INTERNATIONAL STANDARD

ISO 11323

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Iron ore and direct reduced iron — Vocabulary

Minerais de fer et minerais de fer préréduits — Vocabulaire

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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)

7.2.4
bulk density of sinter mix
bulk density (7.1.1) of a wet **sinter mix** (7.2.2), as charged into a sintering apparatus

7.2.5
hearth layer
layer of previously made and sized sinter or other material, placed on the grate of a sintering apparatus before a **sinter mix** (7.2.2) is charged

7.2.6
net bed height
height of the bed of **sinter mix** (7.2.2) above the **hearth layer** (7.2.5), prior to application of **suction** (7.2.7) and prior to ignition

7.2.7
suction
differential pressure, in kilopascals, measured across the sinter bed

7.2.8
ignition intensity
quantity of heat supplied during ignition, per unit of grate area per unit time, expressed in megajoules per square metre per minute

7.2.9
ignition temperature
maximum temperature, in degrees Celsius, attained during ignition at or immediately above the surface of a sinter bed

7.2.10
sintering time
time (t) in minutes elapsed from the start of ignition, until the exhaust gas temperature reaches a maximum

7.2.11
sinter cake
sinter produced, including the **hearth layer** (7.2.5)

7.2.12
sinter handling treatment
tumbling and shatter treatments given to a **sinter cake** (7.2.11) obtained in a sinter pot test, to simulate the effects of the handling and transportation in a sinter plant

7.2.13
return sinter fines
undersize sintered fines separated from a **sinter cake** (7.2.11) by sieving after **sinter handling treatment** (7.2.12)

7.2.14
sinter product
sinter of acceptable **particle size** (6.2)

7.2.15
sinter productivity
mass of **sinter product** (7.2.14) produced per unit of grate area per unit time, after deducting the mass of the **hearth layer** (7.2.5), referred to as P and expressed in tonnes of sinter per square metre per hour

7.2.16
fuel consumption
dry mass (or masses) of solid fuel (or fuels) consumed per unit mass of **sinter product** (7.2.14), after deducting the mass of the **hearth layer** (7.2.5), expressed in kilograms per tonne

7.2.17
sinter yield
percentage (Y) of **sinter product** (7.2.14) in relation to the **sinter cake** (7.2.11) after deducting the mass of the **hearth layer** (7.2.5)

7.2.18
return sinter fines balance
ratio (B) of the mass of **return sinter fines** (7.2.13) added to the **sinter mix** (7.2.2), to the mass of **return sinter fines** generated

7.3 Strength tests

7.3.1
tumble strength
resistance of **lump ore** (3.3), **agglomerates** (3.8) or **hot briquetted iron** (4.3) to size degradation by impact and abrasion, when subjected to tumbling in a rotating drum for a specified time

NOTE In ISO 3271 and ISO 11257 tumble strength is referred to as the tumble and abrasion indices:

a) the **tumble index** is a relative measure of the resistance of **lump ore** (3.3), **agglomerates** (3.8) or **hot briquetted iron** (4.3) to size degradation by impact, referred to as TI and expressed as the percentage by mass of the + 6,30 mm fraction generated in the **test portion** (5.7) after tumbling;

b) the **abrasion index** is a relative measure of the resistance of **lump ore** (3.3), **agglomerates** (3.8) or **hot briquetted iron** (4.3) to size degradation by abrasion, referred to as AI and expressed as the percentage by mass of the − 500 µm fraction generated in the **test portion** (5.7) after tumbling.

7.3.2
abrasion
relative measure of the resistance of **lump ore** (3.3), **agglomerates** (3.8) or **hot briquetted iron** (4.3) to size degradation by abrasion when subjected to tumbling in a rotating drum, referred to as the **abrasion index** (AI) and expressed as a percentage by mass of the − 500 µm fraction generated in the test portion after tumbling for a specified time

7.3.3
crushing strength
value of the compressive load applied to individual **pellets** (3.10) to cause breakage in a compression test

NOTE In ISO 4700 the **crushing strength** (CS) is expressed as the mean value, in decanewtons, of all the measurements on the **pellets** (3.10) of the **test portion** (5.7).

