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POWER PLANTS

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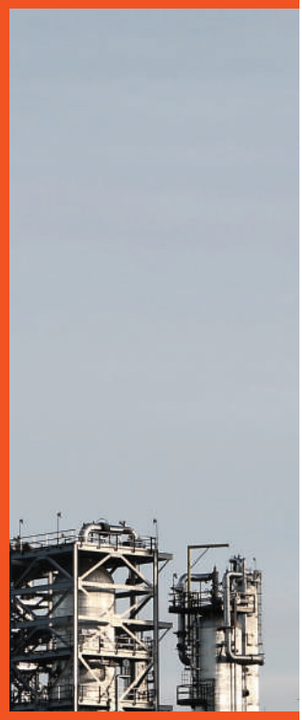
We also supply several Duplex Steel and various stainless-steel grades for cost effective but efficient corrosion resistant solutions. We supply Non-Ferrous Alloys in Copper-based Alloys for Architectural and Industrial Fabrication.

We source our materials from the best mills or partners based in Europe, USA, Japan and many other countries. We offer swift deliveries for your shutdowns, urgent fabrication jobs and the rarest materials in any quantity that is needed for your project.

We can hold stock in any size or quantity sourced direct from the best manufacturing mills for your regular production or manufacturing with flexible pricing and payment options. Apart from conventional metals, we can also supply special metals like Titanium, Molybdenum, Niobium, Tungsten, Tantalum and other special alloys in any form.



FORMS OF SUPPLY

Sheets/Plates/Coils

Round Bars

Pipes

Fittings

Fasteners

Wires

ALLOYS

NICKEL ALLOYS
NICKEL ALLOY 200/201

NICKEL COPPER ALLOYS
NICKEL ALLOY 400/405/K500

NICKEL CHROMIUM IRON ALLOYS
NICKEL ALLOY 600/601/718/925

CORROSION RESISTANT ALLOYS
NICKEL ALLOY 625/825/C276/ C22/C2000/20/22/31/AL6XN/254 SMO/904L

HEAT RESISTANT ALLOYS
NICKEL ALLOY 800HT/X/690/693

DUPLEX STEEL
UNS 31803/UNS 32750/UNS 32760

AUSTENITIC STAINLESS STEEL
SS 347H/304L/321H/310S/316L

MARTENSITIC/FERRITIC STAINLESS STEEL
SS 410/409

COPPER ALLOYS
UNS71500/UNS70600/C46400/ C61400/C63000

INDUSTRIES SERVED

OIL & GAS

PETROCHEMICAL PLANTS

FERTILIZER INDUSTRY

POWER PLANTS

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ARCHITECTURE

NICKEL ALLOY 400

Nickel Alloy 400 is a single-phase, solid solution, nickel-copper alloy with excellent corrosion resistance in a wide range of corrosive media.

Nickel Alloy 400 is characterized by:

- Resistance against chloride-induced stress corrosion
- Excellent strength even at low application temperatures
- Easy processing compared to other high-alloy materials
- Approved for pressure vessels from -10 to 425 °C (14 to 797 °F) pursuant to VdTÜV Material Sheet 263 and up to 480 °C (896 °F) in accordance with ASME Boiler and Pressure Vessel Code.

Designations and standards

Standard	Material designation
EN	2.4360 - NiCu30Fe
ISO	NiCu30
UNS	N04400
AFNOR	NU 30
BS	NA 13

Designations and standards

Product form	DIN	VdTÜV	ISO	ASTM	ASME	SAE AMS	NACE	Others
Sheet, plate	17743 17750	263	6208	B 127	SB 127	4544	MR 0175/ISO 15156 MR 0103	QQ-N-281, Form 4, 6
Strip	17743		6208	B 127	SB 127	4544	MR 0175/ISO 15156	API 5LD QQ-N-281, Form 5
Rod, bar, forging	17743 17752 17754	263	9723	B 164 B 564	SB 164	4675	MR 0175/ISO 15156 MR 0103	QQ-N-281, Form 1, 2
Wire	17743			B 164				

Chemical composition

	Ni	Fe	C	Mn	Si	Al	Cu
Min.	63	1					28
Max.		2.5	0.15	2	0.5	0.5	34

Physical properties

Density	Melting range	Curie temperature
8.82 g/cm^3 (0.32 lb/in^3) at 20 °C (68 °F)	1,300-1,350 °C (2,372-2,462 °F)	20-50 °C (68-122 °F)

