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Heating conductor alloys

Technical delivery conditions for round and flat wire

DIN 17 470

Heizleiterlegierungen; technische Lieferbedingungen für Rund- und Flachdrähte

Supersedes July 1963 edition and DIN 59 470, July 1963 edition

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.

1 Field of application

This standard applies to the nickel-chrome, nickel-chrome-iron, iron-nickel-chrome and iron-chrome-aluminium alloys which are normally used for the manufacture of heating conductors by virtue of their high electrical resistance and of their resistance to scaling.

It gives specifications for round wire from 0,10 to 6,5 mm diameter, and for flat wire from 0,03 to 0,50 mm thickness and 0,3 to 3,0 mm width.

Note. Some of these alloys are also used as electric resistance alloys. DIN 17 471 applies to these.

2 Designation

2.1 Standard designation

2.1.1 Material

A heating conductor alloy identified by material designation NiCr 80 20 and material number 2.4869 shall be designated:

Alloy DIN 17 470 – NiCr 80 20
or Alloy DIN 17 470 – 2.4869

2.1.2 Round and flat wire

The standard designation shall give in the following order:

- the term (round wire or flat wire);
- the number of this DIN Standard;
- the material designation or material number;
- the nominal diameter of round wire, in mm, or nominal thickness and nominal width of flat wire, in mm.

2.1.3 Examples of standard designation

Example 1: round wire

A round wire made from the alloy identified by material designation NiCr 80 20 and material number 2.4869, of 3,0 mm nominal diameter shall be designated:

Round wire
DIN 17 470 – NiCr 80 20 – 3,0
or Round wire
DIN 17 470 – 2.4869 – 3,0

Example 2: flat wire

A flat wire made from the alloy identified by material designation CrAl 20 5 and material number 1.4767, with a nominal thickness of 0,30 mm and a nominal width of 3 mm shall be designated:

Flat wire
DIN 17 470 – CrAl 20 5 – 0,30 × 3
or Flat wire
DIN 17 470 – 1.4767 – 0,30 × 3

2.2 Designation to be used on ordering

2.2.1 For the purpose of processing a purchase order, the standard designation of round and flat wires shall be supplemented by the following details:

- quantity ordered (indication to precede the standard designation);
- internal diameter of coil or length and surface finish (indications to follow the standard designation).

2.2.2 Examples of order designation

Example 1:

Order designation of 100 kg of round wire of 3,0 mm nominal diameter, made from alloy NiCr 80 20 (material number 2.4869), with "oxidized" surface finish, supplied in coils with 500 mm internal diameter:

100 kg round wire DIN 17 470 – NiCr 80 20 – 3,0 oxidized, in coils with 500 mm internal diameter
or **100 kg round wire DIN 17 470 – 2.4869 – 3,0 oxidized, in coils with 500 mm internal diameter**

Example 2:

Order designation of 500 kg of flat wire of 0,30 mm nominal thickness and 3 mm nominal width, made from alloy CrAl 20 5 (material number 1.4767) with "bright" surface finish, wound onto DIN 46 399 – 125 spool:

500 kg flat wire
DIN 17 470 – CrAl 20 5 – 0,30 × 3
bright, on DIN 46 399 – 125 spool
or **500 kg flat wire**
DIN 17 470 – 1.4767 – 0,30 × 3
bright, on DIN 46 399 – 125 spool

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3 Dimensions, permissible dimensional deviations and masses

3.1 The nominal dimensions and the nominal masses determined therefrom on the basis of the density specified in table 7 are listed in table 1 for round wire and in table 2 for flat wire.

3.2 In the case of flat wire, the actual value of the width shall not deviate from the nominal value by more than ± 5 %.

4 Chemical composition

Table 3 lists guideline values relating to the chemical composition of the heating conductor alloys (see final paragraph of Explanatory notes).

5 Condition of wire and method of supply

The wire shall be supplied in the soft annealed condition and, depending on the order, provided with one of the following surface finishes:

- bright, or
- oxidized.

The wire shall be supplied in one of the following forms:

- wound onto spools complying with DIN 46 399 Part 1 or Part 2, or
- in coil, or
- in containers complying with DIN 46 396 Part 1 or Part 2.

6 Properties

6.1 Electrical resistance

6.1.1 Values of the specific electrical resistance of the heating conductor alloys to be complied with are given in table 4.

6.1.2 Nominal values of the electrical resistance per metre of wire to be complied with are given in table 5 for round wire and in table 6 for flat wire. These values have been calculated on the basis of the specific electrical resistance values (see table 4) applicable to the state of equilibrium (see table 4, footnote 1).

6.1.3 In the state of equilibrium (see table 4, footnote 1) the permissible deviation of the electrical resistance per metre at 20 °C from the nominal values specified in table 5 and table 6 shall not exceed ± 5 %.

6.1.4 Within one and the same continuous length of wire, the electrical resistance per metre at 20 °C shall not deviate by more than ± 2 % from the measured value indicated on the adhesive label or on the tie-on tag described in clause 10.

6.2 Other physical properties

Guideline values relating to other physical properties are listed in table 7.

6.3 Strength properties at room temperature

The values given in table 8 are applicable to the strength properties of wire at 20 °C in the soft annealed condition.

6.4 Creep properties

The guideline values given in table 9 are applicable to the 1 % – 1000 h creep strain limit ($R_{p1/1000}$) of wire in the soft annealed condition.

