Wrought nickel-iron alloys
Chemical composition

DIN 17745

ICS 77.150.40

Supersedes
January 1973 edition.

Knetlegierungen aus Nickel und Eisen – Zusammensetzung

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Contents

Foreword

This standard has been prepared by the *Normenausschuss Nichteisenmetalle* (Nonferrous Metals Standards Committee), Technical Committee *Nickelwerkstoffe.*

See Other relevant standards for further standards covering the composition of nickel alloys.

Amendments

This standard differs from the January 1973 edition as follows:

a) The standard has been revised in form and substance (with the alloys classified into soft magnetic and bimetallic materials).

b) Ten nickel-iron alloys have been included.

c) Properties of nickel-iron alloys have been specified and information on the use of such alloys is provided.

d) Tolerances on the coefficient of linear thermal expansion are specified and the thermal behaviour of bimetallic materials is shown graphically.

Previous editions

DIN 1727: 1944-01; DIN 17745: 1963-06, 1973-01.

1 Scope

This standard specifies the chemical composition of wrought nickel-iron alloys with specific magnetic properties and thermal behaviour as used for semi-finished products, and provides information about the forms normally supplied.

Continued on pages 2 to 7.

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original should be consulted as the authoritative text.

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2 Normative references

This standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the titles of the publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

DIN 17405	Soft magnetic materials for d.c. relays – Technical delivery conditions
IEC 60740-2	Laminations for transformers and inductors for use in telecommunication and electronic equipment
ISO 31-0 : 1992	Quantities and units – Part 0: General principles

3 Designation

Wrought nickel-iron alloys shall be designated using either the name of the grade or its material number.

EXAMPLE:

Designation of a grade NiFe45 nickel alloy (material number: 2.4472):

Nickel DIN 17745 – NiFe45

or

Nickel DIN 17745 – 2.4472

4 Chemical composition

The chemical composition of wrought nickel-iron alloys shall be as specified in tables 1 and 2.

5 Forms supplied

Wrought nickel-iron alloys may be supplied in the form of sheet, plate, strip, slit strip, pipes and tubes, bars and rod, or wire. See tables 3 and 4 for recommended applications.

6 Chemical analysis

The analytical method used to establish the chemical composition shall be at the manufacturer's discretion. In cases of doubt, the latest method is to be used.

When expressing the result, the rules given in clause 8 are to be followed.

7 Properties

7.1 Bimetallic materials

The coefficient of linear thermal expansion is a function of the chemical composition and the heat treatment condition of the material. It shall lie within the tolerances specified in table 5. Figure 1 shows the dependence of the coefficient on the service temperature.

7.2 Soft magnetic materials

The magnetic properties of nickel-iron alloys in d.c. applications are described in DIN 17405. They are adversely affected by the formation of eddy currents at high frequencies as the electrical conductivity and the material thickness increase in magnitude.

8 Rounding of results

Rounding of results obtained from the chemical analysis (by measurement or calculation) shall be based on Annex B of ISO 31-0. Rounding shall be carried out in one single stage to the same number of places as is given in table 1.

The following rules are to be complied with:

a) if the figure after the last decimal place to which the value is to be expressed is less than 5, this figure shall be deleted;

b) if the figure after the last decimal place to which the value is to be expressed is 5 or higher, the figure is to be deleted and the last decimal place shall be increased by 1.

