INTERNATIONAL STANDARD

ISO 11323

Second edition
2002-04-15

Iron ore and direct reduced iron — Vocabulary

Minerais de fer et minerais de fer préréduits — Vocabulaire

Reference number
ISO 11323:2002(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

Contents

Page

Foreword iv
1 Scope 1
2 Normative reference 1
3 Natural and processed iron ore 1
4 Direct reduced iron 3
5 Sampling 3
6 Particle size analysis 5
7 Physical testing 8
8 Chemical analysis 12
Annex A (informative) **Concentration ranges of elements of interest** 13
Annex B (informative) **List of equivalent terms in English, French, Japanese, Chinese and Portuguese** 14
Bibliography 22
Alphabetical Index 24

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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 11323 was prepared by Technical Committee ISO/TC 102, *Iron ore and direct reduced iron*.

This second edition cancels and replaces the first edition (ISO 11323:1996) which has been technically revised.

Annexes A and B of this International Standard are for information only.

Iron ore and direct reduced iron — Vocabulary

1 Scope

This International Standard gives the definitions for terms used in TC 102 standards for sampling, sample preparation, moisture and particle size analysis and physical testing of iron ore and direct reduced iron. Also included are some specific analytical terms used in the relevant International Standards.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 565:1990, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings*

3 Natural and processed iron ore

3.1
iron ore
any rocks, minerals or aggregates of minerals, natural or processed, from which iron can be produced commercially

NOTE The principal ferriferous minerals occurring in iron ore either singly or severally are:

a) red, brown and specular hematites, martite and maghemite;

b) magnetite;

c) hydrated iron oxides, including goethite, limonite and limnite;

d) iron carbonates, including siderite or chalybite, ankerite and other mixed carbonates;

e) roasted iron pyrites or pyrite cinders;

f) ferrites (e.g. calcium ferrite) occurring sometimes in natural ores, but mainly in fluxed pellets and sinters.

Also included are manganiferous iron ore and concentrates that contain not more than 8 % manganese by mass (dry basis after heating to 105 °C).

Excluded are finely ground ferriferous minerals used for pigments, glazes, dense medium suspension and other materials not related to iron- and steelmaking.

3.2
natural iron ore
ores as extracted from mines and not subjected to any processes of beneficiation other than sizing

NOTE Such ores are also called direct shipping ores or run-of-mine ores.

3.3
lump ore
ore lump
ores consisting of coarse particles, with a specified lower size limit in the range of 10 mm to 6,3 mm

3.4
sized ores
ores that have been prepared to meet specific size limits

3.5
fine ores
ore fines
ores consisting entirely of small particles, with specified upper size limits in the range of 10 mm to 6,3 mm

3.6
processed ores
ores treated by physical or chemical processes to make them more suitable for the subsequent production of iron and steel

NOTE Main purposes of processing include the following:

a) raising the iron content;

b) decreasing slag-forming constituents;

c) decreasing harmful impurities such as phosphorus, arsenic or sulfur compounds;

d) adjusting size distribution;

e) improving metallurgical behaviour of the metallic furnace burden.

3.7
concentrates
processed ores (3.6) in which the percentage iron content has been raised

3.8
agglomerates
processed ores (3.6) formed into coherent pieces which are substantially larger than the original **particles** (6.1)

NOTE The industrial processes for making agglomerates include sintering and pelletizing.

3.9
sinter
type of **agglomerates** (3.8) made from **fine ores** (3.5) by means of forced draught combustion of an admixed fuel

NOTE Sinter forms through adhesion between particles due to superficial melting, diffusion and recrystallization. Sinters may be fluxed or superfluxed according to their acid and basic oxide contents.

3.10
pellets
spherical **agglomerates** (3.8) formed by balling **fine ores** (3.5), usually finer than 100 μm, with various additives followed sometimes by hot or cold bonding induration

NOTE Pellets may be acid, partially fluxed, fluxed or super-fluxed, according to their acid and basic oxide contents.