6.5 Corrosion behaviour

Table 10 gives a synopsis of the corrosion behaviour of the alloys in the soft annealed condition.

6.6 Behaviour in the wrapping test

In the case of wires with diameters up to 1 mm, the pitch of the coil turns of the helical springs wound as described in subclause 9.3 shall be uniform after the coil has been pulled apart and relieved of the tensile load.

7 Recommendations relating to processing

Products made from heating conductor alloys can be jointed to one another by various processes, e.g. by brazing or welding. The choice of process and the processing conditions depend on the requirements imposed on the joints. Because these requirements vary widely, no universally valid recommendations can be made.

8 Recommendations relating to applications

Table 3 gives recommendations relating to preferred applications, and table 11 gives guideline values relating to the upper temperature of utilization in air and also data on embrittlement phenomena (see also table 10).

9 Testing

9.1 Testing the electrical resistance

9.1.1 The manufacturer shall test one test piece per coil, spool or container in respect of its electrical resistance at 20 °C.

9.1.2 The test piece should preferably be 1 m long.

9.1.3 Normally the test pieces shall be tested in the soft annealed condition, but in arbitration cases they shall be tested in the equilibrium state.

9.1.4 Any measuring instrument capable of measuring the electrical resistance to within ± 1 % may be used for the test.

9.1.5 For the purpose of calculating the specific electrical resistance, the measured resistance per metre shall be multiplied by the actual cross section (not by the nominal cross section) of the wire.

9.2 Tensile test

9.2.1 Should verification (in the form of a certificate) of the minimum values for tensile strength and elongation after fracture specified in table 8, at room temperature in the soft annealed as delivered condition, be desired, then this shall be agreed at the time of ordering, together with details on the type of document required (see DIN 50 049). If an inspection certificate has to be issued, the scope of testing shall also be agreed.

9.2.2 The tensile test shall be carried out as specified in DIN 51 210 Part 1.

9.3 Wrapping test

In arbitration cases, the wrapping test intended to verify that the requirements given in subclause 6.6 have been fulfilled, shall be carried out as specified DIN 51 215, as follows.

A wire about 250 mm in length and about 10 X d in diameter (d being the nominal diameter of the wire) shall be wound in a helix around a mandrel so that the adjacent wraps of the coil are in contact. After the mandrel has been removed, the coil shall be pulled apart to an extent which ensures that its length, after it has been relieved of the tensile load, is equal to at least twice but not more than four times the previous coil length.

10 Marking

The spools, coils or containers shall be identified by means of adhesive labels or tie-on tags. These labels or tags shall show the material designation of the alloy, the electrical resistance per metre, determined at 20 °C for the soft annealed condition (as described in subclause 9.1), and the nominal dimensions of the wire.

