
**Steel and steel products — Vocabulary
relating to chemical analysis**

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Foreword

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This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 1, *Methods of determination of chemical composition*.

ISO/TS 6084:2022

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

To ensure that communication in a particular domain is effective and that difficulties in understanding are minimized, it is essential that the various participants use the same concepts and concept representations. Unambiguous communication related to analytical chemistry concepts is crucial given the implications that can arise from misunderstandings with regard to equipment.

Different levels of scientific and technical knowledge can lead to widely divergent understandings and assumptions about concepts. The result is poor communication that can lead into an increase of the risk of accidents and duplication of efforts as different define concepts according to their perspectives.

Conceptual arrangement of terms and definitions is based on concepts systems that show corresponding relationships analytical chemistry concepts. Such arrangement provides users with a structured view of the analytical methods and will facilitate common understanding of all related concepts. Besides, concepts systems and conceptual arrangement of terminological data will be helpful to any kind of user because it will promote clear, accurate and useful communication.

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Steel and steel products — Vocabulary relating to chemical analysis

1 Scope

This document defines terms relating to methods of the determination of the chemical composition of steel and steel products.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 General terms related to steel and cast iron

3.1.1

alloy steel

steel (3.1.17), other than a stainless steel, that conforms to a specification that requires one or more of the following elements, by mass percent, to have a minimum content equal to or greater than: 0,30 for aluminum; 0,000 8 for boron; 0,30 for chromium; 0,30 for cobalt; 0,40 for copper; 0,40 for lead; 1,65 for manganese; 0,08 for molybdenum; 0,30 for nickel; 0,06 for niobium (columbium); 0,60 for silicon; 0,05 for titanium; 0,30 for tungsten (wolfram); 0,10 for vanadium; 0,05 for zirconium; or 0,10 for any other alloying element, except sulphur, phosphorus, carbon, and nitrogen

[SOURCE: ASTM A941:2018]

3.1.2

austenitic steel

steel (3.1.17) where the structure consists of *austenite* (3.1.3) at ambient temperature

Note 1 to entry: Cast austenitic steels can contain up to about 20 % of *ferrite* (3.1.8).

3.1.3

austenite

solid solution of one or more elements in gamma iron (3.1.19)

3.1.4

boriding

thermochemical treatment of a workpiece to enrich the surface of a workpiece with boron

Note 1 to entry: The medium in which boriding takes place should be specified, e.g. pack boriding, paste boriding, etc.

3.1.5

cast/heat analysis

chemical analysis determined by the steel producer as being representative of a specific heat of *steel* (3.1.17)

Note 1 to entry: Where the analysis reported by the steel producer is not sufficiently complete for conformance with the *heat analysis* (3.1.5) requirements of the applicable product specification to be fully assessed, the manufacturer can complete the assessment of conformance with such *heat analysis* (3.1.5) requirements by using a *product analysis* (3.1.16) for the specified elements that were not reported by the steel producer, provided that *product analysis* (3.1.16) tolerances are not applied and the *heat analysis* (3.1.5) is not altered

[SOURCE: ASTM A941:2018]

3.1.6

cast iron

alloy of iron, carbon and silicon where the carbon content is approximately more than 2 %

3.1.7

ductile iron

nodular cast iron

cast iron (3.1.6) that has been treated while molten with an element (usually magnesium or cerium) that spheroidizes the graphite

[SOURCE: ISO 15156-2:2020, 3.5.4]

3.1.8

ferrite

body-centred cubic lattice structure of iron or *steel* (3.1.17)

3.1.9

forged steel

steel (3.1.17) product obtained by forging and that does not undergo subsequent hot conversion

Note 1 to entry: These products are mainly in the form of circles or squares.

3.1.10

grey cast iron

cast material, mainly iron and carbon based, carbon being present mainly in the form of flake (lamellar) graphite particles

Note 1 to entry: Grey cast iron is also known as flake graphite cast iron, and less commonly as lamellar graphite cast iron.

Note 2 to entry: Graphite form, distribution and size are specified in ISO 945-1.

