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Ferroalloys — Sampling and sieve analysis

Ferro-alliages — Échantillonnage et analyse par tamisage

Reference number
ISO 4551 : 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 4551 was prepared by Technical Committee ISO/TC 132, *Ferroalloys*.

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.

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Tables

Ferroalloys — Sampling and sieve analysis

1 Scope and field of application

This International Standard specifies the methods of sampling, sample preparation and sieve analysis for the determination of the size distribution in a consignment or a lot of all types of ferroalloys of particle size equal to or greater than 40 µm.

2 References

ISO 565, *Test sieves — Woven metal wire cloth, perforated plate and electroformed sheet — Nominal sizes of openings.*

ISO 2591, *Test sieving.*

ISO 3310, *Test sieves — Technical requirements and testing*

— *Part 1: Metal wire cloth.*

— *Part 2: Metal perforated plates.*

ISO 3713, *Ferroalloys — Sampling and sample preparation — General rules.*

3 Definitions

For definitions of the terms "lot", "consignment", "increment", "gross sample", "divided sample", "test sample" and "nominal top size", see ISO 3713.

In addition, for the purpose of this International Standard, the following definitions apply.

3.1 size sample: A sample taken for the determination of the size distribution of a consignment or a part of a consignment.

3.2 charge: A quantity of a ferroalloy to be subjected to control testing at one time on an individual sieve or a nest of sieves.

3.3 hand placing: A sieving operation in which particles of a ferroalloy are presented on to a sieve, screened and the particles (lumps[1]) retained on the sieve are oriented by hand in such a manner that the possibility of their passing through the sieve will be stated with clear classification of the retained particles (lumps) as oversize.

3.4 size fractions: A portion of a test sample separated with paired sieves having opening sizes of x mm and y mm where $x > y$, or with one sieve having an opening size of x mm (or y mm). The portion separated with paired sieves is designated by $-x$ $+y$ mm and the one separated with one sieve is designated by $+x$ mm or $-x$ mm ($+y$ mm or $-$ y mm).

3.5 oversize: A portion of a test sample retained on a sieve of opening size x mm; it is designated by $+x$ mm.

3.6 undersize: A portion of a test sample passed through a sieve of opening size y mm; it is designated by $-y$ mm.

3.7 size distribution: A quantitative grouping of particles in a sample according to their sizes; it is expressed in percentage mass passed or retained on selected sieves in relation to the total mass of the sample.

3.8 sieving: A process of separating a mixture of particles according to their sizes with one or more sieves.

3.9 hand sieving: An operation in which a sieve (or set of sieves) is supported and agitated manually.

3.10 assisted hand sieving: An operation in which a sieve (or set of sieves) is supported mechanically but agitated manually.

1) The word "lump" is used in the body of this International Standard for ferroalloys of more than 100 mm in particle size.

3.11 mechanical sieving: An operation in which a sieve (or set of sieves) is supported and agitated mechanically.

3.12 batch sieving: An operation of hand or mechanical sieving in which the resulting products are retained within a frame of a sieve or a nest of sieves until the end of the test is reached; the number of particle presentations to the apertures is dependent on the length of sieving time.

Batch sieving is usually carried out using a nest of sieves.

3.13 continuous sieving: An operation in which a ferroalloy is continuously fed on to one or several consecutive sieving surfaces over which it travels; the products are continuously discharged.

4 Overall precision

The overall precision is the measure of the precisions of sampling, sample division and measurements. It is expressed as twice the standard deviation of all the operations of sampling, sample division and sieve analysis (see the annex).

Size distribution of a ferroalloy is determined as percentage groups by mass of material which are retained on, between or passed through a nest of sieves selected for testing. Not all of these percentage groups have the same precision.

This International Standard permits the values of overall precision $\pm\beta_{SDM}$ given in tables 1 and 2 as a function of the mass of a consignment sampled to be obtained, where β_{SDM} is the overall precision at a 95 % confidence level.

Other values for overall precision calculated using the formula and data given in the annex may be specified by agreement between the interested parties (see the annex).