Temperature		Specific heat		Thermal conductivity		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion	
°C	°F	J / Kg · K	Btu / lb · °F	W / m · K	Btu · in / sq. ft · h · °F	μΩ · cm	GPa	10^3 ksi	10^{-6} / K	10^{-6} / °F
20	68	452	0.108	23.0	160.0	51.3	182	26.4		
100	212	461	0.110	25.4	176.2	54.0	180	26.1	13.8	7.67
200	392	473	0.113	28.7	199.1	55.5	177	25.7	14.5	8.06
300	572	484	0.116	31.9	221.3	57.5	170	24.7	14.9	8.28
400	762	495	0.118	34.7	240.8	58.5	165	23.9	15.2	8.44
500	932	523	0.125	38.4	266.4	60.0	150	21.8	15.6	8.67
600	1,112	544	0.130	41.2	285.9	61.8			16.0	8.89
700	1,292	555	0.133	43.1	299.0	63.5			16.4	9.11
800	1,472	566	0.135	45.1	312.9	65.5			16.8	9.33
900	1,652	577	0.138	47.5	329.6	67.5			17.3	9.61
1,000	1,832	587	0.140	50.0	346.9					
1,150	2,102	603	0.144	52.9	367.0					

Mechanical properties

The following mechanical properties of Nickel Alloy 400 apply to the described conditions and specifications in the specified semi-fabricated forms and dimensions (ref. chapter on 'Availability'). The properties for larger dimensions have to be agreed upon separately.

Temperature		Yield strength $R_{p\ 0.2}$		Tensile strength R_m	
°C	°F	MPa	ksi	MPa	ksi
20	68	175	25.4	450	65.3
100	212	150	21.8	420	60.9
200	392	135	19.6	390	56.6
300	572	130	18.9	380	55.1
400	762	130	18.9	370	53.7
425	797	130	18.9	370	53.7

Product form	Heat treatment	Standard	Yield strength $R_{p\ 0,2}$		Tensile strength Rm		Elongation A
			MPa	ksi	MPa	ksi	%
Sheet, plate / rod, bar	stress-relieved	ASTM, ASME	275-415	39.9-60.2	550-600	79.8-87.0	≥ 20
Sheet, plate / rod, bar	stress-relieved	DIN	≥ 300	≥ 43.5	≥ 550	≥ 79.8	≥ 25
Sheet, plate / rod, bar	annealed	ASTM, ASME, QQN	≥ 195	≥ 28.3	≥ 480	≥ 69.6	≥ 35
Sheet, plate / rod, bar	annealed	DIN, VdTÜV[1)]	≥ 175	≥ 25.4	≥ 450	≥ 65.3	≥ 30

[1)] VdTÜV values apply to the following dimensions: max. thickness sheet = 50 mm (1.97 in), max. diameter rod and bar = 200 mm (7.87 in)

NICKEL ALLOY 625

Nickel Alloy 625 is a nickel-chromium-molybdenum-niobium alloy with excellent resistance to a variety of corrosive media. In the soft annealed condition (grade 1; annealed at 950 to 1,050 °C (1,742 to 1,922 °F)), the alloy is used for wet corrosion applications and is approved by TÜV for pressure vessels in a temperature range from -196 to 450 °C (-320 to 842 °F). For high temperature applications above 600 °C (1,112 °F), the solution annealed variant (grade 2; annealed at 1,080 to 1,160 °C (1,976 to 2,120 °F)) is generally used. The strength of Nickel Alloy 625 can be enhanced by heat treatment.

Nickel Alloy 625 is also approved by ASME in both the grade 1 and grade 2 conditions for sections I, III, VIII and XII at temperatures defined in ASME Section IID (temperature limits vary by construction code).

Nickel Alloy 625 in the soft annealed condition (grade 1) is characterized by:

- Exceptional resistance to pitting, crevice cor-rosion, erosion and intergranular corrosion
- Immunity to chloride-induced stress corrosion cracking
- Good resistance to mineral acids such as ni-tric, phosphoric, sulfuric and hydrochloric acid
- Good resistance to alkalis and organic acids
- Good mechanical properties

Nickel Alloy 625 in the solution annealed condition (grade 2) is characterized by:

- Excellent creep strength above about 600 °C (1,112 °F)
- Good resistance to many types of hot gas cor-rosion, particularly chlorination

Designations

Standard	Material designation
EN	2.4856 - NiCr22Mo9Nb
ISO	NC22DNb
UNS	N06625
AFNOR	NC22DNb