Table 1. **Nominal dimensions and nominal masses of round wire**

Nominal diameter mm	Nominal cross section mm^2	Nominal surface area per metre of wire length cm^2	Nominal mass, in kg per 1000 m, for alloy							
			NiCr 80 20 2.4869	NiCr 70 30 2.4658	NiCr 60 15 2.4867	NiCr 30 20 1.4860	CrNi 25 20 1.4843	CrAl 25 5 1.4765	CrAl 20 5 1.4767	CrAl 14 4 1.4725
0,10	0,00785	3,14	0,065	0,064	0,064	0,062	0,061	0,056	0,057	0,057
0,11	0,00950	3,46	0,079	0,077	0,078	0,075	0,074	0,067	0,068	0,069
0,12	0,01131	3,77	0,094	0,092	0,093	0,089	0,088	0,080	0,081	0,083
0,13	0,01327	4,08	0,110	0,108	0,109	0,105	0,104	0,094	0,096	0,097
0,14	0,01539	4,40	0,128	0,125	0,126	0,122	0,120	0,109	0,111	0,112
0,15	0,01767	4,71	0,147	0,143	0,145	0,140	0,138	0,125	0,127	0,129
0,16	0,02011	5,03	0,167	0,163	0,165	0,159	0,157	0,143	0,145	0,147
0,18	0,02545	5,65	0,211	0,206	0,209	0,201	0,198	0,181	0,183	0,186
0,20	0,03142	6,28	0,261	0,254	0,258	0,248	0,245	0,223	0,226	0,229
0,22	0,03801	6,91	0,316	0,308	0,312	0,300	0,297	0,270	0,274	0,277
0,25	0,04909	7,85	0,407	0,398	0,403	0,388	0,383	0,349	0,353	0,358
0,28	0,06158	8,80	0,511	0,499	0,505	0,486	0,480	0,437	0,443	0,449
0,30	0,07069	9,42	0,587	0,573	0,580	0,558	0,551	0,502	0,509	0,516
0,32	0,08042	10,05	0,668	0,651	0,659	0,635	0,627	0,571	0,579	0,587
0,35	0,09621	11,00	0,799	0,779	0,789	0,760	0,750	0,683	0,693	0,702
0,40	0,126	12,6	1,04	1,02	1,03	0,99	0,98	0,89	0,90	0,92
0,45	0,159	14,1	1,32	1,29	1,30	1,26	1,24	1,13	1,15	1,16
0,50	0,196	15,7	1,63	1,59	1,61	1,55	1,53	1,39	1,41	1,43
0,55	0,238	17,3	1,97	1,92	1,95	1,88	1,85	1,69	1,71	1,73
0,60	0,283	18,8	2,35	2,29	2,32	2,23	2,21	2,01	2,04	2,06
0,65	0,332	20,4	2,75	2,69	2,72	2,62	2,59	2,36	2,39	2,42
0,70	0,385	22,0	3,19	3,12	3,16	3,04	3,00	2,73	2,77	2,81
0,75	0,442	23,6	3,67	3,58	3,62	3,49	3,45	3,14	3,18	3,23
0,80	0,503	25,1	4,17	4,07	4,12	3,97	3,92	3,57	3,62	3,67
0,90	0,636	28,3	5,28	5,15	5,22	5,03	4,96	4,52	4,58	4,64
1,00	0,785	31,4	6,52	6,36	6,44	6,20	6,13	5,58	5,65	5,73
1,10	0,950	34,6	7,89	7,70	7,79	7,51	7,41	6,75	6,84	6,94
1,2	1,13	37,7	9,4	9,2	9,3	8,9	8,8	8,0	8,1	8,3
1,3	1,33	40,8	11,0	10,8	10,9	10,5	10,4	9,4	9,6	9,7
1,4	1,54	44,0	12,8	12,5	12,6	12,2	12,0	10,9	11,1	11,2
1,5	1,77	47,1	14,7	14,3	14,5	14,0	13,8	12,5	12,7	12,9
1,6	2,01	50,3	16,7	16,3	16,5	15,9	15,7	14,3	14,5	14,7
1,8	2,54	56,5	21,1	20,6	20,9	20,1	19,8	18,1	18,3	18,6
2,0	3,14	62,8	26,1	25,4	25,8	24,8	24,5	22,3	22,6	22,9
2,2	3,80	69,1	31,6	30,8	31,2	30,0	29,7	27,0	27,4	27,7
2,5	4,91	78,5	40,7	39,8	40,3	38,8	38,3	34,9	35,3	35,8
2,8	6,16	88,0	51,1	49,9	50,5	48,6	48,0	43,7	44,3	44,9
3,0	7,07	94,2	58,7	57,3	58,0	55,8	55,1	50,2	50,9	51,6
3,2	8,04	100,5	66,8	65,1	65,9	63,5	62,7	57,1	57,9	58,7
3,5	9,62	110,0	79,9	77,9	78,9	76,0	75,0	68,3	69,3	70,2
3,8	11,34	119,4	94,1	91,9	93,0	89,6	88,5	80,5	81,7	82,8
4,0	12,57	125,7	104,3	101,8	103,0	99,3	98,0	89,2	90,5	91,7
4,2	13,85	131,9	115,0	112,2	113,6	109,4	108,1	98,4	99,8	101,1
4,5	15,90	141,4	132,0	128,8	130,4	125,6	124,1	112,9	114,5	116,1
4,8	18,10	150,8	150,2	146,6	148,4	143,0	141,1	128,5	130,3	132,1
5,0	19,63	157,1	163,0	159,0	161,0	155,1	153,2	139,4	141,4	143,3
5,2	21,24	163,4	176,3	172,0	174,1	167,8	165,6	150,8	152,9	155,0
5,5	23,76	172,8	197,2	192,4	194,8	187,7	185,3	168,7	171,1	173,4
6,0	28,27	188,5	234,7	229,0	231,8	223,4	220,5	200,7	203,6	206,4
6,5	33,18	204,2	275,4	268,8	272,1	262,1	258,8	235,6	238,9	242,2

