
**Nickel, ferronickel and nickel alloys —
Standards for the determination of
chemical composition**

*Nickel, ferronickel et alliages de nickel — Normes pour la
détermination de la composition chimique*

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 155, *Nickel and nickel alloys*.

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.

Nickel, ferronickel and nickel alloys — Standards for the determination of chemical composition

1 Scope

This document lists the International Standards which are currently available for the determination of the chemical composition of nickel, ferronickel and nickel alloys (see [Clause 4](#)).

It provides details on the range of application and gives the principle of the method described in each International Standard (see [Clause 5](#)).

[Annex A](#) shows graphical representations of the content ranges of the methods listed in this document:

- [Figure A.1](#) represents the fields of application of the methods available for the three kinds of matrixes;
- [Figure A.2](#) gives the content ranges of the methods for nickel;
- [Figure A.3](#) gives the content ranges of the methods for ferronickel;
- [Figure A.4](#) gives the content ranges of the methods for nickel alloys.

[Annex B](#) provides a bilingual key of the abbreviated terms used in the figures given in [Annex A](#).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1

referee method

stoichiometric method or a method calibrated against pure metals or stoichiometric compounds, which is used for certification analysis or in case of arbitration

Note 1 to entry: Due to a lack of accuracy or to a low number of laboratories having participated in the related validation tests, some stoichiometric methods or methods calibrated against pure metals or stoichiometric compounds cannot be taken as “referee methods”. They are published as Technical Specifications or Technical Reports.

[SOURCE: CEN/TR 10261:2018, modified — Note 1 to entry has been added.]

3.2

routine method

method calibrated against reference materials, certified reference materials or against standard solutions commercially available that is widely used for control purposes (day-to-day analysis)

Note 1 to entry: By agreement, routine methods can be used for any commercial and/or arbitration purposes.

[SOURCE: ISO/TR 9769:2018, modified — Note 1 to entry has been added.]

3.3 stoichiometry
founded on the “law of conservation of mass” where the total mass of the reactants equals the total mass of the products, leading to the insight that the relations among quantities of reactants and products typically form a ratio of positive integers

4 International Standards for the determination of the chemical composition of nickel, ferronickel and nickel alloys

4.1 Nickel

4.1.1 Silver, Ag (referee methods)

ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method*

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.2 Arsenic, As (referee method)

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.3 Boron, B (referee method)

ISO 11436:1993, *Nickel and nickel alloys — Determination of total boron content — Curcumin molecular absorption spectrometric method*

4.1.4 Bismuth, Bi (referee methods)

ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method*

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.5 Cadmium, Cd (referee methods)

ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method*

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.6 Cobalt, Co (referee method)

ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method*

4.1.7 Copper, Cu (referee method)

ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method*

4.1.8 Iron, Fe (referee method)

ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method*

4.1.9 Manganese, Mn (referee method)

ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method*

4.1.10 Phosphorus, P (referee method)

ISO 11400:1992, *Nickel, ferronickel and nickel alloys — Determination of phosphorus content — Phosphovanadomolybdate molecular absorption spectrometric method*

4.1.11 Lead, Pb (referee methods)

ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method*

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.12 Antimony, Sb (referee method)

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.13 Sulfur, S (referee method)

ISO 7527:1985, *Nickel, ferronickel and nickel alloys — Determination of sulfur content — Iodimetric titration method after induction furnace combustion*

4.1.14 Selenium, Se (referee method)

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.15 Tin, Sn (referee method)

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.16 Tellurium, Te (referee method)

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.17 Thallium, Tl (referee method)

ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method*

4.1.18 Zinc, Zn (referee method)

ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method*

4.2 Ferronickel

4.2.1 Carbon, C (routine method)

ISO 7524:2020, *Ferronickels — Determination of carbon content — Infrared absorption method after induction furnace combustion*

4.2.2 Chromium, Cr (referee method)

ISO 23156:2021, *Ferronickels — Determination of phosphorus, manganese, chromium, copper and cobalt contents — Inductively coupled plasma optical emission spectrometric method*

4.2.3 Cobalt, Co (referee method)

ISO 7520:1985, *Ferronickel — Determination of cobalt content — Flame atomic absorption spectrometric method*