Standards

Product form	DIN	DIN EN	ISO	ASME	ASTM	(SAE) AMS	VdTÜV	NACE	Others
Rod, bar	17744 17752	10228		SB 446	B 446 B 564 E 112	2154 C 5666	499		
Sheet, plate	17744 17750	6208 9722	15156-3	SB 443	B 443	5599	499	MR 0175 MR 0103	API 5LD
Strip	17744	2662	6208	SB 443	B 443	5599 5869	499	MR 0175	API 5LD
Wire	17744 17753	10088-3 10095							

Chemical composition

	Ni	Cr	Fe	C[1)]	Mn	Si	Co	Al	Ti	P	S	Mo	Nb + Ta
Min.	58	21										8	3.2
Max.	71	23	5	0.03	0.5	0.4	1	0.4	0.4	0.01	0.01	10	3.8

[1)] The chemical analysis may differ slightly in some elements in other specifications and contain additional elements; according to DIN EN 10095 for example, the value for C is 0.03 to 0.10 wt.-% and the value for Cu is 0.50 wt.-% max; UNS specifies C as 0.10 wt-% max. and other elements are also different.

Physical properties

Density	Melting range	Relative magnetic permeability at 20 °C (68 °F)
8.47 g/cm³ (0.306 lb/in³)	1,290-1,350 °C (2,354-2,462 °F)	1.003 (Maximum)

Temperature		Specific heat		Thermal conductivity		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion	
°C	°F	J / Kg · K	Btu / lb · °F	W / m · K	Btu · in / sq. ft · h · °F	μΩ · cm	GPa	10³ ksi	10^{-6} / K	10^{-6} / °F
20	68					125	209	30.3		
100	212	496	0.118	12.4	86	126	202	29.3	12.51	7
200	392	521	0.124	14.2	98.5	127	195	28.3	13.03	7.2
300	572	538	0.128	16	110.9	129	190	27.6	13.34	7.4
400	762	555	0.133	17.7	122.7	131	185	26.8	13.62	7.6
500	932	573	0.137	19.3	133.8	132	178	25.8	13.94	7.7
600	1,112	620	0.148	21.5	149.1	131	170	24.7	14.47	8
700	1,292	654	0.156	26.8	185.8	130	162	23.5	15.16	8.4
800	1,472	663	0.158	26.8	185.8	129	153	22.2	15.68	8.7
900	1,652	677	0.162	26.7	185.1	128	142	20.6	16.17	9
1,000	1,832	684	0.163	28.2	195.5	128	128	18.6	16.63	9.2
1,100	2,012	695	0.166	29.6	205.2					
1,200	2,192	705	0.168							

Mechanical properties

The following properties are applicable to Nickel Alloy 625 at room temperature and elevated temperatures in the indi-cated size ranges.

Temperature		Yield strength $R_{p\ 0.2}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	%
20	68	330	47.9	730	105.9	35
100	212	290	42.1	600	87	
200	392	265	38.4	580	84.1	
300	572	260	37.7	560	81.2	
400	752	260	37.7	540	78.3	
450	842	255	37	530	76.9	
500	932	265	38.4	650	94.3	
550	1,022	260	37.7	645	93.5	
600	1,112	255	37	640	92.8	
650	1,202	245	35.5	625	90.6	
700	1,292	240	34.8	610	88.5	
750	1,382	225	32.6	570	82.7	
800	1,472	215	31.2	450	65.3	
850	1,562	200	29	350	50.8	
900	1,652	190	27.6	250	36.3	
1,000	1,832	100	14.5	120	17.4	

NICKEL ALLOY 825

Nickel Alloy 825 is a titanium-stabilized fully austenitic nickel-iron-chromium alloy with additions of copper and molyb-denum.

Nickel Alloy 825 is characterized by:

- High resistance to chloride-induced stress corrosion
- Good resistance to chloride-induced pitting and crevice corrosion
- Good resistance to oxidizing and non-oxidizing hot acids
- Good toughness, even under continuous operation, at both room and elevated temperatures, up to approxi-mately 550 °C (1.020 °F)
- Approval for pressure vessels with wall temperatures up to 450 °C (842 °F) acc. to VdTÜV and 538 °C (1,000 °F) for Section VIII Division 1 vessels acc. to ASME.

