102

INTERNATIONAL STANDARD

ISO 3087

Second edition
1987-04-15

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ORGANISATION INTERNATIONALE DE NORMALISATION
МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Iron ores — Determination of moisture content of a consignment

Minerais de fer — Détermination de l'humidité d'une livraison

Reference number
ISO 3087 : 1987 (E)

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.

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 3087 was prepared by Technical Committee ISO/TC 102, *Iron ores*.

This second edition cancels and replaces the first edition (ISO 3087 : 1974), of which it constitutes a technical revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Iron ores — Determination of moisture content of a consignment

0 Introduction

At present, large tonnages of iron ores are traded internationally and, therefore, the smallest difference in the measured moisture content (percentage by mass) of the same consignment has a considerable effect on transaction of iron ores. The correct determination of moisture content of a consignment is, therefore, a matter of importance for both the purchaser and the vendor.

This second edition of ISO 3087 contains the following major amendments:

a) the inclusion of a test sample having a particle size of less than 31,5 mm;

b) the inclusion of annex B, which deals with methods for correction for sprinkled water and/or rain-water.

This International Standard does not aim to determine the hygroscopic moisture content of the test sample for chemical analysis. If the hygroscopic moisture content is required, see ISO 2596, *Iron ores — Determination of hygroscopic moisture in analytical samples — Gravimetric and Karl Fischer methods.*

This International Standard contains three annexes:

— Annex A specifies a method to be used when it is difficult to conduct sieving, crushing and division owing to a sample being adhesive or excessively wet. In this case the sample may be pre-dried until preparation can be conducted without difficulty, and the pre-dried moisture content of a consignment determined by the procedure specified in annex A.

— Annex B specifies methods of correction for sprinkled water and/or rain-water. In the event that a consignment is subjected to rain-water and/or sprinkled water to control dust emission, then the moisture content of the consignment should be corrected for this added water in accordance with annex B.

— Annex C shows, for information, the precision of moisture measurement of the method specified in this International Standard.

1 Scope and field of application

This International Standard specifies a method for the determination of the moisture content of a consignment of iron ore.

This method is applicable to all iron ores, whether natural or processed (for example concentrates and agglomerates such as pellets, sinters or briquettes). However, some limonites, sulfides, and certain ores containing a high content of combined water may give erroneous results of moisture determination under the conditions specified.

2 References

ISO 3081, *Iron ores — Increment sampling — Manual method.*

ISO 3082, *Iron ores — Increment sampling and sample preparation — Mechanical method.*

ISO 3083, *Iron ores — Preparation of samples — Manual method.*

3 Definitions

For the purpose of this International Standard, the following definitions apply.

3.1 moisture sample: The sample taken for determination of the moisture content of the consignment or part of the consignment.

3.2 test sample: A sample ready for moisture determination which is prepared from each increment, from each subsample, or from the gross sample in accordance with the specified method for the moisture sample.

3.3 test portion: A representative part of a test sample which is actually subjected to moisture measurement.

If the entire quantity of a test sample is subjected to moisture measurement, the test sample may also be called "test portion".

4 Principle

Drying of the test sample in air at 105 °C to constant mass. Determination of the moisture content by establishing the loss in mass of the sample when heated at 105 °C.

5 Apparatus

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

5.2 Drying oven, equipped with a temperature indicator and a control apparatus capable of regulating the temperature at any point in the oven within ±5 °C of the desired temperature 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 both for the circulation of air and for the change of air at least three times every hour.

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

6 Samples

Test samples which have been taken in accordance with ISO 3081 or ISO 3082 and prepared in accordance with ISO 3082 or ISO 3083 shall be used. The mass of a test portion in relation to its whole-through sieve size is specified in table 1, in accordance with ISO 3082 or ISO 3083.

Table 1 — Minimum mass of test portion

Whole-through sieve size of test portion (mm)	Minimum mass of test portion (kg)
31,5	10
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 as 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 test portions to be tested	Number of subsamples per consignment
Per gross sample	4	—
Per subsample	4	2
	2 minimum	3 to 7
	1 minimum	>8
Per increment	1 minimum	—

Perform all the initial weighings of the test portions at the same time and as quickly as possible after obtaining the test portions.

7.2 Measurement

Spread the test portion in a 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 and the numerical value of 0,05 % of the initial mass of the test portion.

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 to minimize 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.

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

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

NOTES

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

2 In the case of a series of moisture measurements carried out on the same type of iron ore, the heating time of the test portion may be specified by check experiments beforehand.

3 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, which are 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.

8 Calculation and expression of results

8.1 Test portion

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

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

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.

