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Iron ores — Determination of the moisture content of a lot

Minerais de fer — Détermination de l'humidité d'un lot

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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 3087 was prepared by Technical Committee ISO/TC 102, *Iron ore and direct reduced iron*, Subcommittee SC 1, *Sampling*.

This fourth edition cancels and replaces the third edition (ISO 3087:1998), which has been technically revised.

Introduction

Currently, large tonnages of iron ore are traded internationally and a small error in the measured moisture content [mass fraction (%)] of a lot has a considerable effect on the commercial transaction. The correct determination of moisture content of a lot is, therefore, a matter of importance for both the purchaser and the vendor.

This International Standard does not address the determination of the hygroscopic moisture content of a test sample for chemical analysis. If the hygroscopic moisture content is required to be determined, reference should be made to ISO 2596:2006, *Iron ores — Determination of hygroscopic moisture in analytical samples — Gravimetric, Karl Fischer and mass-loss methods*.

Iron ores — Determination of the moisture content of a lot

1 Scope

This International Standard specifies a method for the determination of the moisture content of a lot of iron ore. This method is applicable to all iron ores, whether natural or processed.

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 3082, *Iron ores — Sampling and sample preparation procedures*

ISO 11323, *Iron ore and direct reduced iron — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11323 apply.

4 Principle

Dry the test portion in air at 105 °C to constant mass and measure the loss in mass. Express the moisture content as the mass loss relative to the original mass of the sample as a mass fraction (%).

5 Apparatus

5.1 Drying pan, with a smooth surface, free from contamination and capable of accommodating the specified quantity of a test portion in a layer of nominal thickness not greater than 31,5 mm.

5.2 Drying oven, equipped with a temperature indicator and control apparatus capable of regulating the temperature at any point in the oven at 105 °C ± 5 °C and so designed as to maintain this temperature with a current of air to ensure efficient drying but without any loss of sample, and fitted with a fan that allows for both the circulation and change of air.

5.3 Weighing device, accurate to at least 0,05 % of the initial mass of a test portion.

The capacity of the weighing device shall be enough for the initial mass of the test portion.

6 Samples

Test samples which have been taken and prepared in accordance with ISO 3082 shall be used. The mass of a test portion, in relation to its nominal top size, is specified in Table 1, in accordance with ISO 3082.

Table 1 — Minimum mass of test portion

Nominal top size of test portion mm		Minimum mass of test portion kg
over	up to and including	
22,4	31,5	10
10,0	22,4	5
—	10,0	1

7 Procedure

7.1 Number of moisture measurements

Carry out one moisture measurement per test portion on the number of test portions specified in Table 2, according to the conditions of preparation of the test sample.

Table 2 — Number of test portions

Preparation of test sample	Number of partial samples per lot	Number of test portions to be tested
From gross sample	—	4 per gross sample
From partial sample	2	4 per partial sample
	3 to 7	2 minimum per partial sample
	≥ 8	1 minimum per partial sample
From increment	—	1 minimum per increment

In order to minimize losses of moisture to the atmosphere, it is necessary to perform all the initial weighings of the test portions as quickly as possible after obtaining those test portions.

7.2 Measurement

7.2.1 General

The moisture determination shall be measured in accordance with 7.2.2 or, alternatively, for ores with 8 % or more of combined water in accordance with 7.2.3.

When it is difficult to conduct sieving, crushing and dividing, owing to a sample being adhesive or excessively wet, the sample may be predried in accordance with the procedure in Annex A.

7.2.2 Normal method

a) Spread the test portion in a layer of nominal thickness not greater than 31,5 mm in the tared drying pan (5.1) and determine the total mass immediately. Record the total mass, the mass of the drying pan, the initial mass of the test portion (m_1) and the numerical value of 0,05 % of the initial mass of the test portion.

b) Place the drying pan with the test portion in the drying oven (5.2) set at 105 °C, and maintain this temperature for not less than 4 h. Remove the drying pan with the test portion from the drying oven and weigh it immediately while still hot in order to minimize any reabsorption of moisture. Alternatively, weigh the test portion after cooling in air in a container having a close-fitting airtight lid. In each case, report the method of weighing.

c) Once more, place the drying pan with the test portion in the drying oven, heat for a further 1 h, and then repeat the weighing.

d) Repeat the procedure described in the previous item until the difference in mass between subsequent measurements becomes 0,05 % or less of the initial mass of the test portion.

NOTE 1 The weighing device should be protected from the influence of heat.

NOTE 2 Drying times will be dependent on the type of ore under test. For a series of measurements carried out on a particular type of ore, the drying time of the test portion may be specified by check experiments carried out beforehand.

NOTE 3 To reduce drying time, a lower layer-thickness of the sample is recommended. It should be specified by check experiments carried out beforehand.

NOTE 4 For convenience, the test portion of mass 10 kg for ore of particle size less than 31,5 mm may be divided into two portions, each of which is subjected to moisture measurement. In calculating the results, the mean of the two values of initial mass and the mean of the two values of the drying loss in mass should be used.