4.2.4 Cobalt, Co (referee method)

ISO 23156:2021, *Ferronickels — Determination of phosphorus, manganese, chromium, copper and cobalt contents — Inductively coupled plasma optical emission spectrometric method*

4.2.5 Copper, Cr (referee method)

ISO 23156:2021, *Ferronickels — Determination of phosphorus, manganese, chromium, copper and cobalt contents — Inductively coupled plasma optical emission spectrometric method*

4.2.6 Manganese, Mn (referee method)

ISO 23156:2021, *Ferronickels — Determination of phosphorus, manganese, chromium, copper and cobalt contents — Inductively coupled plasma optical emission spectrometric method*

4.2.7 Nickel, Ni (referee method)

ISO 6352:1985, *Ferronickel — Determination of nickel content — Dimethylglyoxime gravimetric method*

4.2.8 Phosphorus, P (referee method)

ISO 11400:1992, *Nickel, ferronickel and nickel alloys — Determination of phosphorus content — Phosphovanadomolybdate molecular absorption spectrometric method*

4.2.9 Phosphorus, Cr (referee method)

ISO 23156:2021, *Ferronickels — Determination of phosphorus, manganese, chromium, copper and cobalt contents — Inductively coupled plasma optical emission spectrometric method*

4.2.10 Sulfur, S (routine method)

ISO 7526:2020, *Ferronickels — Determination of sulfur content — Infrared absorption method after induction furnace combustion*

4.2.11 Sulfur, S (referee method)

ISO 7527:1985, *Nickel, ferronickel and nickel alloys — Determination of sulfur content — Iodimetric titration method after induction furnace combustion*

4.2.12 Silicon, Si (referee method)

ISO 8343:1985, *Ferronickel — Determination of silicon content — Gravimetric method*

4.3 Nickel alloys**4.3.1 Aluminium, Al (referee method)**

ISO 7530-7:1992, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 7: Determination of aluminium content*

4.3.2 Boron, B (referee method)

ISO 11436:1993, *Nickel and nickel alloys — Determination of total boron content — Curcumin molecular absorption spectrometric method*

4.3.3 Cobalt, Co (referee method)

ISO 7530-1:2015, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 1: Determination of cobalt, chromium, copper, iron and manganese*

4.3.4 Chromium, Cr (referee method)

ISO 7529:2017, *Nickel alloys — Determination of chromium content — Potentiometric titration method with ammonium iron(II) sulfate*

ISO 7530-1:2015, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 1: Determination of cobalt, chromium, copper, iron and manganese*

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4.3.5 Copper, Cu (referee method)

ISO 7530-1:2015, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 1: Determination of cobalt, chromium, copper, iron and manganese*

4.3.6 Iron, Fe (referee method)

ISO 7530-1:2015, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 1: Determination of cobalt, chromium, copper, iron and manganese*

4.3.7 Manganese, Mn (referee method)

ISO 7530-1:2015, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 1: Determination of cobalt, chromium, copper, iron and manganese*

4.3.8 Molybdenum, Mo (referee method)

ISO 11435:2011, *Nickel alloys — Determination of molybdenum content — Inductively coupled plasma atomic emission spectrometric method*

4.3.9 Niobium, Nb (referee method)

ISO 22033:2011, *Nickel alloys — Determination of niobium — Inductively coupled plasma atomic emission spectrometric method*

4.3.10 Nickel, Ni (referee method)

ISO/TS 18223:2015, *Nickel alloys — Determination of Nickel content — Inductively coupled plasma atomic emission spectrometric method*

4.3.11 Phosphorus, P (referee method)

ISO 9388:1992, *Nickel alloys — Determination of phosphorus content — Molybdenum blue molecular absorption spectrometric method*

ISO 11400:1992, *Nickel, ferronickel and nickel alloys — Determination of phosphorus content — Phosphovanadomolybdate molecular absorption spectrometric method*

4.3.12 Lead, Pb (referee method)

ISO 11437:2018, *Nickel alloys — Determination of lead — Electrothermal atomic absorption spectrometric method*