Designations and standards

Standardisation	Material designation
EN	2.4858 - NiCr21Mo
ISO	NiFe30Cr21Mo3
UNS	N08825
AFNOR	NC21FeDU

Designations and standards

Product form	DIN	DIN EN	ISO	ASTM	ASME	VdTüV	NACE	API
Rod, bar	17744			B 425	SB 425	432	MR 0103	
	17752			B 564	SB 564		MR 0175	
Sheet, plate	17744			B 424	SB 424	432	MR 0103	5LD
	17750						MR 0175	5LC
Strip	17744		6208	B 424	SB 424	432	MR 0175	5LD
								5LC
Wire	17744			B 425				

Chemical composition

	Ni	Cr	Fe	C	Mn	Si	Co	Cu	Al	Ti	P	S	Mo
Min.	38	19.5	20					1.5		0.6			2.5
Max.	46	23.5	38	0.025	1	0.5	1	3	0.2	1.2	0.02	0.015	3.5

Physical properties

Density	Melting range	Relative magnetic permeability at 20 °C (68 °F)
8.14 g/cm^3 (0.294 lb/in^3)	1,370-1,400 °C (2,500-2,550 °F)	1.005 (Maximum)

Temperature		Specific heat		Thermal conductivity		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion	
°C	°F	J / Kg · K	Btu / lb · °F	W / m · K	Btu · in / sq. ft · h · °F	μΩ · cm	GPa	10^3 ksi	10^{-6} / K	10^{-6} / °F
20	68	440	0.105	10.8	72.8	112	195	28.3	–	
100	212	462	0.110	12.4	86	114	190	27.6	14.1	7.83
200	392	488	0.117	14.1	97.8	118	185	26.8	14.9	8.28
300	572	514	0.123	15.6	108.2	120	179	26	15.2	8.44
400	762	540	0.123	16.9	117.2	124	174	25.2	15.6	8.67
500	932	565	0.135	18.3	126.9	126	168	24.4	15.8	8.78
600	1,112	590	0.141	19.6	135.9	126	161	23.4	16	8.89
700	1,292	615	0.147	21	145.6	127	154	22.3	16.7	9.28
800	1,472	655	0.156	23.2	160.9	128	142	20.6	17.2	9.56
900	1,652	680	0.162	25.7	178.2	129	130	18.9	17.6	9.78
1,000	1,832	710	0.170	28.1	194.8	130	119	17.3	17.9	9.94

Mechanical properties

The following properties are applicable to Nickel Alloy 825 at room and elevated temperatures in the annealed resp. stabilized temper and indicated size ranges. Properties of material outside these size ranges are subject to special enquiry.

Temperature		Yield strength $R_{p\,0.2}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	%
20	68	240	34.8	585	84.8	30
100	212	205	29.7	530	76.9	
150	302	190	27.6	525	76.1	
200	392	180	26.1	515	74.7	
250	482	175	25.4	510	74	
300	572	170	24.7	500	72.5	
350	662	165	23.9	495	71.8	
400	752	160	23.2	490	71.1	
450	842	155	22.5	485	70.3	

Product form	Dimensions	Yield strength $R_{p\,0.2}$	Tensile strength R_m	Elongation A
	mm	MPa	MPa	%
Strip	0.5-6.4	≥ 240	≥ 585	≥ 30
Sheet, plate	5-100	≥ 240	≥ 585	≥ 30
Rod, bar	≤ 240	≥ 220	≥ 550	≥ 35

NICKEL ALLOY C276

Nickel Alloy C-276 is a nickel-chrome-molybdenum alloy with tungsten.

It is characterized by:

- Extraordinary resistance across a wide range of corrosive, watery media; in particular oxidizing and reducing acids
- Particularly high resistance against chloride-induced crevice, pitting and stress corrosion

Designations and standards

Standard	Material designation
EN	2.4819 - NiMo16Cr15W
ISO	NiMo16Cr15Fe6W4
UNS	N10276
AFNOR	NC17D

Designations and standards

Product form	DIN	VdTÜV	ISO	ASTM	ASME	NACE	Others
Sheet, plate	17744	400	6208	B 575	SB 575	MR 0175/ISO 15156	
Strip	17744	400	6208	B 575	SB 575	MR 0175/ISO 15156	API 5LD
Rod, bar, forging	17744 17752	400	9725	B 574 B 564	SB 574 SB 564	MR 0103 MR 0175/ISO 15156	
Wire	17744 17753						

Chemical composition

	Ni	Cr	Fe	C	Mn	Si	W	Mo	Co	V	P	S
Min.	51	15	4				3	15				
Max.	63	16.5	7	0.01	1	0.08	4.5	17	2.5	0.3	0.02	0.01