Table 1 — Overall precision of the determination of the oversize and undersize in consignments of FeCr, FeSiCr, FeSi, FeSiMn, FeMn

Mass of consignment t		Overall precision $\pm\beta_{SDM}$, % (m/m)			
		Oversize	Undersize		
Over	Up to and including	Over 5 up to and including 10	Up to and including 5	Over 5 up to and including 10	Over 10 up to and including 20
5 000	10 000	3,1	1,2	2,0	2,6
2 500	5 000	3,2	1,2	2,1	2,7
1 000	2 500	3,3	1,2	2,1	2,7
500	1 000	3,4	1,3	2,1	2,8
250	500	3,5	1,3	2,2	2,9
100	250	3,7	1,3	2,3	3,0
50	100	3,8	1,4	2,3	3,1
25	50	4,1	1,5	2,5	3,3
10	25	4,8	1,7	2,8	3,9
5	10	5,3	1,8	3,1	4,3
	5	6,1	2,0	3,4	4,8

Table 2 — Overall precision of the determination of the oversize and undersize in consignments of FeW, FeMo, FeNb, FeTi, FeV, FeB

Mass of consignment t		Overall precision $\pm\beta_{SDM}$, % (m/m)			
		Oversize	Undersize		
Over	Up to and including	Over 5 up to and including 10	Up to and including 5	Over 5 up to and including 10	Over 10 up to and including 20
40	64	3,3	1,2	2,1	2,7
25	40	3,5	1,3	2,2	2,9
16	25	3,7	1,3	2,3	3,0
10	16	3,9	1,4	2,4	3,2
5	10	4,2	1,5	2,5	3,4
3	5	4,7	1,6	2,7	3,7
1	3	5,1	1,7	2,9	4,1
0,5	1	5,7	1,9	3,2	4,5
	0,5	6,6	2,2	3,7	5,2

5 Sampling

5.1 General rules

The principal general rules shall be in accordance with ISO 3713.

5.1.1 The mass of an increment shall be determined as a function of the apparent density and the nominal top size of a ferroalloy in a consignment so as to avoid any bias while preparing a gross sample for sieve analysis.

5.1.2 The number of increments shall be determined as a function of the heterogeneity of a ferroalloy according to the percentage of controlled size fractions and sampling precision required.

5.1.3 A gross sample for sieve analysis shall not be subjected to any changes during any of the operations of sampling and sample preparation.

5.2 Mass of an increment

5.2.1 Depending on the nominal top size of a consignment and the value of the apparent density, the masses of increments shall be not less than those given in table 3.

The apparent density of a ferroalloy shall serve as a criterion for its inclusion in one of the above groups.

The coefficient of variation of the increment masses taken from one consignment or a lot shall not exceed 20 %.

5.2.2 The mass of an increment shall be not less than 0,3 kg.

5.2.3 Increments of masses greater than those shown in table 3 shall be taken in cases when a sample can be conveniently taken in one operation across the section of a ferroalloy stream, for example by

a) taking all the material from a certain place on a stopped belt; the length of the place being not less than three times the top size of the ferroalloy passing;

b) taking the whole of the contents of one or several packed units.

Table 3 — Mass of an increment as a function of the nominal top size in a consignment

Nominal top size mm	Mass kg		
	Group 1[1]	Group 2[2]	Group 3[3]
315	—	337	81
200	—	164	46
150	—	104	32
100	79	55	19
75	48	35	13
50	24	18	8
35	13	10	5
25	7	6	3
10	1,5	1,4	1,1
6,3	0,7	0,7	0,6
3,15	0,3	0,3	0,3
2	0,3	0,3	0,3

1) FeW, FeMo, FeNb

2) FeCr, FeSiCr, FeMn, FeTi, FeV, FeB, FeSi, having a silicon content less than 45 % (m/m)

3) FeB, SiCa, FeSiCa, FeSi, having a silicon content equal to or greater than 45 % (m/m)

5.3 Number of increments

The minimum number of increments necessary for attaining the given precision of sampling as a function of the mass of a consignment shall correspond to that shown in tables 4 and 5.

Table 4 — Minimum number of increments and precision of sampling for FeCr, FeSiCr, FeSi, FeSiMn, FeMn

Mass of consignment t		Minimum number of increments	Precision of sampling $\pm\beta_S$, % (m/m)			
			Oversize	Undersize		
Over	Up to and including		Over 5 up to and including 10	Up to and including 5	Over 5 up to and including 10	Over 10 up to and including 20
5 000	10 000	33	2,5	0,8	1,3	1,9
2 500	5 000	30	2,6	0,8	1,4	2,0
1 000	2 500	28	2,7	0,8	1,4	2,1
500	1 000	25	2,8	0,9	1,5	2,2
250	500	23	2,9	0,9	1,6	2,3
100	250	20	3,2	1,0	1,7	2,4
50	100	18	3,3	1,1	1,8	2,6
25	50	15	3,7	1,2	1,9	2,8
10	25	10	4,5	1,4	2,4	3,5
5	10	8	5,0	1,6	2,6	3,9
	5	6	5,8	1,8	3,1	4,5

