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Iron ores — Determination of moisture content

Minerais de fer — Détermination de l'humidité

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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.

International Standard ISO 3087 was drawn up by Technical Committee ISO/TC 102, *Iron ores,* and circulated to the Member Bodies in February 1973.

It has been approved by the Member Bodies of the following countries :

Australia	Iran	Spain
Austria	Italy	Sweden
Belgium	Japan	Thailand
Bulgaria	Netherlands	Turkey
Canada	New Zealand	United Kingdom
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France	Romania	
Germany	South Africa, Rep. of	

The Member Body of the following country expressed disapproval of the document on technical grounds :

India

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Iron ores — Determination of moisture content

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method of determining the moisture content of one sample of iron ore.

The prescribed method is applicable to all iron ores, whether natural or processed (pellets, concentrates and agglomerates).

However, some limonites, sulphides, certain ores containing high combined water and certain processed ores containing metallic iron may give erroneous results under the conditions prescribed.

2 REFERENCES

This document should be read in conjunction with the following International Standards :

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

ISO 3082, *Iron ores — Increment sampling — Mechanical method.*[1)]

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

ISO 3084, *Iron ores — Experimental methods for evaluation of quality variation.*[2)]

ISO 3085, *Iron ores — Experimental methods for checking the precision of sampling.*[2)]

ISO 3086, *Iron ores — Experimental methods for checking the bias of sampling.*

3 DEFINITION

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

4 GENERAL RULES

4.1 The sample for moisture determination shall be taken in accordance with ISO 3081 or ISO 3082 and prepared in accordance with ISO 3083.

NOTE — The sample which has been sieved in water for size determination shall not be used for determination of moisture content.

4.2 When it is difficult to conduct sieving, crushing and dividing owing to the sample being adhesive or heavily wet, the sample may be pre-dried until preparation can be conducted without trouble. In this case, the pre-drying moisture content shall be obtained by the procedure specified in the annex.

5 MOISTURE DETERMINATION IN GENERAL

5.1 Determination

The final moisture sample shall be dried by heating in the drying apparatus and, from the initial and dried masses of each sample, the moisture content, as a percentage by mass, shall be determined.

5.2 Precision and maximum permissible tolerance of moisture determination

5.2.1 *Precision*

The precision mentioned in this clause designates the precision in determining the values of moisture content when a final sample for measuring moisture content of 5 kg or 1 kg has been prepared from a final moisture sample and subjected to moisture determination in the same laboratory.

1) In preparation.

2) At present at the stage of draft.

This International Standard is designed to obtain the values of precision with 95 % probability shown in table 1.

TABLE 1 – **Precision of moisture determination**

Range of average moisture content (%)	**Precision** (absolute %)
3 and under	± 0,14
Over 3 up to 6	± 0,18
Over 6	± 0,22