[SOURCE: EN 1561:2011, 3.1]

3.1.11

killed steel

steel (3.1.17) deoxidized to such a level that essentially no reaction occurred between carbon and oxygen during solidification

[SOURCE: ASTM A941:2018]

3.1.12

malleable iron

white cast iron (3.1.18) that is thermally treated to convert most or all of the cementite to graphite (temper carbon)

[SOURCE: ISO 15156-2:2020, 3.5.3]

3.1.13**martensite**

(phase) formed in carbon containing *steels* (3.1.17) by the cooling of *austenite* (3.1.3) at such a high rate that carbon atoms do not have time to diffuse out of the crystal structure in large enough quantities to form cementite (Fe₃C)

3.1.14**nitriding**

case-hardening process in which nitrogen is introduced into the surface of metallic materials (most commonly ferrous alloys)

EXAMPLE Liquid nitriding, gas nitriding, ion nitriding and *plasma* (3.6.32) nitriding.

[SOURCE: ISO 15156-2:2020, 3.11]

3.1.15**non-alloyed steel**

steel in which the percentage of each element is less than specific limiting values specified

Note 1 to entry: See Table in ISO 4948-1:1982, 3.1.2.

3.1.16**product analysis**

chemical analysis carried out on a sample of the product taken after the final hot rolling operation

3.1.17**steel**

ferrous material the principal element of which is iron and the carbon content of which is not more than 2 % of mass

Note 1 to entry: The presence of large quantities of carbide-forming elements can modify the upper limit of the carbon content.

Note 2 to entry: The nomenclature for unalloyed steels suitable for heat treatment and for alloyed steels is given in ISO 4948-1 and ISO 4948-2.

Note 3 to entry: Small amount of alloying elements added to non-alloy steels can cause the product to be defined as a micro-alloy steel.

3.1.18**white cast iron**

cast iron (3.1.6) that displays a white fracture surface due to the presence of cementite

[SOURCE: ISO 15156-2:2020, 3.5.2]

3.1.19**gamma iron**

pure iron with face-centred cubic lattice structure

3.2 General terms related to preparation of steel and cast iron**3.2.1****grinding**

method of preparing a sample of metal for a physical method of analysis in which the surface of the *test sample* (3.3.15) is abraded using an abrasive wheel

3.2.2**linishing**

method of preparing a sample of metal for a physical method of analysis in which the surface of the *test sample* (3.3.15) is abraded using a flexible rotating disc or continuous belt coated with an abrasive substance

3.2.3

milling

method of preparing sample chips or the surface of a sample for a physical method of analysis in which the surface of the sample is machined using a rotating, multi-edged cutting tool

3.3 General terms related to sample and sampling

3.3.1

aliquot

known amount of a homogeneous material, assumed to be taken with negligible sampling error

Note 1 to entry: The term "aliquot" is usually applied to fluids.

Note 2 to entry: The term "aliquot" is usually used when the fractional part is an exact divisor of the whole; the term "aliquant" has been used when the fractional part is not exact divisor of the whole (e.g. a 15 ml portion is an aliquant of 100 ml).

Note 3 to entry: When a *laboratory sample* (3.3.7) or a *test sample* (3.3.15) is "aliquoted" or otherwise subdivided, the portions have been called split samples.

3.3.2

analyte

component of a system to be analysed

[SOURCE: PAC, 1989, 61, 1657 (Nomenclature for automated and mechanised analysis (Recommendations 1989))]

3.3.3

analytical sample

sample prepared from the *laboratory sample* (3.3.7) and from which analytical portions can be taken

Note 1 to entry: The analytical sample can be subjected to various treatments before an analytical portion is taken.

Note 2 to entry: Where no homogenization or subdivision is necessary, the *laboratory sample* (3.3.7), the *test sample* (3.3.15), and, if the latter requires no further chemical or physical treatment, the analytical samples are identical. With some homogeneous materials such as waters or oils, the *laboratory sample* (3.3.7) may be taken directly from a sample unit and, if no further subdivision or homogenization is carried out, the *laboratory sample* (3.3.7) is the *test sample* (3.3.15). Similarly, with atmospheric particulates collected on a filter, the sample unit is the *laboratory sample* (3.3.7) and, if no further subdivision or homogenization is carried out, also the *test sample* (3.3.15).

[SOURCE: ISO 15193:2009, 3.3, modified — Note to entry added.]