4 Direct reduced iron

4.1
direct reduced iron
DRI
high grade feed for iron- and steelmaking obtained from the reduction of natural or processed iron ores, without reaching the melting temperature

NOTE DRI includes metallized products that have been further processed by hot or cold briquetting.

4.2
briquettes
product formed by compressing **direct reduced iron** (4.1) in moulds

4.3
hot briquetted iron
HBI
direct reduced iron (4.1) briquetted at a temperature greater than 650 °C and having an **apparent density** (7.1.2) greater than 5 g/cm^3

4.4
cold briquetted iron
CBI
direct reduced iron (4.1) briquetted at a temperature lower than 650 °C and having an **apparent density** (7.1.2) lower than 5 g/cm^3

5 Sampling

5.1
lot
discrete and defined quantity of **iron ore** (3.1) and **direct reduced iron** (4.1) for which quality characteristics are to be assessed

5.2
strata
approximately equal parts of a **lot** (5.1) based on time, mass or space

NOTE Example of strata include production periods (e.g. 5 min), production masses (e.g. 1 000 t), holds in vessels, wagons in a train, containers and trucks representing a lot.

5.3
sample
relatively small quantity of **iron ore** (3.1) and **direct reduced iron** (4.1), so taken from a **lot** (5.1) as to be representative in respect of the quality characteristics to be assessed

5.4
gross sample
sample (5.3) comprising all **increments** (5.8), entirely representative of all quality characteristics of a **lot** (5.1)

5.5
partial sample
sample (5.3) comprising less than the complete number of **increments** (5.8) needed for a **gross sample** (5.4)

5.6
test sample
sample (5.3) prepared to meet all specific conditions for a test

5.7
test portion
part of a **test sample** (5.6) that is actually and entirely subjected to the specific test

5.8
increment
quantity of **iron ore** (3.1) and **direct reduced iron** (4.1) taken in a single operation of a device for sampling or **sample division** (5.15)

5.9
cut
increment (5.8) taken in a single traverse of a sample cutter through a stream, bed or stratum of **iron ore** (3.1) and **direct reduced iron** (4.1)

5.10
sampling regime
collection plan for constituting a **sample** (5.3) that defines the number of, mass of and interval between **increments** (5.8)

5.11
sampling scheme
methodical and detailed sequence of all **sampling stages** (5.13), defining successive sampling operations and all associated steps of preparation and division

5.12
sampling procedure
instructions specifying the operational requirements of a particular **sampling scheme** (5.11)

5.13
sampling stage
single **sample division** (5.15) operation, together with any associated **sample preparation** (5.14)

5.14
sample preparation
process of rendering a **sample** (5.3) suitable for the determination of specified quality characteristics

NOTE Preparation can include various processes such as drying, mixing, sieving, sample division or comminution which may be employed at several stages of sampling.

5.15
sample division
any procedure, without comminution, to decrease the mass of any **sample** (5.3) or **increment** (5.8) retained at any **sampling stage** (5.13)

NOTE Division should be controlled so that each divided sample or the total sum of the divided increments remains representative of the lot for specific purposes of the tests.

5.16
proportional mass division
division of **samples** (5.3) or **increments** (5.8) such that the mass of each retained divided portion is a fixed proportion of the mass being divided

5.17
constant mass division
division of **sample** (5.3) or **increments** (5.8) such that the retained divided portions are of almost uniform mass, irrespective of variations in mass of the **samples** or **increments** divided

NOTE This method is required for sampling on mass basis. "Almost uniform" means that variations in mass are less than 20 % in terms of the coefficient of variation.