7.4 Heating and reduction tests

7.4.1
decrepitation
breakage of **lump ore** (3.3), occurring as a result of rapid heating

NOTE In ISO 8371, **decrepitation** is referred to as the **decrepitation index** $DI_{6,3}$ and expressed as the percentage by mass of − 6,3 mm fraction in the **test portion** (5.7) after the thermal treatment.

7.4.2
reduction
removal, by means of reductants, of the oxygen combined with iron in **lump ore** (3.3) or **agglomerates** (3.8)

7.4.3
degree of reduction
the extent to which oxygen has been removed, after a specified reduction time, from iron oxides, expressed as the ratio of oxygen removed by reduction to oxygen originally combined with iron

NOTE 1 ISO 7215, applicable to blast furnace feedstocks, determines after a specified reduction time of 3 h the degree of reduction referred to as the final degree of reduction (R_f) expressed as a percentage by mass.

NOTE 2 ISO 11258, applicable for direct reduction feedstocks, determines after a specified reduction time of 90 minutes the degree of reduction referred to as the final degree of reduction (R_{90}) expressed as percentage by mass.

7.4.4
reducibility
the ease with which oxygen combined with iron can be removed by reductants over time from **lump ore** (3.3) and **agglomerates** (3.8)

NOTE 1 ISO 4695, applicable for blast furnace feedstocks, determines the reducibility index (dR/dt) expressed as the rate of reduction in %/min at the atomic ratio of oxygen/iron at 0,9 in %/min for 40 % degree of reduction.

NOTE 2 ISO 11258, applicable for direct reduction feedstocks, determines the reducibility indices $dR/dt_{(R = 40)}$ for 40 % degree of reduction and $dR/dt_{(R = 90)}$ for 90 % degree of reduction (O/Fe = 0,9), expressed in %/min.

7.4.5
degree of metallization
a relative measure of the amount of **metallic iron** (8.5) in the total iron content of **direct reduced iron** (4.1)

NOTE 1 ISO 11257, applicable for direct reduction feedstocks, determines the **degree of metallization** (7.4.5) after reduction over 300 min, referred to as M, expressed as the ratio of the **metallic iron** (8.5) content after reduction, to the **total iron** (8.6) content as a percentage by mass.

NOTE 2 ISO 11258, applicable for direct reduction feedstocks, determines the degree of metallization (7.4.5) after reduction over 90 minutes referred to as M_R, expressed as the ratio of the **metallic iron** (8.5) content after reduction, to the **total iron** (8.6) content as a percentage by mass.

7.4.6
reduction-disintegration
size degradation of **lump ore** (3.3) and **agglomerates** (3.8) during reduction

7.4.7
low-temperature reduction-disintegration
size degradation of **lump ore** (3.3) or **agglomerates** (3.8) resulting from reduction under low-temperature reduction conditions resembling those prevailing in the upper part of the blast furnace or in various direct reduced iron reactors

NOTE 1 In ISO 4696-1, applicable to blast furnace feedstocks, low-temperature reduction-disintegration is referred to as the reduction-disintegration index, RDI-1, expressed by three indices: the percentage by mass of the + 6,3 mm (RDI-$1_{+6,3}$), – 3,15 mm (RDI-$1_{-3,15}$) and – 0,5 mm (RDI-$1_{-0,5}$) size fractions of the **test portion** (5.7) obtained when tumbled after reduction over 60 min under static conditions.

NOTE 2 In ISO 4696-2, applicable to blast furnace feedstocks, low-temperature reduction-disintegration is referred to as the reduction-disintegration index, RDI-$2_{-2,8}$, expressed by the percentage by mass of the – 2,8 mm size fraction of the **test portion** (5.7) obtained when tumbled after reduction over 30 min under static conditions.