7.2.3 Method for ores of high combined water content

For ores containing 8 % or more combined water, the following procedure may be applied.

a) Spread the test portion in a layer of nominal thickness not greater than 31,5 mm in the tared drying pan (5.1) and determine the total mass immediately. Record the total mass, the mass of the drying pan and the initial mass of the test portion (m_1).

b) Place the drying pan with the test portion in the drying oven (5.2) set at 105 °C and maintain this temperature for not less than 24 h. Remove the drying pan with the test portion from the drying oven and weigh it immediately while still hot in order to minimize any reabsorption of moisture. Alternatively, weigh the test portion after cooling in air in a container having a close-fitting airtight lid. Record the total mass after drying. In each case, report the method of weighing.

NOTE The notes in 7.2.2 apply to this subclause.

8 Verification

Regular checking of apparatus and procedures is essential to verify the test results. Checks shall be carried out prior to the commencement of a routine test in accordance with this International Standard and at regular intervals thereafter. The frequency of checking is a matter for each laboratory to determine. A detailed record of all verification activities shall be maintained for the following items:

a) Sprinkled water measurement

— volumenometer;

b) Rainfall measurement

— rain gauge;

c) Moisture test

— oven temperature/temperature regulation;

— circulation and change of air in oven;

— weighing device.

9 Calculation and expression of results

9.1 Test portion

The result of the determination of the moisture content, w_i, expressed as a mass fraction (%), for each test portion, is given by Equation (1) and reported to the second decimal place.

$$w_i = \frac{m_1 - m_2}{m_1} \times 100 \quad (1)$$

where

m_1 is the initial mass, in grams, of the test portion;

m_2 is the mass, in grams, of the test portion after drying.

9.2 Lot

The moisture content of a lot is given by one of the Equations (2) to (5) as the occasion may demand, and reported to the first decimal place.

Sprinkled water and/or rainwater over iron ore during loading and/or unloading operation shall be corrected according to the procedure specified in Annex B.

9.2.1 When moisture determination is conducted on the gross sample from the lot, the moisture of the lot is determined as follows.

When the range of the four test results does not exceed 1,3r as given in Table 3, the arithmetic mean, $\bar{w}$, of the four results shall be the moisture content, expressed as a mass fraction (%), of the lot as given by Equation (2).

$$\bar{w} = \frac{w_1 + w_2 + w_3 + w_4}{4} \quad (2)$$

where w_1, w_2, w_3 and w_4 are the results of the determinations of the moisture contents, expressed as a mass fraction (%), on each of the four test portions.

When the range of the four test results exceeds 1,3r as given in Table 3, the median shall be taken as the moisture content of the lot. The median of four test results is defined as the mean of the two non-extreme test results.

Table 3 — Repeatability limit of moisture determination on the gross sample

Average of moisture content $\bar{w}$ mass fraction (%)	Repeatability limit r [a] mass fraction (%)	Repeatability limit 1,3r mass fraction (%)
$\bar{w} \leq 3$	0,20	0,26
$3 < \bar{w} \leq 6$	0,25	0,33
$6 < \bar{w}$	0,31	0,40

[a] The theoretical background of the repeatability limit is shown in Annex C.

9.2.2 When mass-basis sampling has been performed and moisture determination is conducted on each partial sample, the weighted mean, $\bar{w}$, of the results from all the partial samples, considering the number of increments for each partial sample, shall be the moisture content, expressed as a mass fraction (%), of the lot, as given by Equation (3).

$$\bar{w} = \frac{\sum_{i=1}^{k} N_i w_i}{\sum_{i=1}^{k} N_i} \quad (3)$$

where

k is the number of partial samples;

N_i is the number of increments in the ith partial sample;

w_i is the result of the determination of the moisture content, expressed as a mass fraction (%), of the ith partial sample, according to Table 2 using as the number of test portions either 4 or 2.

If it is impracticable to sample the lot as a whole, or desirable to sample a lot in separate parts of unequal mass as in the case of time-basis sampling, the moisture content of each part shall be determined independently and the weighted mean, $\bar{w}$, of the results, expressed as a mass fraction (%), of the lot calculated from the individual results using Equation (4).

$$\bar{w} = \frac{\sum_{i=1}^{k} m_i w_i}{\sum_{i=1}^{k} m_i} \quad (4)$$

where

k is the number of partial samples;

m_i is the mass of the ith part;

w_i is the result of the determination of the moisture content, expressed as a mass fraction (%), of the ith part.

9.2.3 When moisture determination is conducted on each increment, the arithmetic mean, $\bar{w}$, of the results for all increments obtained according to 9.1 shall be the moisture content, expressed as a mass fraction (%), of the lot as given by Equation (5).

$$\bar{w} = \frac{\sum_{i=1}^{n} w_i}{n} \quad (5)$$

where

n is the number of increments;

w_i is the result of the determination of the moisture content, expressed as a mass fraction (%), of the ith increment.

10 Test report

The test report shall contain the following information. Examples of test reports are shown in Annex D.

a) A reference to this International Standard, i.e. ISO 3087:2011;

b) details necessary for the identification of the sample;

c) result of the test;