5.18
split use of sample
separate use of parts of a **sample** (5.3), as **test samples** (5.6) for separate determinations of quality characteristics

5.19
multiple use of sample
use of a **sample** (5.3) in its entirety for the determination of one quality characteristic, followed by the use of the same sample in its entirety for the determination of one or more other quality characteristics

5.20
interleaved samples
samples (5.3) constituted by placing consecutive primary **increments** (5.8) alternately into two sample containers

5.21
manual sampling
collecting **samples** (5.3) or **increments** (5.8) by human effort

5.22
mechanical sampling
collecting **samples** (5.3) or **increments** (5.8) by mechanical means

5.23
stratified sampling
sampling of a **lot** (5.1) carried out by taking **increments** (5.8) from specified positions and in appropriate proportions from **strata** (5.2)

5.24
stratified random sampling
stratified **sampling** (5.23) of a **lot** (5.1) carried out by taking one or more **increments** (5.8) at random within each stratum

5.25
systematic sampling
sampling carried out by taking **increments** (5.8) from a **lot** (5.1) at regular intervals

5.26
mass-basis sampling
sampling carried out so that **increments** (5.8) are taken at equal mass intervals, increments being as near as possible of uniform mass

5.27
time-basis sampling
sampling carried out so that **increments** (5.8) are taken from falling streams, or from conveyors, at uniform time intervals, the mass of each increment being proportional to the mass flow rate at the instant of taking the increment

6 Particle size analysis

6.1
particle
discrete and coherent piece of **iron ore** (3.1) or **direct reduced iron** (4.1), regardless of size, shape or mineral content

6.2
particle size
practical size definition, irrespective of **particle** (6.1) shape, obtained by **sieving** (6.10)

NOTE The particle size may be defined by the size of the smallest sieve aperture through which the particle has passed and the size of the largest sieve aperture on which the particle has been retained ($- a + b$ mm). Particle size may be less precisely defined by stating one sieve aperture size ($+ x$ mm) or ($- z$ mm).

6.3
specification size
sieve aperture size (or sizes) chosen to define a percentage mass limit (or limits) for any size fraction (or fractions) considered to be significant

NOTE A specification sieve has the aperture size that corresponds to the specification size; e.g., a pellet feed may be specified as not more than m % + x mm, or a sinter feed as not more than n % $- z$ mm.

6.4
nominal top size
particle size (6.2) expressed by the smallest aperture size of the test sieve (from a square opening complying with the R20 series in ISO 565), such that no more than 5 % by mass of **iron ore** (3.1) and **direct reduced iron** (4.1) is retained on the sieve

NOTE This definition applies to iron ore and crushed HBI, but not to HBI prior to crushing.

6.5
size fraction
sample portion separated by using one sieve, or two sieves of different aperture sizes

6.6
oversize fraction
coarsest portion of a **sample** (5.3), retained on the sieve of largest aperture used in a test, designated as $+ x$ mm and quoted as a percentage of the total mass of the sample

6.7
intermediate size fraction
sieved sample portion specified by two sizes, i.e. the smallest sieve aperture (a mm) through which it has passed and the largest sieve aperture (b mm) on which it has been retained, designated as $- a + b$ mm and quoted as a percentage of the total mass of the **sample** (5.3)

6.8
undersize fraction
finest portion of a **sample** (5.3), comprising all **particles** (6.1) that have passed the sieve of smallest aperture used in a test, designated as $- z$ mm and quoted as a percentage of the total mass of the sample

6.9
size distribution
in size analysis by **sieving** (6.10), the proportion of **particles** (6.1) according to the sizes of sieve apertures used and expressed as percentage masses, passed or retained on sieves of selected apertures, relative to the total mass of the **sample** (5.3)

6.10
sieving
process for separating particulate **iron ore** (3.1) and **direct reduced iron** (4.1) into two or more **size fractions** (6.5), using one or more sieves

6.11
charge
quantity of **iron ore** (3.1) and **direct reduced iron** (4.1) to be treated at one time on one sieve or on a set of sieves

NOTE The permissible mass of a charge depends on the size and aperture of sieves used.

6.12
mass of sample used for sieving
quantity of **iron ore** (3.1) and **direct reduced iron** (4.1) actually sieved for one complete size analysis

NOTE This may comprise several separate **charges** (6.11), in which case it is expressed as the sum of all charges used.