4.3.13 Sulfur, S (referee method)

ISO 7527:1985, *Nickel, ferronickel and nickel alloys — Determination of sulfur content — Iodimetric titration method after induction furnace combustion*

4.3.14 Silicon, Si (referee method)

ISO 7530-8:1992, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 8: Determination of silicon content*

4.3.15 Tantalum, Ta (referee method)

ISO 23166:2018, *Nickel alloys — Determination of tantalum — Inductively coupled plasma optical emission spectrometric method*

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4.3.16 Titanium, Ti (referee method)

ISO 11433:2020, *Nickel alloys — Determination of titanium content — Diantipyrylmethane molecular absorption method*

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4.3.17 Vanadium, V (referee method)

ISO 7530-9:1993, *Nickel alloys — Flame atomic absorption spectrometric analysis — Part 9: Determination of vanadium content*

5 Range of application and principle of the methods

5.1 Nickel

5.1.1 Silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc [Ag, Bi, Cd, Co, Cu, Fe, Mn, Pb and Zn]

Document: ISO 6351:1985, *Nickel — Determination of silver, bismuth, cadmium, cobalt, copper, iron, manganese, lead and zinc contents — Flame atomic absorption spectrometric method.*

Range of application:

- determination in refined, wrought and cast nickel of:
 - silver contents from 0,000 2 % (by mass) to 0,01 % (by mass);
 - bismuth contents from 0,001 0 % (by mass) to 0,01 % (by mass);
 - cadmium contents from 0,000 2 % (by mass) to 0,002 5 % (by mass);

- cobalt contents from 0,001 0 % (by mass) to 1,00 % (by mass);
- copper contents from 0,000 2 % (by mass) to 1,00 % (by mass);
- iron contents from 0,002 5 % (by mass) to 0,15 % (by mass);
- manganese contents from 0,000 5 % (by mass) to 0,20 % (by mass);
- lead contents from 0,000 5 % (by mass) to 0,01 % (by mass);
- zinc contents from 0,000 2 % (by mass) to 0,015 % (by mass).

NOTE 1 The upper limit for the determination of cobalt and copper can be raised to 2 % (by mass) by a minor modification to the method.

NOTE 2 The lower limit for the determination of iron can be extended to less than 0,002 5 % (by mass) provided nickel containing less than 0,000 1 % iron is used for preparation of the standard solutions.

Principle of the method:

- a) dissolution of a test portion in nitric acid diluted (1 + 1), evaporation of excess acid and dilution of the solution to a known volume;
- b) aspiration of the solution into the air-acetylene flame of an atomic absorption spectrometer;
- c) measurement of the absorption of the resonance line energy from the spectrum of each element and comparison with that of calibration solutions of the same element in a matched nickel matrix.

5.1.2 Silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium [Ag, As, Bi, Cd, Pb, Sb, Se, Sn, Te and Tl]

Document: ISO 7523:1985, *Nickel — Determination of silver, arsenic, bismuth, cadmium, lead, antimony, selenium, tin, tellurium and thallium contents — Electrothermal atomic absorption spectrometric method.*

Range of application:

- determination in refined, wrought and cast nickel of:
 - silver contents from 0,1 µg/g (by mass) to 10 µg/g (by mass);
 - arsenic contents from 1 µg/g (by mass) to 20 µg/g (by mass);
 - bismuth contents from 0,5 µg/g (by mass) to 15 µg/g (by mass);
 - cadmium contents from 0,1 µg/g (by mass) to 2 µg/g (by mass);
 - lead contents from 0,1 µg/g (by mass) to 10 µg/g (by mass);
 - antimony contents from 1 µg/g (by mass) to 10 µg/g (by mass);
 - selenium contents from 1 µg/g (by mass) to 10 µg/g (by mass);
 - tin contents from 1 µg/g (by mass) to 5 µg/g (by mass);
 - tellurium contents from 0,2 µg/g (by mass) to 10 µg/g (by mass);
 - thallium contents from 0,5 µg/g (by mass) to 10 µg/g (by mass).

Principle of the method:

- a) dissolution of a test portion in nitric acid and dilution of the solution to a known volume;
- b) introduction of a known volume of the solution into an electrothermal atomizer of an atomic absorption spectrometer;