Table 2. **Nominal dimensions and nominal masses of flat wire**

Nominal width	Nominal thickness	Nominal cross section	Nominal surface area per metre of wire length	Nominal mass, in kg per 1000 m, for alloy							
				NiCr 80 20	NiCr 70 30	NiCr 60 15	NiCr 30 20	CrNi 25 20	CrAl 25 5	CrAl 20 5	CrAl 14 4
mm	mm	mm^2	cm^2	2.4869	2.4658	2.4867	1.4860	1.4843	1.4765	1.4767	1.4725
0,3	0,03	0,009	6,6	0,075	0,073	0,074	0,071	0,070	0,064	0,065	0,066
0,4	0,04	0,016	8,8	0,133	0,130	0,131	0,126	0,125	0,114	0,115	0,117
0,5	0,05	0,025	11,0	0,208	0,203	0,205	0,197	0,195	0,178	0,180	0,183
	0,10	0,050	12,0	0,415	0,405	0,410	0,395	0,390	0,355	0,360	0,365
	0,12	0,060	12,4	0,498	0,486	0,492	0,474	0,468	0,426	0,432	0,438
	0,15	0,075	13,0	0,623	0,608	0,615	0,593	0,585	0,533	0,540	0,548
0,6	0,06	0,036	13,2	0,299	0,292	0,295	0,284	0,281	0,256	0,259	0,263
	0,10	0,060	14,0	0,498	0,486	0,492	0,474	0,468	0,426	0,432	0,438
	0,12	0,072	14,4	0,598	0,583	0,590	0,569	0,562	0,511	0,518	0,526
	0,15	0,090	15,0	0,747	0,729	0,738	0,711	0,702	0,639	0,648	0,657
0,7	0,07	0,049	15,4	0,407	0,397	0,402	0,387	0,382	0,348	0,353	0,358
0,8	0,08	0,064	17,6	0,531	0,518	0,525	0,506	0,499	0,454	0,461	0,467
	0,10	0,080	18,0	0,664	0,648	0,656	0,632	0,624	0,568	0,576	0,584
	0,12	0,096	18,4	0,797	0,778	0,787	0,758	0,749	0,682	0,691	0,701
	0,15	0,120	19,0	0,996	0,972	0,984	0,948	0,936	0,852	0,864	0,876
	0,20	0,160	20,0	1,33	1,30	1,31	1,26	1,25	1,14	1,15	1,17
0,9	0,09	0,081	19,8	0,672	0,656	0,644	0,640	0,632	0,575	0,583	0,591
1,0	0,10	0,100	22,0	0,830	0,810	0,820	0,790	0,780	0,710	0,720	0,730
	0,12	0,120	22,4	0,996	0,972	0,984	0,948	0,936	0,852	0,864	0,876
	0,15	0,150	23,0	1,25	1,22	1,23	1,19	1,17	1,07	1,08	1,10
	0,20	0,200	24,0	1,66	1,62	1,64	1,58	1,56	1,42	1,44	1,46
1,2	0,10	0,120	26,0	0,996	0,972	0,984	0,948	0,936	0,852	0,864	0,876
	0,12	0,144	26,4	1,20	1,17	1,18	1,14	1,12	1,02	1,04	1,05
	0,15	0,180	27,0	1,49	1,46	1,48	1,42	1,40	1,28	1,30	1,31
	0,20	0,240	28,0	1,99	1,94	1,97	1,90	1,87	1,70	1,73	1,75
1,5	0,10	0,150	32,0	1,25	1,22	1,23	1,19	1,17	1,07	1,08	1,10
	0,12	0,180	32,4	1,49	1,46	1,48	1,42	1,40	1,28	1,30	1,31
	0,15	0,225	33,0	1,87	1,82	1,85	1,78	1,76	1,60	1,62	1,64
	0,20	0,300	34,0	2,49	2,43	2,46	2,37	2,34	2,13	2,16	2,19
1,8	0,10	0,180	38,0	1,49	1,46	1,48	1,42	1,40	1,28	1,30	1,31
	0,12	0,216	38,4	1,79	1,75	1,77	1,71	1,68	1,53	1,56	1,58
	0,15	0,270	39,0	2,24	2,19	2,21	2,13	2,11	1,92	1,94	1,97
	0,20	0,360	40,0	2,99	2,92	2,95	2,84	2,81	2,56	2,59	2,63
2,0	0,10	0,200	42,0	1,66	1,62	1,64	1,58	1,56	1,42	1,44	1,46
	0,12	0,240	42,4	1,99	1,94	1,97	1,90	1,87	1,70	1,73	1,75
	0,15	0,300	43,0	2,49	2,43	2,46	2,37	2,34	2,13	2,16	2,19
	0,20	0,400	44,0	1,33	3,24	3,28	3,16	3,12	2,84	2,88	2,92
	0,30	0,600	46,0	4,98	4,86	4,92	4,74	4,68	4,26	4,32	4,38
2,5	0,15	0,375	53,0	3,11	3,04	3,08	2,96	2,93	2,66	2,70	2,74
	0,20	0,500	54,0	4,15	4,05	4,10	3,95	3,90	3,55	3,60	3,65
	0,30	0,750	56,0	6,23	6,08	1,15	5,93	5,85	5,33	5,40	5,48
	0,50	1,250	60,0	10,4	10,1	10,3	9,88	9,75	8,88	9,00	9,13
3,0	0,15	0,450	63,0	3,74	3,65	3,69	3,55	3,51	3,20	3,24	3,29
	0,20	0,600	64,0	4,98	4,86	4,92	4,74	4,68	4,26	4,32	4,38
	0,30	0,900	66,0	7,47	7,29	7,38	7,11	7,02	6,39	6,48	6,57
	0,50	1,500	70,0	12,5	12,2	12,3	11,9	11,7	10,7	10,8	11,0

Table 3. **Chemical composition, properties, use**

Material designation	Material number	Chemical composition % by mass (mean values of alloying elements)				Notes	
		Al	Cr	Fe	Ni	in respect of structure and magnetizability	in respect of preferred use
NiCr 80 20[1]	**2.4869**[1]	–	20	–	80	Austenitic, non-magnetic[2]	Industrial furnace construction and domestic appliances
NiCr 70 30[1]	**2.4658**[1]	–	30	–	70		
NiCr 60 15[1]	**2.4867**[1]	–	15	22	60		
NiCr 30 20	**1.4860**	–	20	Remainder	30		Domestic appliances
CrNi 25 20	**1.4843**	–	25	Remainder	20		Hardening shop furnaces
CrAl 25 5	**1.4765**	5	25	Remainder	–	Ferritic, magnetic	High temperature furnaces, calcining or burning kilns
CrAl 20 5	**1.4767**	5	20	Remainder	–		
CrAl 14 4	**1.4725**	4	14	Remainder	–		Domestic appliances, load resistors

[1] See DIN 17 742 for further details.

[2] A moderate degree of ferromagnetism is possible in the case of NiCr 60 15 alloy.