Table 5 — Minimum number of increments and precision of sampling for FeW, FeMo, FeTi, FeV, FeB, FeNb

Mass of consignment t		Minimum number of increments	Precision of sampling $\pm\beta_S$, % (m/m)			
			Oversize	Undersize		
Over	Up to and including		Over 5 up to and including 10	Up to and including 5	Over 5 up to and including 10	Over 10 up to and including 20
40	64	28	2,7	0,8	1,4	2,1
25	40	24	2,9	0,9	1,5	2,2
16	25	20	3,2	1,0	1,7	2,4
10	16	17	3,4	1,1	1,8	2,7
5	10	14	3,8	1,2	2,0	2,9
3	5	11	4,3	1,3	2,3	3,3
1	3	9	4,7	1,5	2,5	3,6
0,5	1	7	5,3	1,7	2,8	4,1
	0,5	5	6,3	2,0	3,3	4,9

5.4 Equipment used for increment sampling

5.4.1 Equipment used for increment sampling shall be selected taking into consideration the physical and mechanical properties of a ferroalloy so that its size distribution will not be changed.

The following equipment may be used:

a) mechanical sampling devices for increment sampling from a ferroalloy stream;

b) a steel shovel or a scoop;

c) containers for sampling;

d) a probe.

5.4.2 Equipment for increment sampling shall be in accordance with ISO 3713.

5.5 Preparation for sampling

The preparation for sampling shall be in accordance with ISO 3713.

5.6 Methods of increment sampling

The methods of increment sampling shall be in accordance with ISO 3713.

6 Sieve analysis

6.1 General requirements

6.1.1 Sieve analysis of ferroalloys susceptible to breakage through handling shall be carried out near the place of sampling.

6.1.2 A sample for sieve analysis may be divided into fractions of the following particle (lump) sizes by preliminary sieving:

a) over 100 mm;

b) over 25 mm up to and including 100 mm;

c) over 10 mm up to and including 25 mm;

d) over 3,15 mm up to and including 10 mm;

e) over 1 mm up to and including 3,15 mm;

f) 1 mm and less.

6.1.3 Size analysis of ferroalloys of particle size greater than 25 mm shall be carried out over the whole gross sample.

6.1.4 If the mass of a gross sample for sieve analysis of particle size 25 mm and less is more than twice the values given in table 6, it may be decreased to minimize the work involved in sieving.

Table 6 — Minimum mass of a test sample

Nominal top size	Minimum mass of a test sample, kg	
	Groups 1 and 2	Group 3
25,0 mm	50	25
10,0 mm	25	15
3,15 mm	1,0	0,7
710 µm	0,5	0,3
125 µm	0,15	0,05
71 µm	0,10	0,05

6.1.4.1 Division of the mass of a sample for sieve analysis shall be carried out by the methods specified in ISO 3713.

6.1.5 Separation of ferroalloys by fractions may be carried out by one of the following methods:

a) mechanical continuous and batch sievings (see 3.11, 3.12 and 3.13);

b) hand sieving according to ISO 2591;

c) hand placing in individual sieves (see 3.4); the minimum aperture size at which this method may be applied shall be 25 mm.

Hand sieving of the whole sample for sieve analysis carried out under controlled conditions with strict maintenance of the requirements specified in ISO 2591 is the most accurate method for the determination of a ferroalloy size distribution.

6.1.6 For ferroalloys of particle size greater than 25 mm,

a) the mass of a charge shall form a layer of thickness of not greater than 2d (where d is the nominal top size, in millimetres) in the case of batch sieving;

b) the upper sieve shall be charged so that the ferroalloy forms a layer of thickness equal to the nominal top size, in the case of continuous sieving.

6.1.7 For ferroalloys of particle size 25 mm and less, the volume of a charge, procedure of sieving and the maximum volume of the residue on a sieve shall correspond to those specified in ISO 2591.

6.1.8 The duration of sieving shall be determined by size fractions by the methods specified in ISO 2591.

It is sufficient to sieve ferroalloys of particle size less than 20 mm or 10 mm for 2 or 3 min.

For ferroalloys of particle size less than 3,15 mm, the duration of sieving may be 10 min and more. The duration of sieving shall be determined by the rule for the end point specified in ISO 2591.

When it is impossible to apply the rule for the end point (e.g. when using continuous or mechanical batch sieving), an agreement shall be reached between the interested parties concerning the duration and conditions of sieving.

