearest 0,1 g.

4.4 Metal straight edge.

4.5 Sieve, with a minimum opening of 300 µm and a maximum opening of 1 000 µm.

4.6 Tapper, a suitable instrument used for tapping, for example a wooden brush handle or a nylon-head hammer.

4.7 Brush, (10 to 30) mm wide bristled brush.

5 Sample handling and preparation

5.1 The sample shall be conditioned by exposure to the laboratory atmosphere for a minimum of 2 h in a layer of 5 mm maximum thickness, then mixed and divided into test portions prior to analysis. Test portions of approximately 300 g are to be used for each determination. Mixing and splitting of the sample into test portions shall be done in accordance with AS 4538.2.

5.2 Another test portion of approximately 50 g shall be taken into an airtight container for moisture analysis.

6 Procedure

6.1 Moisture determination

The loss of mass at 300 °C of the 50 g test portion (5.2) from the conditioned sample shall be determined as percent loss of mass at 300 °C in accordance with ISO 806.

NOTE By industry convention, loss of mass at 300 °C is often referred to as "moisture" or "moisture on ignition (MOI)".

6.2 Untapped bulk density determination

The determination shall be carried out as follows:

a) Set up the apparatus as shown in Figure 2, in a vibration-free environment ensuring that the delivery apparatus (4.1) is vertical and during the procedure in steps f) to h) take care to strictly minimize vibration or disturbance of the apparatus.

b) Weigh the empty receiver (4.2) to nearest 0,1 g (m_1).

c) Position the receiver centrally below the delivery apparatus (4.1) as shown in Figure 2.

d) Slide the orifice plate to close the 5 mm orifice so preventing entry of the test portion into the delivery tube.

e) Add the test portion to the delivery vessel, through the sieve (4.5), discarding any oversize material.

f) Slide the orifice open to allow full flow of sample through the delivery tube and fill the receiver until just overflowing. Some fine airborne sample may escape the apparatus: as the mass of this is small, results will not be significantly affected.

g) Slide the orifice closed to terminate the flow of sample.

h) Draw a straight edge (4.4) across the top of the receiver to remove excess sample, leaving the sample flat and level with the top of the receiver.

i) Using a brush (4.7), remove any sample adhering to the outside of the receiver.

j) Weigh the receiver and sample to the nearest 0,1 g (m_2).

6.3 Tapped bulk density determination

The determination shall be carried out as follows:

a) Using the sample in the receiver [6.2 j)], tap the sides of the receiver with a the tapper (4.6) The tapping force shall be sufficient to cause settling of the sample but not cause ejection of the sample or damage to the receiver.

b) Add more sample from the delivery apparatus to fill the space above the sample pile and tap as in step [6.3 a)].

c) Repeat step [6.3 b)] until no more settling of the sample can be achieved by tapping.

d) Draw a straight edge across the top of the receiver to remove excess sample, leaving the sample flat and level with the top of the receiver.

e) Using a brush, remove any sample adhering to the outside of the receiver.

f) Weigh the receiver and sample to the nearest 0,1 g (m_3).

7 Calculation and reporting of results

Untapped and tapped density results are reported on a moisture-free basis.

Calculate the untapped density as follows:

$$D_u = \left\{ \frac{m_2 - m_1}{V} \times \frac{100 - M}{100} \right\} \times 1\,000 \quad (1)$$

Calculate the tapped density as follows:

$$D_t = \left\{ \frac{m_3 - m_1}{V} \times \frac{100 - M}{100} \right\} \times 1\,000 \quad (2)$$

where

D_u is the untapped bulk density in kilograms per cubic metre;

D_t is the tapped bulk density in kilograms per cubic metre;

m_1 is the empty mass of the receiver, in grams;

m_2 is the mass of the receiver and sample after unpacked bulk density determination, in grams;

m_3 is the mass of the receiver and sample after packed bulk density determination, in grams;

V is the volume of the receiver, in millilitres;

M is the loss of moisture at 300 °C of conditioned sample as percent.

Report untapped and tapped bulk density in kilograms per cubic metre and rounded to nearest 1 kg/m^3.

8 Precision

A planned trial of the method was carried out in accordance with AS 2850. Samples of four smelter grade aluminas from different refineries were analysed. Results were provided in quadruplicate by six laboratories. The within laboratory (r) and between laboratory (R) precision data (at 95 % confidence limits) calculated from the results are given in Table 1.