Physical properties

Density	Melting range	Relative magnetic permeability at 20 °C (68 °F)
8.9 g/cm^3 (0.32 lb/in^3) at 20 °C (68 °F)	1,325-1,370 °C (2,417-2,498 °F)	1,001 (Maximum)

Temperature		Specific heat capacity		Thermal conductivity		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion	
°C	°F	J / Kg · K	Btu / lb · °F	W / m · K	Btu · in / sq. ft · h · °F	μΩ · cm	GPa	10^3 ksi	10^{-6} / K	10^{-6} / °F
20	68	426	0.102	10.2	70.8	125	208	30.2	12.1	6.72
100	212	438	0.105	11.6	80.5	127	204	29.6	12.4	6.89
200	392	453	0.108	13.4	93.0	128.5	200	29.0	12.8	7.11
300	572	469	0.112	15.1	104.8	129	195	28.3	13.1	7.28
400	762	483	0.115	16.7	115.9	129.5	188	27.3	13.4	7.44
500	932	493	0.118	18.1	125.6	129	182	26.4	13.4	7.44
600	1,112	515	0.123	20.2	140.1	128.5	175	25.4	13.5	7.50
700	1,292	609	0.145	25.7	178.3	128	168	24.4	14.0	7.78
800	1,472	605	0.145	25.8	179.0	126.5	160	23.2	14.6	8.11
900	1,652	609	0.145	25.9	179.7	126	151	21.9	15.1	8.39
1,000	1,832	605	0.145	27.2	188.7	125.5	143	20.7	15.6	8.67

Mechanical properties

The following minimum values at room and increased temperatures apply to the solution-annealed condition for longitu-dinal and traverse test samples of the specified dimensions. The properties for larger dimensions must be agreed sepa-rately.

Temperature		Yield strength $R_{p\,0.2}$		Tensile strength R_m	
°C	°F	MPa	ksi	MPa	ksi
20	68	310	45.0	700	101.5
100	212	280	40.6	660	95.7
200	392	240	34.8	630	91.4
300	572	220	31.9	600	87.0
400	752	195	28.3	570	82.7
450	842	150	21.8	530	76.9

Product form	Dimensions		Yield strength $R_{p\,0.2}$		Tensile strength R_m		Elongation A	Brinell hardness HB
	mm	in	MPa	ksi	MPa	ksi	%	
Sheet	≤ 5	0.20	≥ 310	≥ 45.0	≥ 730	≥ 105.9	≥ 30	≤ 240
Sheet	5-25	0.20-0.98	≥ 280	≥ 40.6	≥ 700	≥ 101.5	≥ 25	≤ 240
Strip	0.1-3	0.004-0.12	≥ 310	≥ 45.0	≥ 730	≥ 105.9	≥ 30	≤ 240
Rod, bar	≤ 100	≤ 3.94	≥ 280	≥ 40.6	≥ 730	≥ 105.9	≥ 30	≤ 240

NICKEL ALLOY 600/H

Nickel Alloy 600 and the solution-annealed variant 600 H are nickel-chromium-iron alloys.

They are characterized by:

- Good resistance against oxidation, carbonization and nitriding,
- Good resistance to stress corrosion in room and increased temperatures,
- Good resistance against dry chlorine and hydrogen chloride,
- Good mechanical properties at both low and high temperatures.

Due to its improved creep resistance, Nickel Alloy 600 H is preferred for use at temperatures above 700 °C (1,292 °F).

Designations

Standards	Material designation
EN	2.4816 – NiCr15Fe
ISO	NiCr15Fe8
UNS	N0660
UK	NA 14
AFNOR	NC15Fe

Standards

Product form	DIN	DIN EN	VdTÜV	ASTM	ASME	NACE	Others
Plate and sheet	17750 17742	10095	305	B 168	SB 168	MR 0175/ISO 15156 MR 0103	SAE AMS 5540 ISO 6208 ISO 9722
Strip	17742	10095	305	B 168	SB 168		SEW 470 SAE AMS 5540 ISO 6208
Bar	17752 17742	10095	305	B 166 B 564	SB 166 SB 564	MR0175/ISO 15156 MR 0103	

Chemical composition

	Fe	Cr	Ni	C	S	Mn	Si	Ti	Cu	P	Al
Min.	6.0	14.0	Bal.	0.05							
Max.	10.0	17.0		0.15	0.015	1.0	0.5	0.3	0.5	0.02	0.3

Due to technical reasons the alloy may contain more elements than listed

Analysis limit values in other specifications can differ slightly in some elements, e.g. according to UNS N06600 the C-content is 0.15% max.; according to VdTÜV data sheet 305: P-content 0.015% max.