Table 4. **Nominal values and permissible deviations of specific electrical resistance**

Material designation	Specific electrical resistance[1], in $\Omega\ mm^2/m$, at °C												
	20	100	200	300	400	500	600	700	800	900	1000	1100	1200
	Permissible deviation												
	± 5 %			± 6 %			± 7 %			± 8 %			
NiCr 80 20	1,12	1,13	1,13	1,14	1,15	1,16	1,15	1,14	1,14	1,14	1,15	1,16	1,17
	(1,08)[2]	(1,09)[2]	(1,10)[2]	(1,12)[2]	(1,14)[2]								
NiCr 70 30	1,19	1,20	1,22	1,23	1,24	1,25	1,24	1,24	1,24	1,24	1,24	1,25	1,25
	(1,16)[2]	(1,17)[2]	(1,18)[2]	(1,20)[2]	(1,22)[2]								
NiCr 60 15	1,13	1,14	1,16	1,18	1,20	1,22	1,21	1,21	1,22	1,23	1,24	1,26	1,28
	(1,11)[2]	(1,12)[2]	(1,14)[2]	(1,16)[2]	(1,18)[2]								
NiCr 30 20	1,04	1,07	1,11	1,14	1,17	1,20	1,22	1,24	1,26	1,28	1,30	1,32	–
CrNi 25 20	0,95	0,99	1,03	1,07	1,11	1,15	1,18	1,20	1,22	1,24	1,26	1,28	–
CrAl 25 5	1,44	1,44	1,44	1,44	1,45	1,45	1,46	1,47	1,48	1,49	1,49	1,49	1,49
CrAl 20 5	1,37	1,37	1,38	1,38	1,39	1,41	1,42	1,43	1,44	1,44	1,45	1,45	1,45
CrAl 14 4	1,25	1,26	1,27	1,28	1,30	1,32	1,34	1,36	1,39	1,41	1,42	1,44	–

[1] The values not given in brackets shall apply

a) to the equilibrium state, i.e. to the condition which sets itself up after an annealing time of 15 minutes at temperatures above 600 °C and subsequent slow cooling (cooling rate not exceeding 10 K/min), and also

b) to the soft annealed condition[3], with the exception of the cases described in footnote 2 below.

[2] In the case of grades NiCr 80 20, NiCr 70 30 and NiCr 60 15, for nominal thicknesses smaller than 2 mm, the equilibrium state described in footnote 1) above will not yet have been attained after the usual annealing phase in the continuous annealing furnace. As far as these grades and thicknesses are concerned, the values given in brackets are applicable to the test in the as delivered condition[3].

[3] As far as heating conductors are concerned, the values not given in brackets can be used as the basis for calculation in every case, because the values are reached after a short period of operation even in the cases described in footnote 2.

Table 5. **Nominal values of electrical resistance per metre of round wire**

Nominal diameter mm	Nominal cross section mm²	Nominal surface area per metre of wire length cm²	Nominal values of electrical resistance per metre, in Ω, at 20 °C for alloy							
			NiCr 80 20 2.4869	NiCr 70 30 2.4658	NiCr 60 15 2.4867	NiCr 30 20 1.4860	CrNi 25 20 1.4843	CrAl 25 5 1.4765	CrAl 20 5 1.4767	CrAl 14 4 1.4725
0,10	0,00785	3,14	142,6	151,5	143,9	132,4	121,0	183,3	174,4	159,2
0,11	0,00950	3,46	117,9	125,2	118,9	109,4	100,0	151,5	144,2	131,5
0,12	0,01131	3,77	99,0	105,2	99,9	92,0	84,0	127,3	121,1	110,5
0,13	0,01327	4,08	84,4	89,7	85,1	78,4	71,6	108,5	103,2	94,2