6.2 Preparation of a gross sample for sieve analysis

6.2.1 A ferroalloy sample shall be subjected to control sieving in the physical state as taken.

If a gross sample for sieve analysis is wet, it is necessary to dry it to the state when division of the material can be effected.

6.2.2 A gross sample shall be prepared for sieve analysis according to figure 1.

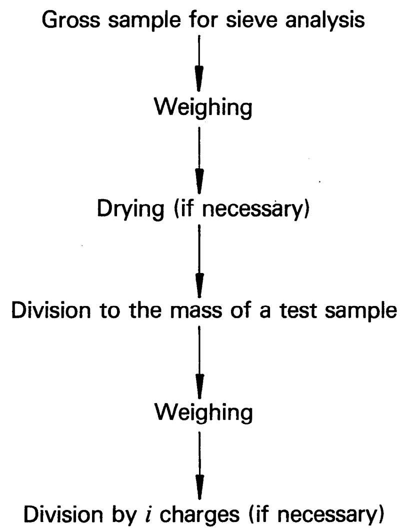

Figure 1 — Diagram for the preparation of a gross sample for sieve analysis

6.2.3 Before sieving, the following shall be established (see 6.1.2):

a) the number and succession of sieves used;

b) the type of equipment required (for manual or mechanical sieving).

It is recommended that the number of sieves in a nest be more than is required for the determination of the controlled fractions to avoid overloading of the bottom sieve. In such a case, it is preferable that not more than 5 % of a ferroalloy remains on the upper sieve and that not more than 25 % of a ferroalloy falls between any pair of sieves.

6.3 Apparatus for sieve analysis

6.3.1 Test sieves

6.3.1.1 Sieve media

The sieve media shall have square openings the sizes of which shall be in accordance with ISO 565.

In view of the high density of ferroalloys, perforated plates are preferred as the sieving medium for opening sizes from 125 to 10 mm and either perforated plates or woven wire for opening sizes from 10 to 3,15 mm. For sizes smaller than 3,15 mm woven wire cloth shall be used.

It is recommended that indiscriminate mixing of types of sieve media be avoided within any determination.

6.3.1.2 Sieve frames

The shape and sizes of sieve frames shall be in accordance with ISO 2591.

The sieve frames shall nest snugly with each other and with the lid and the receiver of the same type. The frame shall be smooth and the seals of the sieves so constructed as to prevent lodging of the material.

6.3.1.3 Preparation and use of sieves

The preparation and use of sieves shall be in accordance with ISO 2591 and their precision shall be verified as specified in ISO 3310.

6.3.2 Sieving apparatus

Any type of apparatus is acceptable, provided that the results obtained are within 2 % of those of hand sieving carried out under the controlled conditions specified in ISO 2591.

6.3.3 Auxiliary devices

6.3.3.1 Equipment for mass determination

Each device for the determination of a mass shall have a sensitivity of at least 0,1 % of its rated capacity and a level of accuracy to permit the mass of the test sample and of each size fraction to be determined to a precision of 0,15 % or better.

6.3.3.2 Implements for collecting material and cleaning sieves

Receivers, scoops, brushes, bars of hardwood, etc., may be used. The use of balls and chains added to the material is not permissible.

6.4 Procedure for sieve analysis

6.4.1 General

A test sample (as one or several charges) shall be placed into a sieve or a nest of sieves and shaken, observing the established rules, up to the end-point. Fractions remaining on each sieve and the receiver shall be weighed separately. The mass of each fraction shall be calculated, as a percentage of the initial mass of the test sample, to determine the size distribution of a consignment.

6.4.1.1 Lumps greater than 100 mm in size

For sizing lumps greater than 100 mm in size, the following methods of sieving may be used:

a) hand placing (see 3.3);

b) mechanical batch sieving (see 3.11 and 3.12).

All lumps the sizes of which exceed the specified level shall be taken out and weighed.

Individual fractions shall be obtained by using sieves having openings of different sizes.

6.4.1.2 Particles over 25 mm up to and including 100 mm in size

The −25 mm fraction shall be separated from a ferroalloy of particle size 100 mm and less.

For sizing particles in the −100 +25 mm range, the following types of sieving may be used:

a) hand batch sieving (see 3.9 and 3.12);

b) mechanical batch sieving (see 3.11 and 3.12);

c) continuous sieving (see 3.13).

6.4.1.3 Particles from 40 µm up to and including 25 mm in size

Sieve analysis of ferroalloys from 40 µm up to and including 25 mm in size shall be carried out in accordance with ISO 2591.

6.5 Evaluation of results

The evaluation of the results shall be carried out in accordance with ISO 2591.