5.2.2 *Maximum permissible tolerance*

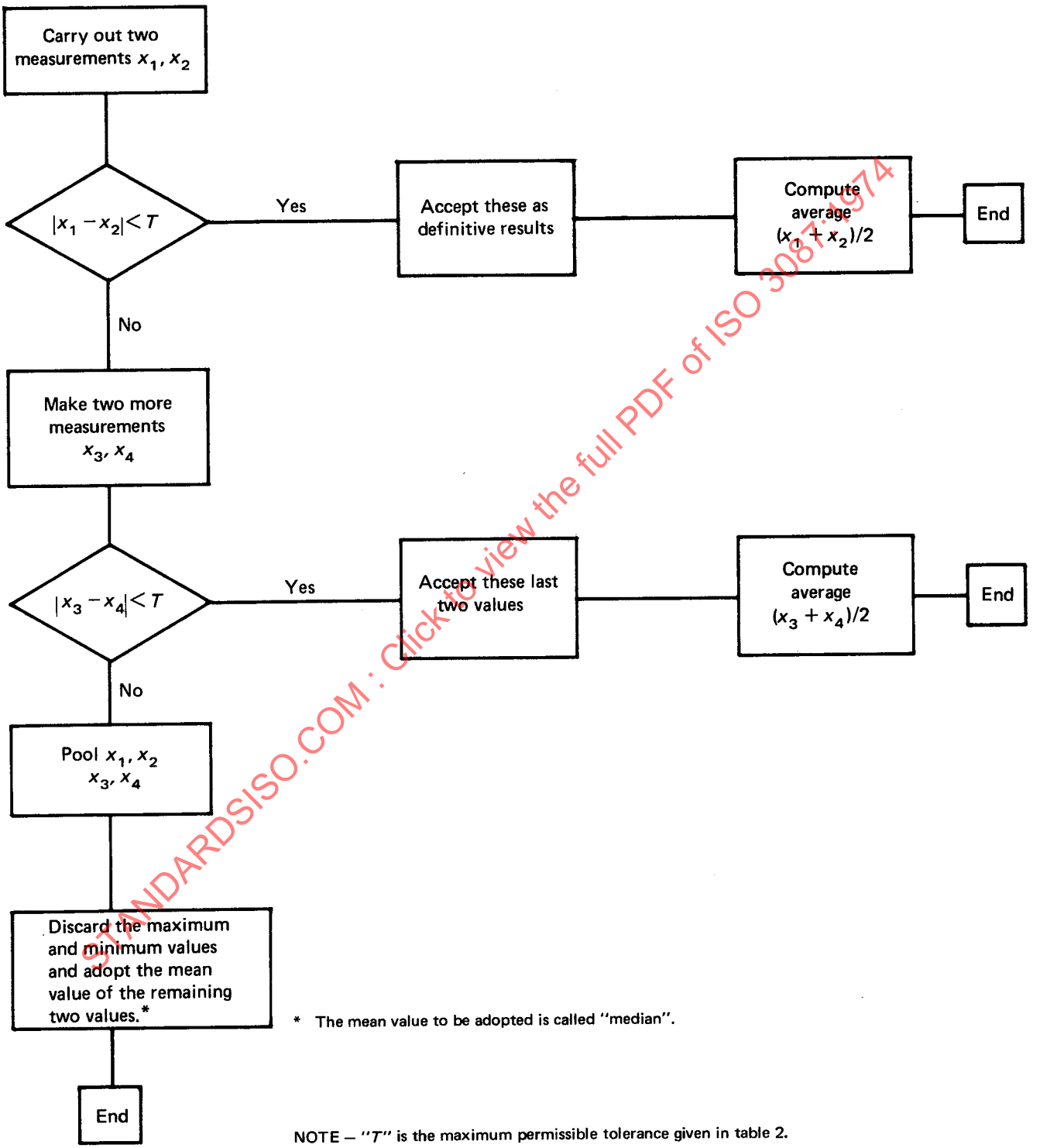
The maximum permissible tolerance of moisture determination, when duplicate measurements have been carried out in the same laboratory, shall be as shown in table 2.

TABLE 2 – **Maximum permissible tolerance of moisture determination**

Range of average moisture content (%)	**Maximum permissible tolerance,** T (absolute %)
3 and under	0,20
Over 3 up to 6	0,25
Over 6	0,30

When the values obtained by a duplicate determination exceed the above limit (T), the moisture determination shall be repeated as a duplicate determination.

NOTE – When two duplicate determinations are carried out, the final result shall be obtained by the flow chart opposite.



* The mean value to be adopted is called "median".

NOTE – "T" is the maximum permissible tolerance given in table 2.

Flow chart of procedure for the processing of the result of moisture determination

6 APPARATUS

6.1 Drying pan, having a smooth surface, free from contamination and capable of accommodating the specified quantity of sample in a layer of less than 30 mm thickness.

6.2 Drying oven, equipped with a temperature control apparatus capable of regulating the temperature at any point in the oven to within ± 5 °C of the desired temperature and so designed as to maintain this temperature.

6.3 Weighing device, having a sensitivity of 0,05 %, or better, of the initial mass of sample, and an accuracy which will ensure repeatability at the precision required.

7 SAMPLE

7.1 In accordance with the method specified in ISO 3083 or ISO 3082, the sample shall be prepared into a final moisture sample of 5 kg or more after crushing to minus 22,4 mm in size. Alternatively, samples of 1 kg or more, after crushing to minus 10 mm, may be used.