NOTE 3 In ISO 13930, applicable to blast furnace feedstocks, low-temperature reduction-disintegration is referred to as the low-temperature reduction-disintegration index, LTD, expressed by three indices: the percentage by mass of the + 6,3 mm ($LTD_{+6,3}$), – 3,15 mm ($LTD_{-3,15}$), and – 0,5 mm ($LTD_{-0,5}$) size fraction of the **test portion** (5.7) obtained when tumbled after reduction over 60 min under dynamic conditions.

NOTE 4 In ISO 11257, applicable to direct reduced iron feedstocks, low-temperature reduction-disintegration is referred to as the reduction-disintegration index, RDI_{DR}, expressed by the percentage by mass of the – 3,15 mm size fraction of the **test portion** (5.7) obtained when tumbled after reduction over 300 minutes under dynamic conditions.

7.4.8
free-swelling
increase in volume of fired **pellets** (3.10) that occurs during reduction under unconstrained conditions

NOTE In ISO 4698 free-swelling is referred to as the free-swelling index, V_{FS}, expressed as the percentage increase in volume, of the pellets before and after reduction.

7.4.9
reduction under load
structural stability of **lump ore** (3.3) or **agglomerates** (3.8) during reduction under load

NOTE In ISO 7992 the structural stability is expressed by the following indices:

a) $\Delta p80$, the differential pressure of the reducing gas at an 80 % degree of reduction;

b) $\Delta h80$, the percentage change in the height of the test bed at an 80 % degree of reduction.

7.4.10
cluster
two or more **particles** (6.1) of reduced **pellets** (3.10) stuck together

7.4.11
clustering
formation of **cluster** (7.4.10) of **pellets** (3.10) when reduced under conditions that resemble those prevailing in the direct reduction processes

NOTE In ISO 11256 clustering is referred to as the **clustering index** (CI) and expressed as a percentage by mass.

8 Chemical analysis

8.1
hygroscopic moisture
water content of an ore (equilibrated with the laboratory atmosphere) that can be removed by heating to 105 °C

8.2
predried sample (for chemical analysis)
sample (5.3) that has been dried at 105 °C, to a constant mass

8.3
combined water
water content of an ore that can be driven off by heating up to 950 °C after the removal of hygroscopic moisture

8.4
loss on ignition
change in mass of an ore held at 1 000 °C, excluding the loss due to **hygroscopic moisture** (8.1)

8.5
metallic iron
iron neither bonded to oxygen nor present as pyrites

8.6
total iron
all iron present in any form, free and combined with oxygen or other elements

8.7
acid-soluble iron
iron(II) present in an ore as a divalent iron oxide (FeO) which is soluble in hydrochloric acid

8.8
water-soluble chloride
chloride content of an ore extractable by leaching with aqueous solution at 90 °C to 95 °C, at neutral pH conditions

8.9
certified reference material iron ore
(CRM iron ore)
certified reference material prepared from an iron ore for the purpose of chemical analysis

Annex A
(informative)

Concentration ranges of elements of interest

A.1 Iron ore

Element	Concentration (% by mass)		
Fe	30	to	72
Si	0,1	to	10
Ca	0,01	to	10
Al	0,10	to	5
Ti	0,01	to	5
Mg	0,01	to	3
Mn	0,01	to	8
P	0,003	to	2
S	0,002	to	1
Na	0,002	to	1
K	0,002	to	1
V	0,005	to	0,5
F	0,005	to	1
Cu	0,003	to	0,1
Cr	0,003	to	0,1
Ni	0,003	to	0,1
Co	0,000 5	to	0,08
Pb	0,001 0	to	0,5
Zn	0,001 0	to	0,5
Sn	0,001	to	0,1
As	0,000 1	to	0,1
Water soluble Cl	0,005	to	0,1
Hygroscopic H_2O	0,05	to	6
Loss on ignition	0,25	to	10
Combined H_2O	0,05	to	10
Fe(II)	1	to	25

A.2 Direct reduced iron

Element	Concentration (% by mass)		
Metallic Fe	15	to	95
C	0,05	to	2,5
S	0,001	to	0,05

Annex B
(informative)

List of equivalent terms in English, French, Japanese, Chinese and Portuguese

NOTE In addition to terms used in two of the three official ISO languages (English and French), this International Standard gives the equivalent terms in Japanese, Chinese and Portuguese; these are published under the responsibility of the member bodies for Japan, China and Portugal (JISC, CSBTS and IPQ). However, only the terms and definitions given in the official languages can be considered as ISO terms and definitions.