On request C-content from 0.025%; P-content: 0.015% max.

Physical properties

Density	Melting range	Relative magnetic permeability at 20 °C (68 °F)
8.5 g/cm³ at 20 °C 531 lb/ft³ at 68 °F	1,370 – 1,425 °C (2,500 – 2,600 °F)	1.005 (max)

Temperature		Specific heat capacity		Thermal conductivity		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion	
°C	°F	$\frac{J}{Kg \cdot K}$	$\frac{Btu}{lb \cdot °F}$	$\frac{W}{m \cdot K}$	$\frac{Btu \cdot in}{h \cdot ft^2 \cdot °F}$	μΩ · cm	GPa	10^3 psi	$\frac{10^{-6}}{K}$	$\frac{10^{-6}}{°F}$
20	68	455	0.109	14.8	102.7	103	214	31.0	-	-
100	212	475	0.113	15.8	109.6	104	209	30.3	13.7	7.61
200	392	495	0.118	17.0	117.9	106	205	29.7	14.1	7.83
300	572	508	0.121	18.4	127.7	107	200	29.0	14.4	8.0
400	752	525	0.125	20.0	138.8	108	194	28.1	14.8	8.22
500	932	550	0.131	22.0	152.6	111	187	27.1	15.1	8.39
600	1,112	572	0.137	24.0	166.5	112	180	26.1	15.4	8.56
700	1,292	602	0.144	25.7	178.3	112	172	24.9	15.8	8.78
800	1,472	620	0.148	27.5	190.8	112	163	23.6	16.1	8.94
900	1,652	630	0.15	29.4	204	113	153	22.2	16.4	9.11
1,000	1,832	635	0.152	31.2	216.5	114	143	20.7	16.9	9.39

Mechanical properties

The following mechanical properties apply to Nickel Alloy 600 and Nickel Alloy 600 H in the annealed or solution-annealed condition and in the specified semi-finished forms and dimensions. The properties for larger dimensions must be agreed separately.

Temperature		Yield strength $R_{p\,0.2}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	%
20	68	200	29.0	550	79.8	30
100	212	180	26.1	520	75.4	
200	392	165	23.9	500	72.5	
300	572	155	22.5	485	70.3	
400	752	150	21.8	480	69.6	
450	842	145	21.0	475	68.9	

Temperature		Yield strength $R_{p\,0.2}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	%
20	68	180	26.1	500-700	72.5-102	35
100	212	170	24.7	480	69.6	
200	392	160	23.2	460	66.7	
300	572	150	21.8	445	64.5	
400	752	150	21.8	440	63.8	
500	932	145	21	435	63.1	

NICKEL ALLOY 601

Nickel Alloy 601 is a nickel-chromium-iron alloy with additions of aluminum and titanium. Nickel Alloy 601 is character-ized by:

- Outstanding resistance to oxidation at high temperatures
- Good resistance to carburizing conditions
- Good resistance in oxidizing, sulfuric atmospheres
- Good mechanical properties at both room temperature and elevated temperatures
- Good resistance to stress-corrosion cracking

Nickel Alloy 601 is specifically recommended for service above 550 °C (1,022 °F) because of its higher creep-rupture properties resulting from its controlled carbon content and coarse grain size.

Designations and standards

Standardisation	Material designation
EN	2.4851 - NiCr23Fe
ISO	NiCr23Fe15Al
UNS	N06601
AFNOR	NC23FeA

Designations and standards

Product form	DIN	DIN EN	ISO	ASTM	ASME	VdTüV	(SAE) AMS	SEW
Rod, bar	17742 17752	10095		B 166	SB 166			
Sheet, plate	17742 17750	10095	6208 9722	B 168	SB 168		5870	
Strip	17742 17750	10095		B 168	SB 168		5870	470
Wire	17742 17753	10095		B 166				

Chemical composition

	Ni	Cr	Fe	C[1)]	Mn	Si	Co[2)]	Cu	Al	Ti	P	S	B
Min.	58	21		0.03					1				
Max.	63	25	18	0.1	1	0.5		0.5	1.7	0.5	0.02	0.015	0.006

[1)] C = 0.03-0.10 wt.-% (according to DIN EN 10095); C ≤ 0.10 wt.-% (according to DIN 17742 and UNS N06601)

[2)] A max. of 1.5 wt.-% Co, classified as Ni, is permitted. In ASTM, Co is not specified.