Table 1: Chemical composition of soft magnetic materials

Nickel grade		Percentages by mass										Approx. density in g/cm³ [1]
Name	Material number		Ni	C	Co	Cr	Cu	Fe	Mn	Mo	Si	
Ni 30	**1.3903**	Min.	29,0	—	—	—	—	Other	—	—	—	8,15
		Max.	32,0	0,40	—	—	—	—	1,0	—	0,60	
Ni 40	**1.3909**	Min.	39,0	—	—	—	—	Other	—	—	—	8,2
		Max.	42,0	0,05	—	—	—	—	1,0	—	0,30	
Ni 36 [2]	**1.3910**	Min.	35,0	—	—	—	—	Other	—	—	—	8,1
RNi 24 [3]	**1.3911**	Max.	38,0	0,05	—	—	—	—	1,0	—	0,30	
Ni 48 [2] [4]	**1.3922**	Min.	46,0	—	—	—	—	Other	—	—	—	8,3
RNi 12 [3]	**1.3926**	Max.	49,0	0,05	—	—	—	—	0,50	—	0,30	
RNi 8 [3]	**1.3927**											
NiFe44	**2.4420**	Min.	Other	—	—	—	—	42,0	—	—	—	8,3
		Max.	—	0,05	—	—	—	46,0	0,50	—	0,30	
NiFe16CuCr [5]	**2.4501**	Min.	Other	—	—	1,5	4,0	15,0	—	—	—	8,7
		Max.	—	0,05	—	2,5	6,0	18,0	1,0	—	0,30	
NiFe16CuMo [5]	**2.4530**	Min.	Other	—	—	—	4,0	12,0	—	2,0	—	8,7
		Max.	—	0,05	—	—	6,0	16,0	1,0	5,0	0,40	
NiFe15Mo [5]	**2.4545**	Min.	Other	—	—	—	—	11,0	—	2,0	—	8,7
		Max.	—	0,05	—	—	—	17,0	1,0	6,0	0,40	

[1] For information only.

[2] When ordering the material, the intended use is to be indicated since the alloy can be supplied either as soft magnetic or bimetallic material (with slightly differing compositions).

[3] From DIN 17405.

[4] Designated by E31 in IEC 60740-2.

[5] Depending on its properties and intended use, the material will be designated differently (e.g. E11 as in IEC 60740-2, RNi2 and RNi5 as in DIN 17405.

Table 2: Chemical composition of bimetallic materials

Nickel grade		Percentages by mass										Approx. density in g/cm³ [2]
Name	Material number		Ni	C	Co	Cr	Cu	Fe	Mn [1]	Mo	Si [1]	
Ni 36 [3]	**1.3912**	Min.	35,0	—	—	—	—	Other	—	—	—	8,1
		Max.	37,0	0,05	—	—	—	—	0,50	—	0,30	
Ni 38	**1.3913**	Min.	37,0	—	—	—	—	Other	—	—	—	8,2
		Max.	40,0	0,05	—	—	—	—	0,60	—	0,30	
Ni 42 [4]	**1.3917**	Min.	40,0	—	—	—	—	Other	—	—	—	8,2
		Max.	43,0	0,05	—	—	—	—	1,0	—	0,30	
Ni 46	**1.3920**	Min.	45,0	—	—	—	—	Other	—	—	—	8,2
		Max.	47,0	0,05	—	—	—	—	1,0	—	0,30	
Ni 48 [3]	**1.3922**	Min.	47,0	—	—	—	—	Other	—	—	—	8,3
		Max.	49,0	0,05	—	—	—	—	0,5	—	0,30	
NiCr 42 6	**1.3946**	Min.	41,0	—	—	5,0	—	Other	—	—	—	8,2
		Max.	43,0	0,07	—	6,0	—	—	0,50	—	0,30	
NiCo 29 18	**1.3981**	Min.	28,0	—	16,0	—	—	Other	—	—	—	8,3
		Max.	30,0	0,05	18,0	—	—	—	0,50	—	0,30	
NiCo 28 23	**1.3982**	Min.	27,0	—	22,0	—	—	Other	—	—	—	8,3
		Max.	29,0	0,05	24,0	—	—	—	0,50	—	0,30	
NiFe45 [4]	**2.4472**	Min.	Other	—	—	—	—	44,0	—	—	—	8,3
		Max.	—	0,02	—	—	—	46,0	0,60	—	0,30	
NiFe46 [4]	**2.4475**	Min.	Other	—	—	—	—	46,0	—	—	—	8,3
		Max.	—	0,02	—	—	—	49,0	0,60	—	0,30	
NiFe47 [4]	**2.4478**	Min.	Other	—	—	—	—	47,0	—	—	—	8,3
		Max.	—	0,02	—	—	—	50,0	0,60	—	0,30	
NiFe48Cr	**2.4480**	Min.	Other	—	—	0,7	—	45,0	—	—	—	8,3
		Max.	—	0,02	—	1,5	—	48,0	1,0	—	0,30	
NiFe47Cr6	**2.4486**	Min.	Other	—	—	5,5	—	44,5	—	—	—	8,1
		Max.	—	0,02	—	6,5	—	47,0	1,0	—	0,30	

[1] If supplied in powder form, it is possible that the alloy will not contain manganese or silicon.

[2] For information only.