7.2 When one gross sample is obtained from the consignment, four final moisture samples shall be prepared and two of these shall be submitted initially for the determination of moisture content individually.

7.3 When sub-samples from a consignment are not combined into one gross sample, one final moisture sample shall be prepared from each sub-sample, and each of these shall be submitted for the determination of moisture content.

NOTES

1 Some moisture may be lost from the sample in the course of crushing from minus 22,4 mm to minus 10 mm in the case of a moderately wet sample. However, if no bias is confirmed by check experiments on a specific ore, the moisture sample of 1 kg or more may be obtained by crushing the sample to minus 10 mm.

2 When a consignment is very large, it is recommended that a moisture sub-sample be prepared and subjected to moisture determination for each part of the consignment as indicated in table 3. This is in order to obtain not only a better precision (including sampling, preparation and moisture determination) but also a result that has no bias.

TABLE 3 — **Minimum number of parts per consignment**

Mass of consignment tonnes		Minimum number of parts per consignment
over	up to and including	
70 000	150 000	10
30 000	70 000	5
15 000	30 000	3
5 000	15 000	2
	5 000	1

3 When it takes a long time for loading or unloading of a consignment, the consignment shall be divided for each 8 h period, and a moisture sub-sample shall be constituted and subjected to moisture determination for each part thus obtained. Such division should be subject to the condition of weather, for example heavy rain, high temperature, etc. and/or to the conditions or circumstances at the time of loading or unloading, and should be decided by agreement between the parties concerned.

8 PROCEDURE

8.1 Spread the final moisture sample, prepared in accordance with clause 7, into a thickness of less than 30 mm in the tared drying pan and determine the total mass immediately. Record the total mass, the mass of the drying pan, the initial mass of the sample and the numerical value of 0,05 % of the initial mass of the sample (see table 4).

8.2 Place the drying pan with the sample in the drying oven set at 105 °C and heat for more than 4 h.

8.3 Remove the drying pan with the sample from the drying oven and weigh immediately after drying, while still hot. Alternatively the sample may be weighed after cooling in air in a container having a close-fitting lid.

In each case report the method of weighing.

NOTE — The weighing device should be protected from the effects of the hot material by asbestos plate.

8.4 Again place the drying pan with the sample in the drying oven, heat for 1 h, then repeat the weighing.

8.5 Repeat the procedure in 8.4, until the difference in mass between subsequent determinations becomes 0,05 % or less of the initial mass of the sample.

NOTE — In the case of a series of determinations carried out on the same kind of iron ore, the heating time of the sample may be specified by check experiments beforehand.

9 EXPRESSION OF RESULTS

9.1 Moisture content of each final moisture sample

The moisture contents shall be obtained by formula (1) and reported to the second decimal place.

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

where

M_i is the moisture content, as a percentage by mass, of each sample;

m_1 is the initial mass, in grams, of the sample;

m_2 is the mass, in grams, of the sample after drying.

9.2 Moisture content of the consignment

The moisture content of the consignment or lot shall be obtained from one of the following formulas, as appropriate, and reported to the second decimal place.

1) When the determination of moisture content is conducted on the gross sample from the consignment or lot, the arithmetic mean of the two results obtained from the two samples in accordance with 9.1 shall be the moisture content of the consignment or lot, as given by formula (2).

$$M = \frac{M_1 + M_2}{2} \qquad \ldots (2)$$

where

M is the moisture content, as a percentage by mass, of the consignment or lot;

M_1 and M_2 are the moisture contents, as a percentage by mass, of the two moisture samples, respectively.

2) When the determination of moisture content is conducted on each sub-sample, the weighted mean of the results for all sub-samples, considering the number of increments in each sub-sample, shall be the moisture content of the consignment or lot, as given by formula (3).

$$M = \frac{\sum_{i=1}^{k} N_i M_i}{\sum_{i=1}^{k} N_i} \qquad \ldots (3)$$

where

M is the moisture content, as a percentage by mass, of the consignment or lot;

k is the number of sub-samples;

N_i is the number of increments in the i-th sub-sample;

M_i is the moisture content, as a percentage by mass, of the i-th sub-sample.

