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Aluminium ores — Determination of the moisture content of bulk material

Minerais alumineux — Détermination de l'humidité du matériau en vrac

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9033 was prepared by Technical Committee ISO/TC 129, *Aluminium ores.*

Annexes A and B form an integral part of this International Standard.

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Aluminium ores — Determination of the moisture content of bulk material

1 Scope

This International Standard specifies a method for the determination of the moisture content of aluminium ores. It applies to the samples taken from bulk aluminium ores, e.g. shipments and stockpiles. Annex A specifies a method to be used when it is difficult to carry out sieving, crushing and dividing owing to the sample being adhesive or excessively wet. In this case the sample may be pre-dried until preparation can be conducted without any trouble and the pre-dried moisture content of a consignment can be determined by the procedure specified in annex A. Annex B specifies methods of correction for sprayed water and/or rainfall. In the event of the consignment being subjected to rainfall and/or sprayed water to control dust emission, then the moisture content of the consignment can be corrected for this added water in accordance with annex B.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 6140 : —[1], *Aluminium ores — Preparation of samples.*

ISO 8685 : —[1], *Aluminium ores — Sampling procedures.*

3 Principles

Drying of a test portion to constant mass in a ventilated oven with forced circulation of air regulated at 105 °C ± 5 °C. Measurement of the loss in mass.

4 Apparatus

Ordinary laboratory equipment, and

4.1 Drying pan.

4.2 Ventilated oven, with forced circulation of air regulated at 105 °C ± 5 °C.

4.3 Weighing device, capable of being read to an accuracy of 0,01 % of the mass of the test portion.

5 Sampling and samples

Test samples shall be taken and prepared in accordance with the procedures specified in ISO 8685 and ISO 6140 respectively. Two possibilities exist for the preparation of the moisture samples. These are

a) the moisture sample prepared from each increment or subsample is prepared and analysed individually;

b) the moisture samples from each increment or subsample are combined to form a gross sample.

6 Procedure

6.1 Test portions

The test portions prepared by the procedure specified in ISO 6140 shall be provided in sealed containers and shall have the minimum masses specified in table 1.

When the drying oven (4.2) cannot accommodate the larger test portions, the test portion may be divided into several parts for drying. Divide the portion into the minimum number of parts possible, taking care to avoid a change in moisture content.

NOTE — In no case shall the minimum mass of a part be less than 1 kg.

Alternatively, to avoid dividing large test portions into parts for drying, moisture determinations may be carried out on individual increments or subsamples as taken, provided the sum of the masses of all the increments or subsamples exceeds the mass of the test portions given in table 1.

6.2 Number of determinations

Moisture determination may be carried out in one of the following ways:

a) Where moisture samples from individual increments or subsamples are analysed separately, one moisture determination shall be carried out on each subsample.

1) To be published.

NOTE — If there are fewer than four subsamples per consignment, duplicate test portions shall be prepared from each subsample and analysed.

b) Where the moisture samples from each subsample are combined to form a gross moisture sample, four test portions shall be prepared. Moisture determinations shall be carried out on two of the test portions with the remaining two test portions kept in reserve.

6.3 Drying of test portion

Weigh the container and aluminium ore test portion before opening the container (as received). Weigh the clean, dry drying pan (4.1). Transfer the aluminium ore to the drying pan and spread the ore evenly to a depth not exceeding that specified in table 1.

Place the drying pan with the ore together with the container and lid (if any) plus any adhering particles of ore, in the oven (4.2) and maintain at a temperature of 105 °C ± 5 °C for the minimum drying time specified in table 1.

NOTE — The drying pan should be placed on a shelf within the oven and not on the floor of the oven. It should not touch the sides of the oven.

Remove the container and lid, drying pan and ore from the oven and weigh immediately. Return the container and lid, drying pan and ore to the oven and maintain at a temperature of 105 °C ± 5 °C for a further 2 h.