0,14	0,01539	4,40	72,8	77,3	73,4	67,6	61,7	93,5	89,0	81,2
0,15	0,01767	4,71	63,4	67,3	63,9	58,9	53,8	81,5	77,5	70,7
0,16	0,02011	5,03	55,7	59,2	56,2	51,7	47,2	71,6	68,1	62,2
0,18	0,02545	5,65	44,0	46,8	44,4	40,9	37,3	56,6	53,8	49,1
0,20	0,03142	6,28	35,7	37,9	36,0	33,1	30,2	45,8	43,6	39,8
0,22	0,03801	6,91	29,5	31,3	29,7	27,4	25,0	37,9	36,0	32,9
0,25	0,04909	7,85	22,8	24,2	23,0	21,2	19,4	29,3	27,9	25,5
0,28	0,06158	8,80	18,2	19,3	18,4	16,9	15,4	23,4	22,2	20,3
0,30	0,07069	9,42	15,8	16,8	16,0	14,7	13,4	20,4	19,4	17,7
0,32	0,08042	10,05	13,9	14,8	14,1	12,9	11,8	17,9	17,0	15,5
0,35	0,09621	11,00	11,6	12,4	11,7	10,8	9,9	15,0	14,2	13,0
0,40	0,126	12,6	8,91 [1]	9,47 [1]	8,99 [1]	8,28	7,56	11,46	10,90	9,95
0,45	0,159	14,1	7,04	7,48	7,10	6,54	5,97	9,05	8,61	7,86
0,50	0,196	15,7	5,70	6,06	5,76	5,30	4,84	7,33	6,98	6,37
0,55	0,238	17,3	4,71	5,01	4,76	4,38	4,00	6,06	5,77	5,26
0,60	0,283	18,8	3,96	4,21	4,00	3,68	3,36	5,09	4,85	4,42
0,65	0,332	20,4	3,38	3,59	3,41	3,13	2,86	4,34	4,13	3,77
0,70	0,385	22,0	2,91	3,09	2,94	2,70	2,47	3,74	3,56	3,25
0,75	0,442	23,6	2,54	2,69	2,56	2,35	2,15	3,26	3,10	2,83
0,80	0,503	25,1	2,23	2,37	2,25	2,07	1,89	2,86	2,73	2,49
0,90	0,636	28,3	1,76	1,87	1,78	1,63	1,49	2,26	2,15	1,96
1,00	0,785	31,4	1,43	1,52	1,44	1,32	1,21	1,83	1,74	1,59
1,10	0,950	34,6	1,18	1,25	1,19	1,09	1,00	1,152	1,44	1,32
1,2	1,13	37,7	0,990	1,052	0,999	0,920	0,840	1,273	1,211	1,105
1,3	1,33	40,8	0,844	0,897	0,851	0,784	0,716	1,085	1,032	0,942
1,4	1,54	44,0	0,728	0,773	0,734	0,676	0,617	0,935	0,890	0,812
1,5	1,77	47,1	0,634	0,673	0,639	0,589	0,538	0,815	0,775	0,707
1,6	2,01	50,3	0,557	0,592	0,562	0,517	0,472	0,716	0,681	0,622
1,8	2,54	56,5	0,440	0,468	0,444	0,409	0,373	0,566	0,538	0,491
2,0	3,14	62,8	0,357	0,379	0,360	0,331	0,302	0,458	0,436	0,398
2,2	3,80	69,1	0,295	0,313	0,297	0,274	0,250	0,379	0,360	0,329
2,5	4,91	78,5	0,228	0,242	0,230	0,212	0,194	0,293	0,279	0,255
2,8	6,16	88,0	0,182	0,193	0,184	0,169	0,154	0,234	0,222	0,203
3,0	7,07	94,2	0,158	0,168	0,160	0,147	0,134	0,204	0,194	0,177
3,2	8,04	100,5	0,139	0,148	0,141	0,129	0,118	0,179	0,170	0,155
3,5	9,62	110,0	0,116	0,124	0,117	0,108	0,099	0,150	0,142	0,130
3,8	11,34	119,4	0,099	0,105	0,100	0,092	0,084	0,127	0,121	0,110
4,0	12,57	125,7	0,089	0,095	0,090	0,083	0,076	0,115	0,109	0,099
4,2	13,85	131,9	0,081	0,086	0,082	0,075	0,069	0,104	0,099	0,090
4,5	15,90	141,4	0,070	0,075	0,071	0,065	0,060	0,091	0,086	0,079
4,8	18,10	150,8	0,062	0,066	0,062	0,057	0,052	0,080	0,076	0,069
5,0	19,63	157,1	0,057	0,061	0,058	0,053	0,048	0,073	0,070	0,064
5,2	21,24	163,4	0,053	0,056	0,053	0,049	0,045	0,068	0,065	0,059
5,5	23,76	172,8	0,047	0,050	0,048	0,044	0,040	0,061	0,058	0,053
6,0	26,27	188,5	0,040	0,042	0,040	0,037	0,034	0,051	0,018	0,044
6,5	33,18	204,2	0,034	0,036	0,034	0,031	0,029	0,043	0,041	0,038