6.13
hand placing
sieving (6.10) method that may be used when a **sample** (5.3) contains relatively coarse **particles** (6.1), usually 20 mm or larger in size, each particle being individually presented to a sieve aperture by hand and turned until it can either pass through, without force being applied, or can be classed clearly as oversize

6.14
hand sieving
sieving (6.10) operation in which a sieve or a set of sieves is supported and agitated manually

6.15
assisted hand sieving
sieving (6.10) operation in which a sieve or a set of sieves is supported mechanically, but is agitated manually

6.16
machine sieving
sieving (6.10) operation, in batch or continuous sieving, in which one or more sieves are supported and agitated by mechanical means

6.17
batch sieving
sieving (6.10) operation in which a specific mass or volume of sample is presented to one or more sieves which are agitated either by hand or by mechanical means

NOTE Oversize fractions remain within the frames of the retaining sieves until the end of the sieving operation. The number of presentations of the particles to the sieve apertures depends on the length of sieving time.

6.18
continuous sieving
machine sieving (6.16) operation in which the sample is fed continuously over one or several consecutive sieving surfaces which are mechanically agitated, rotated or inclined

NOTE The ore particles travel over each sieving surface until they either pass through or remain on as oversize. There is continuous discharge of all oversize fractions and of the final undersize product. Usually, numbers of presentations of particles to the sieve apertures depend on the length of sieving time.

6.19
dry sieving
sieving (6.10) without the application of water

6.20
wet sieving
sieving (6.10) with a sufficient application of water to ensure the passage of undersize particles through the sieve apertures

6.21
sieving amplitude
maximum displacement of a sieve from its mean position during the motion of sieving

NOTE In sieving with a straight line motion, the amplitude is half of the total linear movement. With an elliptical motion, it is half of the major axis of the ellipse. With a circular motion it is the radius of the circle.

6.22
end point
elapsed time after which further sieving does not yield sufficient additional mass of undersize to significantly change the result

7 Physical testing

7.1 Bulk density and apparent density

7.1.1
bulk density
mass in air of a unit volume of **iron ore** (3.1) and **direct reduced iron** (4.1), including the voids between and within the **particles** (6.1), referred to as ρ_{ap} and expressed in kilograms per cubic metre

NOTE In industrial practice, bulk density of iron ore is expressed as the ratio of the mass to the volume of a measuring container filled under specified conditions.

7.1.2
apparent density
ratio of the mass in air of **hot briquetted iron** (4.3) to its **apparent volume** (7.1.3).

NOTE In ISO 15968 the apparent density is referred to as ρ_a and expressed in grams per cubic centimetre.

7.1.3
apparent volume
volume of **hot briquetted iron** (4.3), including the volume of any closed and open pores, as given by the mass of water displaced by the material previously saturated in water at a specified temperature

7.1.4
open pores
pores of **hot briquetted iron** (4.3), penetrated by water upon immersion

7.1.5
closed pores
pores of **hot briquetted iron** (4.3), not penetrated by water upon immersion

7.1.6
water absorption
mass of water at a specified temperature that is absorbed into the **open pores** (7.1.4) of dry **hot briquetted iron** (4.3)

NOTE In ISO 15968 **water absorption** (7.1.6) is referred to as a, expressed as a percentage of the dry mass.

7.2 Sinter tests

7.2.1
ore mix
blend of ores and other iron-bearing materials, such as mill scale, basic oxygen steelmaking slag, dust, etc., used for a sinter test

NOTE This term does not include **return sinter fines** (7.2.13), fluxes, coke breeze or other solid fuels.

7.2.2
sinter mix
materials charged into a sintering apparatus, including the **ore mix** (7.2.1), fluxes, coke breeze or any other solid fuels, **return sinter fines** (7.2.13) and water

7.2.3
mixing time
time in minutes used for blending and granulating a **sinter mix** (7.2.2)