8.2 Consignment

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

8.2.1 When moisture determination is conducted on the gross sample from the consignment, the moisture content of the consignment is determined as follows.

When the range of the four test results does not exceed 1,3*r* as shown in table 3, the arithmetic mean, $\bar{w}$, of the four results shall be the moisture content, expressed as a percentage by mass, of the consignment as given by equation (2)

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

where w_1, w_2, w_3 and w_4 are the results of the determinations of the moisture contents, expressed as percentages by mass, on each of the four test portions.

When the range of the four test results exceeds 1,3*r* given in table 3, the median shall be taken as the moisture content of the consignment.

The median of four test results is defined as the mean of the two non-extreme test results.

Table 3 — Repeatability of moisture determination on the gross sample

Average of moisture content, $\bar{w}$ [% (*m*/*m*)]	Repeatability, *r* (%)	1,3*r* (%)
$\bar{w} < 3$	0,20	0,26
$3 < \bar{w} < 6$	0,25	0,33
$6 < \bar{w}$	0,31	0,40

8.2.2 When mass-basis sampling has been performed and moisture determination is conducted on each subsample, the weighted mean, $\bar{w}$, of the results from all the subsamples, considering the number of increments for each subsample, shall be the moisture content, expressed as a percentage by mass, of the consignment, as given by equation (3)

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

where

k is the number of subsamples;

N_i is the number of increments in the ith subsample;

w_i is the result of the determination of the moisture content, expressed as a percentage by mass, of the ith subsample, according to equation (5) using as the number of test portions, n, either 4 or 2.

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

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

where

k is the number of parts in a consignment;

m_i is the mass of the ith part;

w_i is the result of the determination of the moisture content, expressed as a percentage by mass, of the ith part.

8.2.3 When moisture determination is conducted on each increment, the arithmetic mean, $\bar{w}$, of the results for all increments obtained according to 8.1 shall be the moisture content, expressed as a percentage by mass, of the consignment, as given by equation (5)

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

where

n is the number of increments;

w_i is the result of the determination of the moisture content, expressed as a percentage by mass, of the ith increment.

9 Test report

The test report shall contain the following information:

a) reference to this International Standard;

b) details necessary for the identification of the sample;

c) result of the test;

d) reference number of the result;

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

Four examples are shown in tables 4, 5, 6, and 7. Table 4 is a test report for moisture measurement on a test portion. Table 5 is mainly used for the calculation of moisture content of a consignment from subsamples obtained by mass-basis sampling, while table 6 is used for time-basis sampling. Table 7 is a test report for determination of moisture content of a consignment on four test portions taken from the gross sample.

Table 4 — Example of a test report for values of moisture measurement on a test portion

Type of iron ore:					
Identity and quantity of consignment:					
Sample No.:	Minimum mass of test portion: 5 kg	Whole-through sieve size of test portion: 22,4 mm		Date:	
Total mass before drying (g)			(1)	6 015	
Mass of drying pan (g)			(2)	950	
Initial mass of test portion (g)			(3) = (1) − (2)	5 065	
Value of 0,05 % of initial mass of test portion (g)			(4) = $\frac{(3)}{2\,000}$	2,5	
				mass	difference *
Total mass after 4 h drying (g)			(5)	5 805	
Total mass after further 1 h drying (g)			(6)	5 795	(5) − (6) 10
Total mass after another 1 h drying (g)			(7)	5 793	(6) − (7) 2
Final drying loss (g)			(8) = (1) − (7)	222	
Value of moisture measurement, w_i (%)			(9) = $\frac{(8)}{(3)} \times 100$	4,38	
Remarks:			Method of weighing (see 7.2)		
Assayer:					

* The difference (5) − (6) was 10 g and exceeded (4), consequently another 1 h drying was conducted. The difference (6) − (7) became 2 g and was less than (4). Therefore, the drying of this test portion was terminated.