[1] These values apply to the equilibrium state (see table 4, footnote 1 to 3).

Table 6. **Nominal values of electrical resistance per metre of flat wire**

Nominal width	Nominal thickness	Nominal cross section	Nominal surface area per metre of wire length	Nominal values of electrical resistance per metre, in Ω, at 20 °C for alloy							
				NiCr 80 20[1]	NiCr 70 30[1]	NiCr 60 15[1]	NiCr 30 20	CrNi 25 20	CrAl 25 5	CrAl 20 5	CrAl 14 4
mm	mm	mm²	cm²	2.4869	2.4658	2.4867	1.4860	1.4843	1.4765	1.4767	1.4725
0,3	0,03	0,009	6,6	124	132	126	116	106	160	152	139
0,4	0,04	0,016	8,8	70,0	74,4	70,6	65,0	59,4	90,0	85,6	78,1
0,5	0,05	0,025	11,0	44,8	47,6	45,2	41,6	38,0	57,6	54,8	50,0
	0,10	0,050	12,0	22,4	23,8	22,6	20,8	19,0	28,8	27,4	25,0
	0,12	0,060	12,4	18,7	19,8	18,8	17,3	15,8	24,0	22,8	20,8
	0,15	0,075	13,0	14,9	15,9	15,1	13,9	12,7	19,2	18,3	16,7
0,6	0,06	0,036	13,2	31,1	33,1	31,4	28,9	26,4	40,0	38,1	34,7
	0,10	0,060	14,0	18,7	19,8	18,8	17,3	15,8	24,0	22,8	20,8
	0,12	0,072	14,4	15,6	16,5	15,7	14,4	13,2	20,0	19,0	17,4
	0,15	0,090	15,0	12,4	13,2	12,6	11,6	10,6	16,0	15,2	13,2
0,7	0,07	0,049	15,4	22,9	24,3	23,1	21,2	19,4	29,4	27,9	25,5
0,8	0,08	0,064	17,6	17,5	18,6	17,7	16,3	14,8	22,5	21,4	19,5
	0,10	0,080	18,0	14,0	14,9	14,1	13,0	11,9	18,0	17,1	15,6
	0,12	0,096	18,4	11,7	12,4	11,8	10,8	9,90	15,0	14,3	13,0
	0,15	0,120	19,0	9,33	9,92	9,42	8,67	7,92	12,0	11,4	10,4
	0,20	0,160	20,0	7,00	7,44	7,06	6,50	5,94	9,00	8,56	7,81
0,9	0,09	0,081	19,8	13,9	14,7	14,0	12,8	11,7	17,8	16,9	15,4
1,0	0,10	0,100	22,0	11,2	11,9	11,3	10,4	9,50	14,4	13,7	12,5
	0,12	0,120	22,4	9,33	9,92	9,42	8,67	7,92	12,0	11,4	10,4
	0,15	0,150	23,0	7,47	7,93	7,53	6,93	6,33	9,60	9,13	8,33
	0,20	0,200	24,0	5,60	5,95	5,65	5,20	4,75	7,20	6,85	6,25
1,2	0,10	0,120	26,0	9,33	9,92	9,42	8,67	7,92	12,0	11,4	10,4
	0,12	0,144	26,4	7,78	8,26	7,85	7,22	6,60	10,0	9,51	8,68
	0,15	0,180	27,0	6,22	6,61	6,28	5,78	5,28	8,00	7,61	6,94
	0,20	0,240	28,0	4,67	4,96	4,71	4,33	3,96	6,00	5,71	5,21
1,5	0,10	0,150	32,0	7,47	7,93	7,53	6,93	6,33	9,60	9,13	8,33
	0,12	0,180	32,4	6,22	6,61	6,28	5,78	5,28	8,00	7,61	6,94
	0,15	0,225	33,0	4,98	5,29	5,02	4,62	4,22	6,40	6,09	4,44
	0,20	0,300	34,0	3,73	3,97	3,77	3,47	3,17	4,80	4,57	4,17
1,8	0,10	0,180	38,0	6,22	6,61	6,28	5,78	5,28	8,00	7,61	6,94
	0,12	0,216	38,4	5,19	5,51	5,23	4,81	4,40	6,67	6,34	5,79
	0,15	0,270	39,0	4,15	4,41	4,19	3,85	3,52	5,33	5,07	4,63
	0,20	0,360	40,0	3,11	3,31	3,14	2,89	2,64	4,00	3,81	3,47
2,0	0,10	0,200	42,0	5,60	5,95	5,65	5,20	4,75	7,20	6,85	6,25
	0,12	0,240	42,4	4,67	4,96	4,71	4,33	3,96	6,00	5,71	5,21
	0,15	0,300	43,0	3,73	3,97	3,77	3,47	3,17	4,80	4,57	4,17
	0,20	0,400	44,0	2,80	2,98	2,83	2,60	2,37	3,60	3,42	3,13
	0,30	0,600	46,0	1,87	1,98	1,88	1,73	1,58	2,40	2,28	2,08
2,5	0,15	0,375	53,0	2,99	3,17	3,01	2,77	2,53	3,84	3,65	3,33
	0,20	0,500	54,0	2,24	2,38	2,26	2,08	1,90	2,88	2,74	2,50
	0,30	0,750	56,0	1,49	1,59	1,51	1,39	1,27	1,92	1,83	1,67
	0,50	1,250	60,0	0,90	0,95	0,90	0,83	0,76	1,15	1,10	1,00
3,0	0,15	0,450	63,0	2,49	2,64	2,51	2,31	2,11	3,20	3,04	2,78
	0,20	0,600	64,0	1,87	1,98	1,88	1,73	1,58	2,40	2,28	2,08
	0,30	0,900	66,0	1,24	1,32	1,26	1,16	1,06	1,60	1,52	1,39
	0,50	1,500	70,0	0,747	0,793	0,753	0,693	0,633	0,960	0,913	0,833

[1] The values listed for grades NiCr 80 20, NiCr 70 30 and NiCr 60 15 are only applicable to the equilibrium state (see table 4, footnote 1 to 3).

Table 7. **Physical properties (guideline data)**

Material designation	Density g/cm³, at 20 °C	Melting temperature °C	Specific heat, $\frac{J}{g \times K}$, at 20 °C	Specific heat, $\frac{J}{g \times K}$, at 1000 °C	Thermal conductivity, $\frac{W}{m \times K}$, at 20 °C	Mean linear coefficient of thermal expansion $\frac{10^{-6}}{K}$ between 20 °C and 400 °C	between 20 °C and 800 °C	between 20 °C and 1000 °C
NiCr 80 20	8,3	1400	0,42	0,50	15	15	16	17
NiCr 70 30	8,1	1380	0,42	0,50	14	15	16	17
NiCr 60 15	8,2	1390	0,46	0,50	13	15	16	17
NiCr 30 20	7,9	1390	0,50	0,54	13	16	18	19
CrNi 25 20	7,8	1380	0,50	0,54	13	17	18	19
CrAl 25 5	7,1	1500	0,46	0,63	13	12	14	15
CrAl 20 5	7,2	1500	0,46	0,63	13	12	14	15
CrAl 14 4	7,3	1500	0,48	0,65	15	12	14	15

The values listed above are guideline values.

Table 8. **Strength properties at 20 °C in the soft annealed condition**

Material designation	Tensile strength[1] N/mm² min.	Elongation after fracture[2] (L_0 = 100 mm), in %, for nominal diameters or nominal thicknesses, in mm: from 0,02 up to 0,063 ≈	above 0,063 up to 0,125 ≈	above 0,125 up to 0,5 ≈	above 0,5 up to 1 min.	above 1[3] min.
NiCr 80 20	650	8	14	18	18	25
NiCr 70 30						
NiCr 60 15	600					
NiCr 30 20						
CrNi 25 20						
CrAl 25 5	600	6	8	10	10	12
CrAl 20 5						
CrAl 14 4		8	10	14	14	18

[1]) These values apply to wires with diameters exceeding 2 mm. In the case of smaller diameters, the minimum values are appreciably higher, depending on the alloy and size involved. These values are also applicable to flat wires, for thicknesses corresponding to the wire diameter.