3.3.4

consignment

quantity of metal delivered at one time

3.3.5

duplicate samples

replicate samples

multiple (or two) samples taken under comparable conditions

Note 1 to entry: This selection can be accomplished by taking units adjacent in time or space. Although the replicate samples are expected to be identical, often the only thing replicated is the act of taking the physical sample. A duplicate sample is a replicate sample consisting of two portions. The umpire samples usually used to settle a dispute; the replicate sample is usually used to estimate sample variability.

[SOURCE: PAC, 1990, 62, 1193 (Nomenclature for sampling in analytical chemistry (Recommendations 1990))]

3.3.6**increment**

quantity of metal obtained by sampling at one time from a *consignment* (3.3.4)

3.3.7**laboratory sample**

sample or *subsample(s)* (3.3.13) sent to or received by the laboratory

Note 1 to entry: When the laboratory sample is further prepared (reduced) by subdividing, mixing, *grinding* (3.2.1), or by combinations of these operations, the result is the *test sample* (3.3.15). When no preparation of the laboratory sample is required, the laboratory sample is the *test sample* (3.3.15). A *test portion* (3.3.14) is removed from the *test sample* (3.3.15) for the performance of the test or for analysis.

Note 2 to entry: The laboratory sample is the final sample from the point of view of sample collection but it is the initial sample from the point of view of the laboratory.

Note 3 to entry: Several laboratory samples can be prepared and sent to different laboratories or to the same laboratory for different purposes. When sent to the same laboratory, the set is generally considered as a single laboratory sample and is documented as a single sample.

[SOURCE: IUPAC orange book: 2002, 18.3.6, Sampling stages]

3.3.8**lot**

quantity of material that is assumed to be a single population for sampling purposes

[SOURCE: PAC, 1990, 62, 1193 (Nomenclature for sampling in analytical chemistry (Recommendations 1990))]

3.3.9**matrix**

components of the sample other than the *analyte* (3.3.2)

Note 1 to entry: to entry. In analysis.

[SOURCE: PAC, 1989, 61, 1657 (Nomenclature for automated and mechanised analysis (Recommendations 1989))]

3.3.10**primary sample**

collection of one or more *increments* (3.3.6) or units initially taken from a population

Note 1 to entry: The portions can be either combined (composited or bulked sample) or kept separate (gross sample). If combined and mixed to homogeneity, it is a blended bulk sample.

Note 2 to entry: The term "bulk sample" is commonly used in the sampling literature as the sample formed by combining *increments* (3.3.6). The term "bulk sample" is ambiguous since it could also mean a sample from a bulk *lot* (3.3.8) and it does not indicate whether the *increments* (3.3.6) or units are kept separate or combined. Such use should be discouraged because less ambiguous alternative expressions (composite sample, aggregate sample) are available.

Note 3 to entry: "Lot sample" and "batch sample" have also been used for this concept, but they are self-limiting terms.

Note 4 to entry: The use of "primary" in this sense is not meant to imply the necessity for multistage sampling.

[SOURCE: IUPAC orange book: 2002, 18.3.6, Sampling stages]

3.3.11**representative sample**

sample that has the same properties as a defined batch of material and represents the bulk material, within a defined confidence limit

[SOURCE: ISO 14488:2007, 3.7]

3.3.12

specimen

one or more pieces taken from each product in the sample, for the purpose of producing test pieces

[SOURCE: ISO 6361-1:2011, 3.7]

3.3.13

subsample

sample obtained by procedures in which the items of interest are randomly distributed in parts of equal or unequal size

Note 1 to entry: A sub-sample can be any of the following:

- a) a portion of the sample obtained by selection or division;
- b) an individual unit of the *lot* (3.3.8) taken as part of the sample;
- c) the final unit of multistage sampling.

Note 2 to entry: The term “subsample” is used either in the sense of a “sample of a sample” or as a synonym for “unit”. In practice, the meaning is usually apparent from the context or is defined.