Table 5 — Example of recording and calculating procedure for determination of moisture content of a consignment from subsamples (mass-basis sampling)

Ref. No.:		Method used: ISO 3087		Method of weighing (see 7.2)					
Sample No.:		Minimum mass of test portion: 5 kg		Whole-through sieve size of test portion: 22,4 mm					
Date:		Type of iron ore:		Name of consignment:				Assayer:	
Sub-sample No.	(1) Number of increments	(2) Total mass before drying (g)	(3) Total mass after drying (g)	(4) Mass of drying pan (g)	(5) = (2) − (4) Initial mass of test portion (g)	(6) = (3) − (4) Mass of dried test portion (g)	(7) = (5) − (6) Drying loss (g)	(8) = $\frac{(7)}{(5)} \times 100$ Results of moisture determination, w_i (%)	(9) (1) × (8)
1	5	6 015	5 793	950	5 065	4 843	222	4,38	21,90
2	5	6 110	5 895	953	5 157	4 942	215	4,17	20,85
3	5	5 970	5 755	946	5 024	4 809	215	4,28	21,40
4	6	6 280	6 060	955	5 325	5 105	220	4,13	24,78
5	6	5 970	5 750	948	5 022	4 802	220	4,38	26,28
6	5	6 021	5 804	951	5 070	4 853	217	4,28	21,40
7	5	6 123	5 905	953	5 170	4 952	218	4,22	21,10
8	6	6 378	6 154	949	5 429	5 205	224	4,13	24,78
Total	43								182,49

Moisture content of consignment, $\bar{w}$ (%) = $\frac{\sum(9)}{\sum(1)} = \frac{182,49}{43} = 4,24 \approx 4,2$

Remarks:

Table 6 — Example of recording and calculating procedure for determination of moisture content of a consignment from subsamples (time-basis sampling)

Ref. No. :		Method used : ISO 3087		Method of weighing (see 7.2)				
Sample No. :		Minimum mass of test portion : 5 kg		Whole-through sieve size of test portion : 22,4 mm				
Date :		Type of iron ore :		Name of consignment :			Assayer :	

Sub-sample No.	(1) Mass of the ith part (t)	(2) Total mass before drying (g)	(3) Total mass after drying (g)	(4) Mass of drying pan (g)	(5) = (2) − (4) Initial mass of test portion (g)	(6) = (3) − (4) Mass of dried test portion (g)	(7) = (5) − (6) Drying loss (g)	(8) = $\frac{(7)}{(5)} \times 100$ Results of moisture determination, w_i (%)	(9) (1) × (8)
1	1 520	6 105	5 873	951	5 154	4 922	232	4,50	6 840
2	1 710	6 007	5 785	950	5 057	4 835	222	4,39	7 507
3	1 565	6 130	5 906	953	5 177	4 953	224	4,33	6 776
4	1 478	5 983	5 760	949	5 034	4 811	223	4,43	6 548
5	1 330	6 042	5 807	952	5 090	4 855	235	4,62	6 145
6	1 623	6 112	5 916	948	5 164	4 968	196	3,80	6 167
7	1 587	5 980	5 760	952	5 028	4 808	220	4,38	6 951
8	1 431	6 210	6 003	950	5 260	5 053	207	3,94	5 638
Total	12 244								52 572

Moisture content of consignment, $\bar{w}$ (%) $= \frac{\sum(9)}{\sum(1)} = \frac{52\,572}{12\,244} = 4{,}29 \approx 4{,}3$

Remarks :

Table 7 — Example of test report for determination of moisture content of a consignment on four test portions taken from the gross sample

Type and grade of iron ore:								
Identity and quantity of consignment:								
Sample No.:	Minimum mass of test portion: 5 kg		Whole-through sieve size of test portion: 22,4 mm				Date:	
Total mass before drying (g)	(1)	6 004		6 015		5 970		5 988	
Mass of drying pan (g)	(2)	957		950		946		948	
Initial mass of portion (g)	(3) = (1) − (2)	5 047		5 065		5 024		5 040	
Value of 0,05 % of initial mass of test portion (g)	$(4) = \frac{(3)}{2\,000}$	2,5		2,5		2,5		2,5	
		mass	difference	mass	difference	mass	difference	mass	difference
Total mass after 4 h drying (g)	(5)	5 800		5 805		5 768		5 791	
Total mass after further 1 h drying (g)	(6)	5 793	(5) − (6) 7	5 795	(5) − (6) 10	5 757	(5) − (8) 11	5 779	(5) − (6) 12
Total mass after another 1 h drying (g)	(7)	5 792	(6) − (7) 1	5 793	(6) − (7) 2	5 755	(6) − (7) 2	5 777	(6) − (7) 2
Final drying loss (g)	(8) = (1) − (7)	212		222		215		211	
Moisture content of each test portion (%)	$(9) = \frac{(8)}{(3)} \times 100$	4,20		4,38		4,28		4,18	
Range (%)		0,20							
Repeatability (%) × 1,3 (table 3)		0,33							
Moisture content of consignment (%)		$\frac{4,20 + 4,38 + 4,28 + 4,18}{4} = 4,26 \approx 4,3$							
Remarks:		Method of weighing (see 7.2)							
Assayer:									