[2]) The values for elongation after fracture listed in the table specifying wire diameters smaller than 0,5 mm can only be regarded as guideline values, in accordance with DIN 51 210. This also applies to flat wires.

[3]) In the case of wire diameters exceeding 3 mm, a gauge length $L_0 = 10\,d_0$ may be agreed.

Table 9. **Guideline values relating to the 1 %–1000 h creep strain limit**

Material designation	Creep strain limit $R_{p1/1000}$, in N/mm², at °C						
	600	700	800	900	1000	1100	1200
NiCr 80 20	80	40	15	9	4	1,5	0,5
NiCr 70 30							
NiCr 60 15							
NiCr 30 20	100	45	20	9	4	1,5	–
CrNi 25 20							
CrAl 25 5	40	15	6	2,5	1	0,3	0,1
CrAl 20 5							
CrAl 14 4	16	8	4	2	0,8	–	–

Table 10. **Corrosion behaviour**[1]

Material designation	Resistance to atmospheric corrosion at 20 °C	Resistance to corrosion up to the upper temperature of utilization[2] against				
		air and other oxygenous gases	nitrogenous gases, low in oxygen content	sulfurous gases		carburization
				oxidizing	reducing	
NiCr 80 20	High	High	High	Low	Low	Low
NiCr 70 30				Average		
NiCr 60 15				Low		High
NiCr 30 20			Average	Average		
CrNi 25 20					Average	Average
CrAl 25 5	Average	High	Low	High	High	High
CrAl 20 5						
CrAl 14 4						

[1] Provided with an oxidized surface finish (see clause 5), the wires exhibit an improved resistance in certain cases.
[2] See table 11.

Table 11. **Guideline values relating to the upper temperature of utilization and to the embrittlement ranges**

Material designation	Upper temperature of utilization in air °C	Notes	
NiCr 80 20	1200	Reduced bendability between	500 to 900 °C.
NiCr 70 30	1200		
NiCr 60 15	1150		
NiCr 30 20	1100		500 to 700 °C.
CrNi 25 20	1050	Likelihood of cold brittleness after use at temperatures between 500 and 850 °C.	
CrAl 25 5	1300	Cold brittleness after use at temperatures exceeding 1000 °C; also likelihood of cold brittleness after use at temperatures between 400 and 550 °C.	
CrAl 20 5	1200		
CrAl 14 4	1000		

The upper temperature of utilization applies to wires not less than 2 mm in diameter. These values are also applicable to flat wires with a thickness corresponding to the wire diameter.

Standards referred to

DIN 17 471	Electric resistance alloys; properties
DIN 17 742	Wrought nickel alloys containing chromium; composition
DIN 46 396 Part 1	Containers up to 500 mm in diameter for bare and insulated round wire
DIN 46 396 Part 2	Containers above 500 mm in diameter for bare and insulated round wire
DIN 46 399 Part 1	Spools for delivery of bare and insulated wire; dimensions
DIN 46 399 Part 2	Spools for delivery of bare and insulated wire; technical delivery conditions for polystyrene or modified polystyrene spools
DIN 50 049	Documents on materials testing
DIN 51 210 Part 1	Testing of metallic materials; tensile test on wires without extensometer measurement
DIN 51 215	Testing of metallic materials; wrapping test for wires; general information

Previous editions

DIN 59 470: 04.53; 07.63
DIN 17 470: 11.51; 07.63

Amendments

The following amendments have been made in comparison with the July 1963 edition of this standard and with the July 1963 edition of DIN 59 470:

a) The content of DIN 59 470 has been incorporated in the present standard.

b) The choice of grades has been widened (see Explanatory notes).

c) The values given in the tables have been completely revised and converted to SI units.

Explanatory notes

This revised edition of DIN 17 470 features the following principal amendments in comparison with the July 1963 edition:

a) Because of their significance, alloys NiCr 70 30 and CrAl 14 4 have been included in the standard for the first time.

b) It has been stated unambiguously by what amounts and in which circumstances the specific electrical resistance in the soft annealed condition may deviate from the values applicable to the equilibrium state (see table 4, footnotes 1 to 3).

c) The values listed in the tables have been completely revised and converted to SI units. In the course of this revision, it was at first intended to combine DIN 17 470 and DIN 17 471 to form one standard, because several heating conductor alloys are also listed in DIN 17 471 as electrical resistance alloys. In the final outcome, however, this objective was not achieved, because of requirements which differ in certain respects; in the case of heating conductor alloys, the resistance to scaling and the creep strength are parameters of major importance, whilst in the case of electric resistance alloys, it is the attainment of as low as possible a temperature dependence of the electric resistance which is the most important feature. In lieu thereof however, DIN 59 470, which specified the nominal dimensions and the electric resistances per metre of the round and flat wires made from the alloys listed in DIN 17 470 has now been included in the present revised edition, so that the user can now find all the data relating to the products mentioned in the one standard.

Because the specification of precise data concerning the chemical composition of the alloys is of little significance in comparison with the characteristic values relating to the electric resistance, only guideline values have been quoted for the chemical composition, as was done previously.

International Patent Classification

H 05 B 3-64