In the following tables:

(F)	means French,
(J)	means Japanese,
(C)	means Chinese,
(P)	means Portuguese

Term	Remarks
1 Acid-soluble iron(II) (F) fer(II) soluble dans l'acide (J) 酸可溶性鉄(II) (C) 酸溶亚铁 (P) ferro(II) solúvel em ácido	ISO 9035 specifies a titrimetric method for the reducibility test methods specified in ISO 4695 or ISO 7215.
2 Agglomerates (F) minerais agglomérés (J) 塊成鉱 (C) 人造块矿 (P) aglomerados	
3 Briquettes (F) briquettes (J) ブリケット (C) 压块 (P) briquetes	
4 Bulk density (F) masse volumique apparente (J) かさ密度 (C) 体积密度 (P) densidade a granel	ISO 3852 specifies two methods: Method 1 for ores having maximum particle size of 40 mm or smaller. Method 2 for any ores.
5 Chemical analysis (F) analyse chimique (J) 化学分析 (C) 化学分析 (P) análise química	ISO/TC 102/SC 2 is in charge of preparing International Standards relating to chemical analysis of iron ores and direct reduced iron.
6 Cold briquetted iron (CBI) (F) fer briqueté à froid (J) コールドブリケットアイアン (C) 冷压铁块 (P) ferro briquetado a frio	CBI is outside the field of activities of TC 102 for development of any test methods.
7 Combined water (F) eau de constitution (J) 化合水 (C) 化合水 (P) água combinada	ISO 7335 specifies a Karl Fischer titrimetric method for 0,05 % to 10 % (m/m): pre-drying of the test portion at 105 °C, then heating up to 950 °C.

Term	Remarks
8 Concentrates (F) minerais concentrés (J) 精鉱 (C) 精矿 (P) concentrados	
9 Constant mass division (F) division à masse constante (J) 定量縮分 (C) 定量缩分 (P) divisão a massa constante	
10 Crushing strength (F) résistance à l'écrasement (J) 圧かい強度 (C) 压溃强度 (P) resistência à compressão	ISO 4700 specifies a method for the determination of the crushing strength of fired iron ore pellets. Number of pellets to be tested: 60 or more.
11 Decrepitation (F) décrépitation (J) 熱割れ (C) 热裂 (P) crepitação	ISO 8371 specifies a method for the determination of the decrepitation index of lump ore.
12 Degree of metallization (F) degré de métallisation (J) 金属化率 (C) 金属化率 (P) grau de metalização	
13 Direct reduced iron (DRI) (F) fer de réduction directe (J) 直接還元鉄 (C) 直接还原铁 (P) ferro esponja	
14 Dry sieving (F) tamisage à sec (J) 乾式ふるい分け (C) 干式筛分 (P) peneiramento a seco	

Term	Remarks
15 Fine ores; ore fines (F) fines de minerai (J) 粉鉱石 (C) 粉矿 (P) minérios finos; finos de minério	
16 Free-swelling (F) gonflement libre (J) ふくれ (C) 自由膨胀 (P) inchamento livre	ISO 4698 specifies a method for the determination of the free-swelling index during unconstrained reduction of fired iron ore pellets. Test portion: 18 pellets per test.
17 Gross sample (F) échantillon global (J) 大口試料 (C) 大样 (P) amostra global	
18 Hand sieving (F) tamisage à la main (J) 手動ふるい分け (C) 手工筛分 (P) peneiramento manual	
19 Hot briquetted iron (HBI) (F) fer briqueté à chaud (J) ホットブリケットアイアン (C) 热压铁块 (P) ferro briquetado a quente	
20 Hygroscopic moisture (F) humidité hygroscopique (J) 吸湿水分 (C) 吸湿水 (P) umidade higroscópica	ISO 2596 specifies two methods: Method 1 – Gravimetric method. Method 2 – Karl Fisher method.
21 Increment (F) prélèvement élémentaire (J) インクリメント C) 份样 (P) incremento	