Remove the container and lid, drying pan and ore from the oven and weigh. These two weighings should agree to within the limits specified in table 1. If they do not, the 2 h drying and weighing should be repeated until this criterion is achieved. When the masses agree to within the specified limits, record the mass of the dry container plus lid plus drying pan plus dried ore.

Brush out any ore adhering to the container and weigh the dry container plus lid.

Table 1 — Requirements for the determination of moisture

Nominal top size of ore	Layer thickness	Minimum mass	Maximum allowable difference between subsequent weighings of dried samples	Accuracy of weighing	Minimum drying time
mm	mm	kg	g	g	h
63,0	70	110	110	10	16
45,0	50	40	40	4	12
31,5	35	14	14	1	8
22,4	25	5	5	0,5	6
16,0	20	2	2	0,2	4
11,2	13	1	1	0,1	4

7 Expression of results

7.1 Moisture content of test portion

Calculate the moisture content of the test portion from the equation:

$$w_i = \frac{(m_1 + m_2 - m_3)}{(m_1 - m_4)} \times 100$$

where

w_i is the moisture content, as a percentage by mass, of the test portion;

m_1 is the initial mass, in kilograms, of the container, lid and test portion;

m_2 is the mass, in kilograms, of the drying pan;

m_3 is the dry mass, in kilograms, of the container, lid, drying pan and test portion;

m_4 is the mass, in kilograms, of the dry empty container and lid.

Masses shall be recorded to the nearest 1 g, except for the 110 kg sample where the mass shall be recorded to the nearest 10 g.

7.2 Moisture content of consignment

7.2.1 Moisture samples from each increment or subsample analysed separately

The moisture content of a consignment shall be calculated using the following equation:

$$w = \frac{\sum_{i=1}^{k} \mu_i w_i}{\sum_{i=1}^{k} \mu_i}$$

where

w is the moisture content, as a percentage by mass, of the consignment;

k is the number of subsamples into which the consignment has been divided;

μ_i is the mass, in tonnes, of the ith subsample;

w_i is the moisture content, as a percentage by mass, of the ith subsample (test portion).

7.2.2 Moisture samples combined to form a gross sample

If the moisture determinations carried out on each of the duplicate test portions in 6.2 b) do not differ by more than 0,3 % absolute, the reserve test portions may be discarded, and the moisture content of the consignment calculated from the equation

$$w = \frac{w_{i1} + w_{i2}}{2}$$

where w_{i1} and w_{i2} are the moisture contents, as percentages by mass, of test portions 1 and 2 respectively.

If the values w_{i1} and w_{i2} differ by more than 0,3 % (m/m), repeat the determination (6.3) on the remaining two test portions. If these agree within 0,3 % (m/m), calculate the moisture content of the consignment as the mean of the results of the duplicate determinations.

If these two results do not lie within 0,3 % (m/m), take all four results, reject the highest and lowest values, and calculate the moisture content of the consignment as the mean of the remaining two results.

7.3 Correction for rainfall and sprayed water

Corrections for rainfall and sprayed water shall be made by the procedure specified in annex B.

7.4 Calculation of final result

The result as obtained in 7.2.1 or 7.2.2 shall be calculated to the third decimal place and rounded off to the first decimal place as follows:

a) when the figure in the second decimal place is less than 5, it is discarded and the figure in the first decimal place is kept unchanged;

b) when the figure in the second decimal place is 5 and there are figures other than 0 in the third decimal place, or when the figure in the second decimal place is greater than 5, the figure in the first decimal place is increased by one;

c) when the figure in the second decimal place is 5 and there are no figures other than 0 in the third decimal place, the 5 is discarded and the figure in the first decimal place is kept unchanged if it is 0, 2, 4, 6 or 8 and is increased by one if it is 1, 3, 5, 7 or 9.

8 Test report

The test report shall include the following information:

a) details necessary for the identification of the sample;

b) reference to this International Standard;

c) result of the test;

d) reference number of the results;

e) any characteristics noticed during the determination and any operations not specified in this International Standard which may have had an influence on the result.