[SOURCE: ISO 11074:2015, 4.1.34]

3.3.14

test portion

part of the test sample, or part of the sample taken from the melt, submitted to analysis, in certain cases, the test portion can be selected from the sample product itself

Note 1 to entry: The following special types of test portions in the form of a solid mass obtained from a probe sample are distinguished

- disc originating from the sampling of molten metal (from a special sampler or a small ingot), used for OES or XRF <https://standards.iteh.ai/catalog/standards/sist/ddbf2cd2-c9ef-49e3-a370-366f1daf1f34/iso->
- test portion in the shape of a small disc, commonly described as a slug, obtained by punching,
- test portion in the form of a small appendage, commonly described as a lug,
- test portion in the form of a small-diameter rod, commonly described as a pin, obtained by cutting.

Note 2 to entry: When the test sample is in the form of chips or powder, or when a sample in the form of a solid mass is analysed by a thermal method, the *test portion* (3.3.14) is obtained by weighing. In the case of a physical method of analysis, the part actually analysed will constitute only a small mass of the test sample. In an optical emission spectrometric method, the mass of metal consumed in an electrical *discharge* (3.6.14) is about 0,5 mg to 1 mg, in an X-ray fluorescence spectrometric method, the characteristic radiation is produced from a very thin surface layer of the sample.

3.3.15

test sample

sample taken or formed from the *laboratory sample* (3.3.7), by a process involving homogenization using physical or mechanical treatments such as *grinding* (3.2.1), drilling, *milling* (3.2.3) or sieving

Note 1 to entry: The test sample is then in a form suitable for subsampling for analytical purposes, for storing for future analysis or for using for test purposes other than analytical.

[SOURCE: IUPAC orange book: 2002, 10.3.4.9]

3.3.16

test solution

analytical solution

solution prepared by dissolving, with or without reaction, the *test portion* (3.3.14) in a liquid

[SOURCE: IUPAC orange book: 2002, 18.3.6 Sampling stages]

3.3.17**trace element**

element having an average concentration of less than about 100 parts per million atoms (ppm) or less than 0,01 % by weight

[SOURCE: PAC, 1979, 51, 2243 (General aspects of trace analytical methods - IV. Recommendations for nomenclature, standard procedures and reporting of experimental data for surface analysis techniques)]

3.4 General terms related to analytical standards**3.4.1****blank test solution**

solution that contains all the chemicals except for the element to be determined in the same concentration as required for the preparation of a *reference standard solution* (3.4.17) of that element

[SOURCE: OIML R 100-1:2013, 3.3.2]

3.4.2**blank reference solution**

solution used to set the zero absorbance on the *spectrometer* (3.5.22) and that normally consists of a pure solvent such as deionized water

[SOURCE: OIML R 100-1:2013, 3.3.1]

3.4.3**blank value**

reading or result originating from the *matrix* (3.3.9), reagents and any residual *bias* (3.8.5) in the measurement device or process, which contributes to the value obtained for the quantity in the analytical procedure

[SOURCE: PAC, 1989, 61, 1657 (Nomenclature for automated and mechanised analysis (Recommendations 1989))]

3.4.4**bracketing technique**

analytical method consisting of bracketing the measured absorption or machine reading of the sample between two measurements made on *calibration solutions* (3.4.8) of neighbouring concentrations within the optimum working range

[SOURCE: ISO 6486-2:1999, 3.3]

3.4.5**calibration**

operation that, under specified conditions, in a first step, establishes a relation between the *quantity values* (3.4.16) with measurement uncertainties provided by measurement standards and corresponding indications with associated *measurement uncertainties* (3.8.20) and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication

Note 1 to entry: A calibration can be expressed by a statement, calibration function, calibration diagram, *calibration curve* (3.4.7), or calibration table. In some cases, it can consist of an additive or multiplicative correction of the indication with associated *measurement uncertainty* (3.8.20).

Note 2 to entry: Calibration should not be confused with adjustment of a measuring system, often mistakenly called "self-calibration", nor with *verification* (3.8.47) of calibration.

[SOURCE: ISO/IEC Guide 99:2007, 2.39]

3.4.6

calibration blank solution

solution prepared in the same way as the *calibration solution* (3.4.8) but leaving out the *analyte* (3.3.2), also called “zero member” of the *calibration* (3.4.5) series

[SOURCE: ISO 21400:2018, 3.8, modified]

3.4.7

calibration curve

expression of the relation between indication and corresponding *measured quantity value* (3.4.16.2)

Note 1 to entry: A calibration curve expresses a one-to-one relation that does not supply a measurement result as it bears no information about the *measurement uncertainty* (3.8.20).

