INTERNATIONAL STANDARD

ISO 2926

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Aluminium oxide used for the production of primary aluminium — Particle size analysis for the range 45 µm to 150 µm — Method using electroformed sieves

Oxyde d'aluminium utilisé pour la production d'aluminium primaire — Analyse granulométrique dans la gamme 45 µm à 150 µm — Méthode par emploi de tamis électroformés

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 2926 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 2926:1974), which has been technically revised to reflect modern industry practice, and has substantially improved accuracy and precision over the first edition. The major changes are:

— the mandatory use of electroformed sieves instead of woven wire sieves;

— the mandatory use of a sieve shaker with a vertical hammer-drop action concurrent with the lateral sieving action;

— a different set of nominal aperture sizes to correspond to modern industry practice;

— weighing of fractions "on-sieve" rather than "off-sieve";

— changed sample preparation (no pre-drying);

— removal of the limit of 50 % atmospheric relative humidity;

— calculation of percentages using a "mass recovered" denominator rather than "original mass".

Introduction

This International Standard is based on AS 2879.6-1995 prepared by Standards Australia.

Aluminium oxide used for the production of primary aluminium — Particle size analysis for the range 45 µm to 150 µm — Method using electroformed sieves

1 Scope

This International Standard specifies a dry sieve method using electroformed sieves for determining the mass distribution of the particle sizes in aluminium oxide used for the production of primary aluminium.

This method is applicable to calcined aluminium oxide containing a maximum of 20 % mass fraction of particles having a mean diameter exceeding 150 µm, and containing a maximum of 15 % mass fraction of particles having a mean diameter less than 45 µm.

This method is not applicable to the use of woven wire sieves.

2 Normative references

The following referenced documents are indispensable for the application 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 3310-3, *Test sieves — Technical requirements and testing — Part 3: Test sieves of electroformed sheets*

3 Principle

A test portion of the crude sample is sieved mechanically through electroformed sieves.

Each of the separate fractions is weighed on the sieve, and a cumulative mass of material retained on each sieve aperture size is calculated.

4 Apparatus

4.1 Test sieves, each including a sieving medium (screen) and a frame.

The frames shall be cylindrical, having nominal diameters of 200 mm and heights between 50 mm and 75 mm. A lid and a bottom receiver shall be included. The sieves, lid and bottom receiver shall be capable of being fitted together tightly to form a series of test sieves[1)] .

The screens shall be constructed of smooth electroformed sheet having square openings. The aperture tolerances shall be in accordance with ISO 3310-3.

1) Certified electroformed sieves manufactured by Bukbee-Meers of St Paul, Minnesota, USA, are examples of suitable products available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of these products.

The sieve apertures shall have nominal sizes of 150 µm, 106 µm, 75 µm, 53 µm and 45 µm.

4.2 Mechanical sieve shaker, capable of clamping the sieves mounted inside each other together with the top lid and bottom receiver to form a vertical assembly.

The apparatus[2)] shall impart to the sieve assembly a simultaneous horizontal rotary motion and a vertical tapping action resulting from the fall of a hammer. This combined action shall cause sufficient displacement of the aluminium oxide particles to prevent aggregation but not cause any deformation of the sieving screen or any size reduction of the aluminium oxide particles through shock or abrasion.

4.3 Laboratory top pan balance, capable of weighing the sieves to the nearest 0,01 g.

The balance may be fitted with a lightweight frame mounted on the weighing pan to enable direct weighing of test sieves and receiver.

4.4 Ultrasonic bath, of sufficient capacity to immerse one test sieve fully in a vertical plane to prevent cavitation damage to the sieve sheet.

5 Procedure

5.1 Sample preparation

Split the sample into test portions by riffling or rotary sample division until the required mass is obtained.

Weigh the final split to the nearest 0,01 g. The mass (m_0) of the final split should fall in the range 30 g to 50 g.

5.2 Preparation of test sieves

Prepare the test sieves as follows.

a) Clean each test sieve (4.1) in turn by immersing it vertically in distilled water in the ultrasonic bath (4.4). A non-corrosive wetting agent may be used. Cleaning times of between 15 s and 20 s are adequate. Longer times may cause damage to the sieve screen.

b) After immersion, rinse each sieve with distilled water and dry in a laboratory oven at 100 °C. Ensure that the sieves are thoroughly dry.

c) Cool to room temperature and weigh each sieve (masses m_1) on the top pan balance (4.3) to the nearest 0,01 g. Similarly weigh the bottom receiver.

5.3 Determination

Determine the size distribution as follows.

a) Assemble the test sieves (4.1) on the mechanical sieve shaker (4.2) in order of increasing aperture size from bottom to top, starting with the bottom receiver.

b) Spread the test portion (5.1) on the top-most sieve. Close with the tightly fitting lid and install the positioning cover. Lower the hammer onto the cover.

c) Switch on the mechanical sieve shaker and allow it to operate for 30 min.

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2) RO-TAP Testing sieve shakers, (W. S. Tyler Inc., Mentor, Ohio, U.S.A.), operated in accordance with the manufacturer's recommended settings, are examples of suitable products available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of these products.

d) Remove the sieve stack, and weigh each sieve and its contents to the nearest 0,01 g (masses m_2).

e) Similarly weigh the bottom receiver and contents.

f) Clean the sieves in preparation for the next test sample as follows. Invert each sieve over a suitable container, brush the underside lightly to remove entrapped particles and tap the sieve frame lightly to remove any adhering particles.