Annex A
(normative)

Determination of moisture content of adhesive or wet aluminium ore

A.1 General

When it is difficult to conduct sieving, crushing and dividing owing to the sample being adhesive or excessively wet, the sample may be pre-dried until preparation can be conducted without any trouble.

The ore should not be overdried to the point where it is likely to reabsorb moisture during subsequent processing. This point should be determined by experimentation for each type of aluminium ore.

A.2 Procedure and expression of results

Determine the initial mass of the test sample, spread the test sample in a uniform thickness and dry it by air-drying or in a drying apparatus with a temperature no higher than 105 °C. After drying, again determine the mass of the test sample and calculate the pre-dried moisture content from the following equation:

$$w_p = \frac{m_5 - m_6}{m_5} \times 100$$

where

w_p is the pre-dried moisture content, as a percentage by mass, of the test portion;

m_5 is the initial mass, in grams, of the test sample;

m_6 is the mass, in grams, of the test sample after pre-drying.

Prepare the test portions for moisture measurement from the pre-dried sample according to clause 6 and then determine the drying loss of the test portion according to clause 7. Calculate the additional moisture content, as a percentage by mass, according to 7.1.

The total (as received) moisture content is calculated from the following equation:

$$w_j = w_p + \frac{100 - w_p}{100} \times w_i$$

where

w_i is the additional moisture content, as a percentage by mass, obtained according to 7.1 after pre-drying;

w_j is the total moisture content of the test sample;

w_p is as defined above.

Determine the moisture content of the consignment from the equation:

$$w = \frac{\sum_{j=1}^{k} \mu_j w_j}{\sum_{j=1}^{k} \mu_j}$$

where

w is the moisture content, as a percentage by mass, of the consignment;

k is the number of subsamples into which the consignment has been divided;

μ_j is the mass, in tonnes, of the jth subsample;

w_j is the moisture content, as a percentage by mass, corrected for pre-dried moisture, of the jth subsample (test portion).

Annex B
(normative)

Correction for sprayed water and/or rainfall

B.1 Scope

This annex deals with the corrections to be made to the moisture content of a consignment of aluminium ore to take into account the water sprayed onto the ore to prevent the production of dust during handling operations. Depending upon whether sprayed water is added prior to or after moisture determination, the correction for moisture content will be negative or positive respectively.

This annex also covers the method for correction to the moisture content of a consignment of aluminium ore due to rainfall.

Water may be sprayed in the following cases:

a) where environmental regulations at loading and/or unloading ports require dust control,

or

b) where difficulty of ore handling due to its characteristics, weather conditions, handling equipment, etc. make the presence of additional water beneficial.

Correction for rainfall is applied in the case of a significant effect by rainfall on the moisture content of the consignment. A level at which such correction is made may be agreed upon between the parties concerned.

B.2 Corrections for sprayed water

B.2.1 Sprayed water

Sprayed water refers to water introduced between the points of moisture determination and tonnage determination.

B.2.2 Determination of mass of sprayed water

The measurement of the volume of sprayed water should be made with a meter with an accuracy of ±5 %. The volume obtained should be converted to a mass in tonnes by multiplying the value obtained by the density of the water used.

NOTE — Fresh water is assumed to have a density of 1 t/m^3.

B.2.3 Mass of consignment for moisture correction

The mass of the consignment, in tonnes, shall be determined by calculation of the difference between the initial and final draft survey tonnage.

B.2.4 Calculation of moisture content corrected for sprayed water on loading

The final moisture content shall be calculated from the following equation:

$$w_s = w + (100 - w) \times \frac{m_7}{m_8} \times f$$

where

w_s is the moisture content, as a percentage by mass, of the consignment corrected for sprayed water;

w is the mean value of the moisture content, expressed as a percentage by mass, as determined in 7.2;

m_7 is the mass, in tonnes, of sprayed water;

m_8 is the mass, in tonnes, of the consignment;

f is the factor taking into account water lost during spraying. The value of f is decided by commercial agreement between the parties concerned. A value of $f = 1$ indicates that no loss has occurred.