[SOURCE: ISO/IEC Guide 99:2007, 4.31]

3.4.8

calibration solution

solution used to calibrate the instrument, prepared from a *stock solution* (3.4.21) or a certified standard by adding acids, *buffer* (3.6.5), *reference element* (3.7.7) and salts as needed

[SOURCE: ISO 21400:2018, 3.9]

3.4.9

certified reference material

CRM

reference material (RM) characterized by a metrologically valid procedure for one or more specified properties, accompanied by an RM certificate that provides the value of the specified property, its associated *uncertainty* (3.8.20), and a statement of metrological traceability

Note 1 to entry: The concept of value includes a nominal property or a qualitative attribute such as identity or sequence. Uncertainties for such attributes can be expressed as probabilities or levels of confidence.

[SOURCE: ISO Guide 30:2015, 2.1.2, modified —Notes 2, 3 and 4 to entry deleted.]

3.4.10

internal standard

compound added to a sample in a fixed amount that has similar properties (spectral, physical, isobaric etc.) to the target *analyte* (3.3.2) used to correct for instrument *drift* (3.6.15) and *matrix interference* (3.7.11)

[SOURCE: ISO/TS 20593:2017, 3.6, modified]

3.4.11

internal standard line

spectral line (3.6.40) of an *internal standard* (3.4.10), to which the radiant energy of an analytical line is compared

[SOURCE: ASTM E135:2021]

3.4.12

matrix solution

synthetic solution consisting of the solvent and containing, if possible, all the constituents of the *analytical sample* (3.3.3) except the *analyte* (3.3.2)

3.4.13**primary reference material**

primary RM

high purity material of the *analyte* (3.3.2), certified for the mass/mole fraction of the *analyte* (3.3.2) in the material, and which constitutes the realization of the International System of Units (SI) for the *analyte* (3.3.2) of interest

Note 1 to entry: A primary reference material has its value assigned either directly by a primary RMP or indirectly by determining the impurities of the material by appropriate analytical methods (e.g. mass balance method).

[SOURCE: ISO 17511:2020, 3.35]

3.4.14**reference material**

RM

material, sufficiently homogeneous and stable with respect to one or more specified properties, which has been established to be fit for its intended use in a measurement process

Note 1 to entry: RM is a generic term.

Note 2 to entry: Properties can be quantitative or qualitative, e.g. identity of substances or species.

Note 3 to entry: Uses can include the *calibration* (3.4.5) of a measurement system, assessment of a measurement procedure, assigning values to other materials, and *quality control* (3.8.26).

Note 4 to entry: ISO/IEC Guide 99:2007, 5.13 has an analogous definition, but restricts the term “measurement” to apply to quantitative values. However, Note 3 of ISO/IEC Guide 99:2007, 5.13, specifically includes qualitative properties, called “nominal properties”.

[SOURCE: ISO/Guide 30:2015, 2.1.1]

3.4.15**reference method**

reference measurement procedure

measurement procedure accepted as providing measurement results fit for their intended use in assessing *measurement trueness* (3.8.46) of *measured quantity values* (3.4.16.2) obtained from other measurement procedures for quantities of the same kind, in *calibration* (3.4.5), or in characterizing *reference materials* (3.4.14)

Note 1 to entry: The *accuracy* (3.8.1) of a reference method must be demonstrated through direct comparison with a definitive method or with a *primary Reference Material* (3.4.13).

[SOURCE: ISO/IEC Guide 99:2007, 2.7, modified — New preferred term added, Note to entry added.]

3.4.16**quantity value**

number and reference together expressing magnitude of a quantity

[SOURCE: JCGM 200:2012 1.19]

3.4.16.1**reference quantity value**

reference value

quantity value (3.4.16) used as a basis for comparison with values of quantities of the same kind

Note 1 to entry: A reference quantity value can be a *true quantity value* (3.8.45) of a measurand, in which case it is unknown, or a conventional quantity value, in which case it is known.

Note 2 to entry: A reference quantity value with associated *measurement uncertainty* (3.8.20) is usually provided with reference to:

a) a material, e.g. a *certified reference material* (3.4.9);