6 Calculation of results

Calculate the results as follows:

a) Calculate the masses of each retained sample from the following equation:

$$m_3 = m_2 - m_1 \quad (1)$$

where

m_3 is the mass of retained sample, in grams;

m_2 is the mass of test sieve plus retained sample, in grams;

m_1 is the mass of test sieve, in grams.

In the case of the sample collected in the bottom receiver, m_1 is the mass of the bottom receiver and m_2 is the mass of the bottom receiver plus contents.

b) Calculate the cumulative mass m_4 for each sieve size.

c) Calculate the mass recovered m_5, using the following equation:

$$m_5 = \sum m_3 \quad (2)$$

where m_3 is the mass of sieve contents for each sieve and the bottom receiver.

If the mass m_5 exceeds the mass of the original test portion (m_0) by more than 0,5 g, or if m_5 is less than m_0, then another test portion should be analysed. Due to absorption of moisture during the test, some increase in mass is normal. Any loss in mass is most likely caused by physical loss of sample.

d) Calculate, to two decimal places, the cumulative percent final mass m_6 for each sieve aperture size, using the following equation:

$$m_6 = \frac{m_4}{m_5} \times 100$$

e) Prepare a table of values of m_6 corresponding to each successive nominal aperture size. Report each value of m_6 to one decimal place.

NOTE 1 It can be useful to plot a cumulative distribution curve of the mass passing through each sieve, expressed as a percentage, against the corresponding nominal aperture size, in order of decreasing aperture size.

NOTE 2 Annex A gives an example of a calculation (Table A.1) and reporting (Table A.2) of size analysis

7 Test report

The test report shall include the following information:

a) the table of cumulative percent mass retained for each nominal aperture size (m_6 values), expressed as percent mass fraction of the original sample;

b) reference to this International Standard, i.e. ISO 2926:2005;

c) any unusual features noted during the determination and any operation not included in this International Standard which may have affected the results.

8 Precision

The values for repeatability and reproducibility should not exceed those given in Table 1.

Table 1 — Precision for size analysis

Percentage by mass (absolute)

Sieve fraction	Repeatability r	Reproducibility R
+ 150 µm	1,2	1,7
+ 106 µm	1,2	8,2
+ 75 µm	0,9	2,0
+ 53 µm	0,5	2,9
+ 45 µm	0,2	0,9
The results of the test programme from which these values were derived are presented in Annex B.		

Annex A
(informative)

Example of calculation of size analysis

Table A.1 — Example of calculation of size analysis

Sieve aperture or pan µm	Mass of sieve or pan m_1 g	Sieve mass + mass retained m_2 g	Mass retained m_3 g	Cumulative mass m_4 g	Retained cumulative m_6 %
150	411,06	412,49	1,43	1,43	3,76
106	435,93	446,10	10,17	11,60	30,48
75	430,88	446,38	15,50	27,10	71,20
53	427,12	434,60	7,48	34,58	90,86
45	408,80	410,18	1,38	35,98	94,48
Pan	284,62	286,72	2,10		
Initial mass m_0 = 37,81 g. Total mass recovered m_5 = 38,06 g.					

Table A.2 — Example of reporting size analysis

Sieve fraction	Mass fraction retained (cumulative) %
+150 µm	3,8
+106 µm	30,5
+75 µm	71,2
+53 µm	90,9
+45 µm	94,5

Annex B
(informative)

Results of interlaboratory test programme

A test programme using this method was conducted according to AS 2850 on three different refinery aluminas by participants from five Australian alumina refinery laboratories. The results are shown below. The values given for each laboratory are the mean values of two separate results. The between-laboratory means $\bar{x}$ and single standard deviations $\bar{\sigma}$ under reproducibility conditions are also shown.

Table B.1 — Results of test programme on three refinery aluminas by five laboratories

Percentage mass fraction

Alumina sample	Laboratory identity	Mean values for each fraction				
		+150 µm	+106 µm	+75 µm	+53 µm	+45 µm
S-074	Lab 1	7,1	45,8	80,8	91,3	93,2
	Lab 2	8,2	41,9	81,1	91,0	93,0
	Lab 3	7,8	46,6	80,1	91,6	92,9
	Lab 4	7,4	41,2	80,5	90,9	93,8
	Lab 5	7,4	41,7	80,3	90,9	93,0
	$\bar{x}$	7,6	43,4	80,6	91,1	93,2
	$\bar{\sigma}$	0,4	2,3	0,4	0,3	0,3
S-075	Lab 1	18,1	60,9	85,4	91,6	92,9
	Lab 2	18,5	57,7	85,5	91,6	92,9
	Lab 3	20,2	63,3	85,6	91,9	92,8
	Lab 4	17,6	56,8	85,4	91,4	93,3
	Lab 5	18,1	57,4	84,9	91,5	92,7
	$\bar{x}$	18,5	59,2	85,4	91,6	92,9
	$\bar{\sigma}$	0,9	2,5	0,2	0,2	0,2
S-076	Lab 1	3,1	33,0	72,7	91,2	94,6
	Lab 2	4,7	30,0	73,1	91,4	94,7
	Lab 3	4,2	36,0	73,8	92,6	94,8
	Lab 4	4,1	28,7	72,0	89,8	94,9
	Lab 5	3,5	29,7	72,5	90,9	94,5
	$\bar{x}$	3,9	31,5	72,8	91,2	94,7
	$\bar{\sigma}$	0,6	2,7	0,6	0,9	0,1

Bibliography

[1] AS 2850, *Chemical analysis — Interlaboratory test programs — For determining precision of analytical method(s) — Guide to the planning and conduct*

[2] AS 2879.6-1975, *Alumina — Determination of the mass distribution of particle sizes using electroformed sieves*

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