Physical properties

Density	Melting range	Relative magnetic permeability at 20 °C (68 °F)	Curie temperature
8.05 g/cm³ (0.29 lb/in³)	1,330-1,370 °C (2,426-2,498 °F)	1.01 (Maximum)	-196 °C (Maximum) (-320.8 °F)

Temperature		Specific heat		Thermal conductivity		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion		Thermal diffusivity
°C	°F	J / kg · K	Btu / lb · °F	W / m · K	Btu · in / sq. ft · h · °F	μΩ · cm	GPa	10³ ksi	10⁻⁶ / K	10⁻⁶ / °F	10⁻⁶ · m² / s
20	68	472	0.113	11.3	78.3	122	207	30.0			2.97
100	212	484	0.116	12.5	86.7	124	201	29.2	14.46	8.03	3.24
200	392	498	0.119	14.2	98.5	126	196	28.4	14.59	8.11	3.57
300	572	512	0.122	15.8	109.5	128	191	27.7	14.77	8.21	3.9
400	762	526	0.123	17.5	121.3	131	186	27.0	15.04	8.34	4.22
500	932	540	0.129	19.2	133.1	132	180	26.1	15.3	8.5	4.51
600	1,112	554	0.132	20.6	142.8	132	171	24.8	15.57	8.65	4.76
700	1,292	569	0.134	22	152.5	132	161	23.4	15.69	8.72	4.95
800	1,472	588	0.140	23.2	160.9	132	150	21.8	16.34	9.01	5.09
900	1,652	609	0.145	24.4	169.2	133	138	20.0	16.83	9.35	5.21
1,000	1,832	651	0.155	26.6	184.4	133	124	17.0	17.38	9.66	5.34
1,100	2,012	668	0.160	28.2	195.5		110	16.0	18.05	10.03	5.58

Mechanical properties

The following properties are applicable to Nickel Alloy 601 in the annealed condition and indicated size ranges.

Temperature		Yield strength $R_{p\,0.2}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	%
20	68	270	39.2	620	89.9	30
100	212	260	37.7	610	88.5	45
200	392	220	31.9	610	88.5	45
300	572	200	29	570	82.7	45
400	762	180	26.1	530	76.9	45
500	932	175	25.4	510	74	45
600	1,112	165	23.9	470	68.2	45
700	1,292	130	18.9	420	60.9	50
800	1,472	110	16	270	39.2	55
900	1,652	75	10.9	120	17.4	65
1,000	1,832	60	8.7	80	11.6	65

Product form	Dimensions	Yield strength $R_{p\,0.2}$	Tensile strength R_m	Elongation A	Brinell hardness
	mm	MPa	MPa	%	HB
Strip	≤ 25	≥ 205	550	≥ 30	≤ 220
Sheet, plate	≤ 75	≥ 205	550	≥ 30	≤ 220
Rod, bar	≤ 160	≥ 205	550	≥ 30	≤ 220
Rolled wire	≤ 25		550		

Temperature		Time yield limit[1] $R_{p\,1.0}/10^4$ h	$R_{p\,1.0}/10^5$ h	Creep rupture strength[2] $R_m/10^4$ h	$R_m/10^5$ h
°C	°F	MPa	MPa	MPa	MPa
600	1,112	151	116	205	156
650	1,202	112	70		
700	1,292	69	39	101	55
750	1,382	38	21,7		
800	1,472	22	11,8	31	17
850	1,562	12	6,2		
900	1,652	6,9	2,2	10	4.0
950	1,742	4	1,5		
1,000	1,832	2,3		4,6	2.0
1,100	2,012	1,6			

NICKEL ALLOY 800H/HT

Nickel Alloy 800 H is an austenitic, heat resistant iron-nickel -chromium alloy with controlled levels of carbon, aluminum and titanium.

The analysis of Nickel Alloy 800 H is identical to that of Nickel Alloy 800. A special solution annealing results in a grain sizes ≥ 90 µm (ASTM No. 4), which increases the creep rupture strength above 600 °C (1,112 °F) significantly.

Nickel Alloy 800 H is characterized by:

- Good creep rupture strength at temperatures above 600 °C (1,112 °F)
- Good resistance in oxidizing, nitriding and carburizing conditions
- Metallurgical stability in long-term use at high temperatures

Nickel Alloy 800 HP is an austenitic nickel-iron-chromium alloy with increased content of (Al + Ti), compared to Nickel Alloy 800 H.