Term	Remarks
22 Iron ore (F) minerais de fer (J) 鉄鉱石 (C) 铁矿石 (P) minério de ferro	
23 Loss on ignition (LOI) (F) perte au feu (J) 強熱減量 (C) 灼烧减量 (P) perda ao fogo	Heating at 1 000 °C for 60 min.
24 Lump ore; ore lump (F) minerais en roches (J) 塊鉱石 (C) 块矿 (P) minérios granulados	
25 Manual sampling (F) échantillonnage manuel (J) 手動式サンプリング (C) 手工取样 (P) amostragem manual	
26 Mass-basis sampling (F) échantillonnage à masse constante (J) 質量基準サンプリング (C) 定量取样 (P) amostragem base massa	
27 Mechanical sampling (F) échantillonnage mécanique (J) 機械式サンプリング (C) 机械取样 (P) amostragem mecânica	
28 Metallic iron (F) fer métallique (J) 金属鉄 (C) 金属铁 (P) ferro metálico	ISO 5416 specifies a bromine-methanol titrimetric method for metallic iron in DRI.

Term	Remarks
29 Nominal top size (F) dimension supérieure nominale (J) 最大粒度 (C) 最大粒度 (P) tamanho máximo nominal	
30 Pellets (F) boulettes (J) ペレット (C) 球团 (P) pelotas	The following International Standards specify the physical test methods specifically applicable to pellets. ISO 4698 for the swelling test. ISO 4700 for the crushing test.
31 Physical testing (F) essais physiques (J) 物理試験 (C) 物理试验 (P) ensaio físico	ISO/TC 102/SC 3 is responsible for physical testing of iron ores as blast furnace burden materials; ISO/TC 102/SC 5 is responsible for physical testing for direct reduction.
32 Predried sample (F) échantillon préséché (J) 事前乾燥試料 (C) 予干燥试样 (P) amostra pré-seca	ISO 7764 specifies a method for the preparation of predried test samples to be used for chemical analysis.
33 Processed ores (F) minerais traités (J) 処理鉱石 (C) 处理矿石 (P) minérios processados	
34 Reducibility (F) réductibilité (J) 被還元性 (C) 还原度 (P) redutibildade	ISO 4695 (reduction at 950 °C) reducibility: reduction rate at the degree of reduction of 60 %. ISO 7215 (reduction at 900 °C for 3h) reducibility: degree of reduction after 3h reduction.
35 Sample division (F) division de l'échantillon (J) 試料縮分 (C) 样品缩分 (P) divisão de amostra	

Term	Remarks
36 Sample preparation (F) préparation d'un échantillon (J) 試料調製 (C) 制样 (P) preparação de amostra	
37 Sampling (F) échantillonnage (J) サンプリング (C) 取样 (P) amostragem	ISO/TC 102/SC 1 is in charge of developing International Standards relating to sampling and sample preparation of iron ore and direct reduced iron.
38 Sinter (F) minerais frittés (J) 焼結鉱 (C) 烧结矿 (P) sínter	
39 Sinter tests (F) essais de frittage (J) 焼結試験 (C) 烧结试验 (P) ensaios de sinterização	ISO 8263 specifies a method for presentation of the results of sintering tests.
40 Sized ores (F) minerais calibrés (J) 整粒鉱 (C) 整粒矿 (P) minérios bitolados	
41 Test portion (F) prise d'essai (J) 供試料，測定試料 (C) 实验样 (P) porção teste	
42 Time-basis sampling (F) échantillonnage à temps constant (J) 時間基準サンプリング (C) 定时取样 (P) amostragem base tempo	