NOTE – If it is impracticable to sample the consignment or lot as a whole or desirable to sample a consignment or lot in separate parts of unequal mass, the moisture content of each part should be determined independently and the weighted mean moisture content of the consignment or lot calculated from the individual results by formula (4).

$$M = \frac{\sum_{i=1}^{k} m_i M_i}{\sum_{i=1}^{k} m_i} \qquad \ldots (4)$$

where

M is the moisture content, as a percentage by mass, of the consignment or lot;

k is the number of parts in a consignment or lot;

m_i is the mass of the i-th part;

M_i is the moisture content, as a percentage by mass, of the i-th part.

3) When the determination of moisture content is conducted on each increment, the arithmetic mean of the results obtained in accordance with 9.1 for all increments shall be the moisture content of the consignment, as given by formula (5).

$$M = \frac{\sum_{i=1}^{n} M_i}{n} \qquad \ldots (5)$$

where

n is the number of increments;

M_i is the moisture content, as a percentage by mass, of the i-th increment.

The above formulas are applicable only if sampling is carried out in accordance with ISO 3081 or ISO 3082.

10 TEST REPORT

Three examples are shown in tables 4, 5 and 6. Table 4 is the test report for determination of moisture content of each sample, table 5 is mainly used for the calculation of moisture content of the consignment, and table 6 is the test report for determination of moisture content on a gross sample (duplicate determinations).

TABLE 4 — **Example of test report for determination of moisture content of each sample**

Type and grade of iron ore :				
Identity and quantity of consignment :				
Sample No. :	Mass of sample : 5 kg	Particle size of sample : −22,4 mm		Date :
Total mass before drying (g)		(1)	6 015	
Mass of drying pan (g)		(2)	950	
Initial mass of sample (g)		(3)=(1)−(2)	5 065	
Value of 0,05 % of initial mass of sample (g)		$(4)=\frac{(3)}{2\,000}$	2,5	
			mass	difference*
Total mass after 4 h drying (g)		(5)	5 805	
Total mass after 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	
Moisture content (M_i) (%)		$(9)=\frac{(8)}{(3)}\times 100$	4,38	
Remarks :				
Assayer :				

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

TABLE 5 — **Example of recording and calculating paper for determination of moisture content of consignment**

Sample No. :		Mass of sample : 5 kg			Particle size of sample : −22,4 mm				
Date :		Type and grade of iron ore :			Name of consignment :			Assayer :	
Sub-sample No.	(1) No. of increments	(2) Total mass before drying (g)	(3) Total mass after drying (g)	(4) Mass of drying pan (g)	(5) Initial mass of sample (g)	(6) Mass of dried sample (g)	(7) Drying loss (g)	(8) Moisture content (M_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
Total	27	Moisture content (M) (%) $=\frac{\Sigma(9)}{\Sigma(1)}=\frac{115,21}{27}=4,27$							115,21

Final result : 4,27 %

TABLE 6 – **Example of test report for determination of moisture content on a gross sample**

(Duplicate determinations)

Type and grade of iron ore :					
Identity and quantity of consignment :					
Sample No. :	Mass of sample : 5 kg	Particle size of sample : −22,4 mm		Date :	
Total mass before drying (g)	(1)	6 015		5 970	
Mass of drying pan (g)	(2)	950		946	
Initial mass of sample (g)	(3)=(1)−(2)	5 065		5 024	
Value of 0,05 % of initial mass of sample (g)	$(4) = \frac{(3)}{2\,000}$	2,5		2,5	
		mass	difference	mass	difference
Total mass after 4 h drying (g)	(5)	5 805		5 768	
Total mass after 1 h drying (g)	(6)	5 795	(5)−(6) 10	5 757	(5)−(6) 11
Total mass after another 1 h drying (g)	(7)	5 793	(6)−(7) 2	5 755	(6)−(7) 2
Final drying loss (g)	(8) = (1)−(7)	222		215	
Moisture content of each sample (%)	$(9) = \frac{(8)}{(3)} \times 100$	4,38		4,28	
Maximum permissible tolerance (%)		0,25			
Moisture content (%)		4,33			
Remarks :					
Assayer :					