[3] When ordering the material, the intended use is to be indicated since the alloy can be supplied either as soft magnetic or bimetallic material (with slightly differing compositions).

[4] The thermal behaviour of the material can be controlled by changing the nominal nickel content within tight limits.

Table 3: Use of soft magnetic materials

Nickel grade		Properties	Application
Name	Material number		
Ni 30	**1.3903**	Saturation magnetization highly temperature-dependent	Thermal compensation in permanent magnets, thermal circuit-breakers
Ni 40	**1.3909**	High resistivity, low losses	Laminations at high frequencies
Ni 36	**1.3910**	Low production costs, multi-purpose, low-duty applications	Screening
RNi 24	**1.3911**		
Ni 48	**1.3922**	High permeability, low coercive field strength	Relay components, transformers
RNi 12	**1.3926**		
RNi 8	**1.3927**		
NiFe44	**2.4420**	High initial and maximum permeability, high saturation magnetization	Transducers, totalizing current transformers for residual current devices
NiFe16CuCr	**2.4501**	Very high initial and maximum permeability, very low coercive field strength	Totalizing current transformers for residual current devices, magnetic heads
NiFe16CuMo	**2.4530**		
NiFe15Mo	**2.4545**		

Table 4: Use of bimetallic materials

Nickel grade		Application
Name	Material number	
Ni 36	**1.3912**	Alloy with low to very low coefficient of linear thermal expansion, passive elements of thermocouples and lens masks for television tubes
Ni 38	**1.3913**	
Ni 42	**1.3917**	Inserts for fusing into soft glass, glass/ceramic-metal-joints
Ni 46	**1.3920**	
Ni 48	**1.3922**	
NiCr 42 6	**1.3946**	
NiCo 29 18	**1.3981**	Inserts for fusing into hard glass, glass/ceramic-metal-joints
NiCo 28 23	**1.3982**	
NiFe45	**2.4472**	Inserts for fusing into soft glass
NiFe46	**2.4475**	
NiFe47	**2.4478**	
NiFe48Cr	**2.4480**	
NiFe47Cr6	**2.4486**	

Table 5: Tolerances on the coefficient of linear thermal expansion of bimetallic materials for selected temperature ranges

Name of alloy	Material number	Temperature range	Coefficient of linear thermal expansion, in 10^{-6} K^{-1}	Remarks
Ni 36	**1.3912**	AT to 100 °C	1,2 to 1,8	Variants with a coefficient of 0,4 $10^{-6}K^{-1}$ (resulting from a modified chemical composition and additional heat treatment) are available on request.
Ni 38	**1.3913**	AT to 150 °C	3,0 to 3,8	–
Ni 42	**1.3917**	AT to 300 °C	4,0 to 5,8	Tolerances will be closer if chemical composition keeps within closer limits.
Ni 46	**1.3920**	AT to 300 °C	7,1 to 8,4	Tolerances will be closer if chemical composition keeps within closer limits.
Ni 48	**1.3922**	AT to 400 °C	8,3 to 8,9	–
NiCr 42 6	**1.3946**	AT to 400 °C	9,6 to 10,4	–
NiCo 29 18	**1.3981**	AT to 400 °C	4,6 to 5,6	Tolerances will be closer if chemical composition keeps within closer limits. Variants with no martensite (except for isolated acicular martensite) down to –196 °C are available on request.
NiCo 28 23	**1.3982**	AT to 400 °C	6,2 to 7,8	Tolerances will be closer if chemical composition keeps within closer limits. No martensite down to –196 °C (except for isolated acicular martensite).
NiFe45	**2.4472**	AT to 400 °C	11,1 to 11,7	–
NiFe46	**2.4475**	AT to 400 °C	9,8 to 10,6	–
NiFe47	**2.4478**	AT to 400 °C	9,7 to 10,5	–
NiFe48Cr	**2.4480**	AT to 400 °C	9,9 to 10,7	–
NiFe47Cr6	**2.4486**	AT to 400 °C	10,0 to 10,8	–

AT – ambient temperature.

NOTE: Tolerances relate to the annealed condition (e.g. annealed in an inert atmosphere at a temperature from 900 °C to 1 100 °C, a rest period of 15 minutes to one hour and successive slow cooling (at 5 K or less per minute, down to less than –300 °C).