B.2.5 Calculation of moisture content corrected for sprayed water on discharge

The final moisture content, expressed as a percentage by mass, shall be calculated from the following equation:

$$w_s = w - (100 - w) \times \frac{m_7}{m_8} \times f$$

where w_s, w, m_7, m_8 and f are as defined in B.2.4.

B.3 Corrections for rainfall

B.3.1 Principle

Determination of the moisture content of the consignment from the as-tested moisture content, by allowing for the effects of rainfall into the vessel's hold(s) and onto the handling equipment during the handling operations.

B.3.2 Effective area exposed to rainfall

The effective area exposed to rainfall shall be calculated by adding up the areas specified in B.3.2.1 to B.3.2.3, rounded to the nearest 1 m^2.

B.3.2.1 Hold(s)

The open area, in square metres, of the hold(s) in which the consignment is exposed to rainfall shall be calculated on the basis of the drawings provided on board the carrying vessel.

B.3.2.2 Surge hopper(s)

The open area, in square metres, of the hopper(s) used for transportation of the consignment and exposed to rainfall shall be calculated on the basis of drawings of the hopper(s).

B.3.2.3 Belt conveyor(s)

The open area, in square metres, of the belt conveyor(s) shall be calculated by multiplying the effective belt width by the length exposed to rainfall during transportation of the consignment between the vessel's holds and the point where samples are taken for moisture determination.

B.3.3 Duration of rainfall

The duration of rainfall shall be determined from the time of the initial draft survey to completion of sampling.

B.3.4 Determination of rainfall

The rainfall shall be determined by means of an approved rainfall gauge placed close to the loading or unloading point. The rainfall shall be measured to the nearest 0,1 mm.

B.3.5 Mass of rainwater

The mass of rainwater shall be calculated from the following equation and rounded to the nearest whole number

$$m_R = AR \times \frac{1}{1\,000} \times \varrho$$

where

m_R is the mass, in tonnes, of rainwater;

A is the area, in square metres, calculated in B.3.2;

R is the rainfall, in millimetres, obtained in B.3.4;

ϱ is the density of the rainwater, in tonnes per cubic metre (in this case, $\varrho = 1$ t/m^3).

B.3.6 Calculation of moisture content corrected for rainfall on loading

The moisture content of the consignment shall be calculated from the following equation:

$$w_R = w + (100 - w) \times \frac{m_R}{m_8}$$

where

w_R is the moisture content, expressed as a percentage by mass, of the consignment corrected for rainfall;

w is the mean value of the moisture content, expressed as a percentage by mass, as determined in clause 7.2;

m_R is the mass, in tonnes, of rainwater;

m_8 is the mass, in tonnes, of the consignment.

B.3.7 Calculation of moisture content corrected for rainfall on discharge

The moisture content, expressed as a percentage by mass, of the consignment shall be calculated from the following equation:

$$w_R = w - (100 - w) \times \frac{m_R}{m_8}$$

where w_R, m_R and m_8 are as defined in B.3.6.

B.4 Corrections for sprayed water and rainfall

B.4.1 Corrections for sprayed water and rainfall on loading

The corrected moisture content of a consignment which has been exposed to both sprayed water and rainfall shall be calculated from the following equation:

$$w_o = w + (100 - w) \times \frac{(m_7 f + m_R)}{m_8}$$

where

w_o is the corrected moisture content, expressed as a percentage by mass, of the consignment;

w, m_7, m_8, m_R and f are as previously defined.

B.4.2 Corrections for sprayed water and rainfall on discharge

The corrected moisture content, expressed as a percentage by mass, of a consignment which has been exposed to both sprayed water and rainfall shall be calculated from the following equation:

$$w_o = w - (100 - w) \times \frac{(m_7 f + m_R)}{m_8}$$

where w_o, w, m_7, m_8, m_R and f are as previously defined.

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