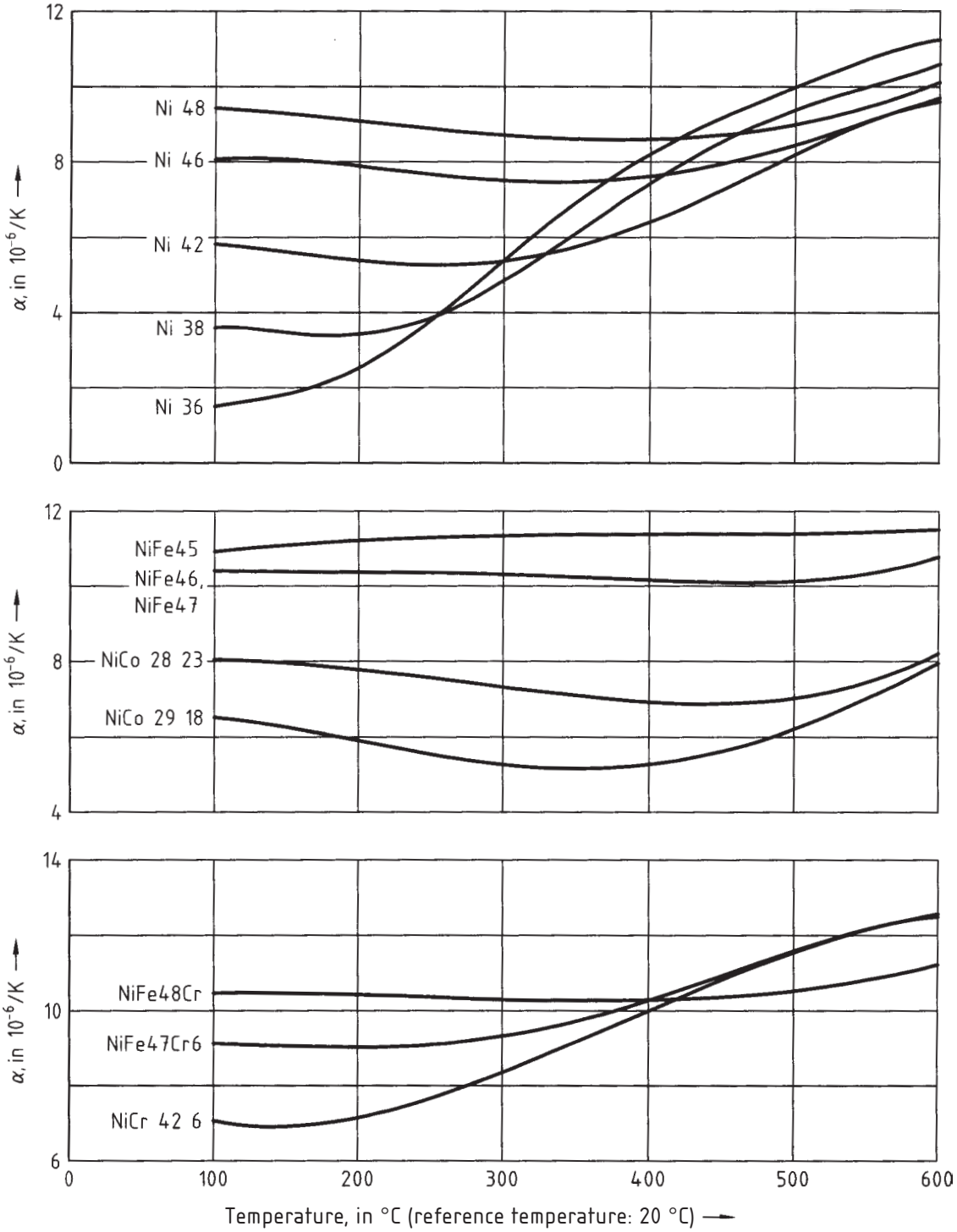

Figure 1: Mean coefficient of linear thermal expansion, α, of bimetallic materials in the annealed condition as a function of temperature (examples)

Other relevant standards

DIN 17740 Wrought nickel – Chemical composition
DIN 17741 Low-alloy wrought nickel alloys – Chemical composition
DIN 17742 Wrought nickel-chromium alloys – Chemical composition
DIN 17743 Wrought nickel-copper alloys – Chemical composition
DIN 17744 Wrought nickel-chromium-molybdenum alloys – Chemical composition