A special solution annealing results in a grain sizes ≥ 90 µm (ASTM No. 4) and highest creep rupture strength above 700 °C (1,290 °F) due to titanium car-bide precipitation. Below 700 °C (1,290 °F), γ´ precipi-tates combined with a loss of ductility.

Nickel Alloy 800 HP is characterized by:

- Excellent creep rupture strength at tempera-tures above 700 °C (1,290 °F)
- Good resistance to reducing, oxidizing and ni-triding atmospheres and to atmospheres which alternate between reducing and oxidiz-ing conditions
- Metallurgical stability in long-term use at high temperatures

If the repeated lowering of operating temperatures below 700 °C (1,290 °F) cannot be ruled out, or the operating tem-perature is permanently below 700 °C (1,290 °F), the use of Nickel Alloy 800 H is recommended. At temperatures be-low 600 °C (1,112 °F), soft annealed Nickel Alloy 800 is generally used.

Standard	Material designation	
	VDM® Alloy 800 H	**VDM® Alloy 800 HP**
EN	1.4876 - X10NiCrAlTi32-20[1)] 1.4958 - X5NiCrAlTi31-20[2)]	1.4959 - X8NiCrAlTi32-21[2)]
ISO	FeNi32Cr21AlTi-HC	FeNi32Cr21AlTi-HT
UNS	N08810	N08811
AFNOR		Fe-Ni29Cr17
NA	15 (H)	

[1)] Nickel Alloy data sheet 412, version 01.84 with old W.-No. 1.4876

[2)] W.-No. according to DIN EN 10302

Product form	DIN	DIN EN	ISO	ASTM	ASME	VdTÜV	SEW	Others
Sheet, plate		10028-7 10095[1)] 10302		A 240 B 409	SA 240 SB 409	412 434[1)]		ASME Code Case 1325[1)] NACE MR 0175/ISO 15156
Strip		10028-7 10088-1 10095 10302	6208	A 240 B 409	SA 240 SB 409	412 434[1)]	470	SAE AMS 5871[2)]
Rod, bar		10095[1)] 10302		B 408 B 564	SB 408 SB 564	412 434[1)]	470	

[1)] only valid for Nickel Alloy Alloy 800 H

[2)] only valid for Nickel Alloy Alloy 800 HP

Chemical composition

	Ni	Cr	Fe	C	Mn	Si	Cu	Al	Ti	P	S	(Al + Ti)
Min.	30	19	43	0,06	0,5	0,2		0,2	0,2			
Max.	32	21	50	0,1	1	0,6	0,5	0,6	0,6	0,015	0,01	0,7

	Ni	Cr	Fe	C	Mn	Si	Cu	Al	Ti	P	S	(Al + Ti)
Min.	30	19	43	0,06	0,5	0,2		0,2	0,3			0,85
Max.	32	22	50	0,1	1	0,6	0,5	0,6	0,6	0,015	0,01	1,2

Physical properties

Density	Melting range	Relative magnetic permeability at 20 °C (68 °F)
8.0 g/cm³ (0.29 lb/in³) at 20 °C (68 °F)	1,350-1,400 °C (2,462-2,552 °F)	1.01

Temperature		Specific heat		Thermal conductivity		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion	
°C	°F	$\frac{K}{Kg \cdot K}$	$\frac{Btu}{lb \cdot °F}$	$\frac{W}{m \cdot K}$	$\frac{Btu \cdot in}{sq.\ ft \cdot h \cdot °F}$	μΩ · cm	GPa	10^3 ksi	$\frac{10^{-6}}{K}$	$\frac{10^{-6}}{°F}$
20	68	443	0.106	12.4	86	101	194	28.1	14	7.78
100	212	457	0.109	13.7	95.1	104	189	27.4	14.08	7.82
200	392	474	0.113	15.3	106.2	108	183	26.5	14.6	8.11
300	572	492	0.118	17	117.9	112	177	25.7	14.92	8.28
400	762	512	0.122	18.9	131.1	115	170	24.7	15.2	8.44
500	932	548	0.131	21.4	148.5	118	163	23.6	15.49	8.61
600	1,112	578	0.138	23.6	163.7	120	156	22.6	15.87	8.82
700	1,292	588	0.140	24.7	171.4	122	149	21.6	16.42	9.12
800	1,472	598	0.143	25.8	179	124	141	20.5	16.98	9.43
900	1,652	602	0.144	26.7	185.2	126	134	19.4	17.36	9.64
1,000	1,832	613	0.146	28	194.3	127	127	18.4	17.76	9.87
1,100	2,012	628	0.150	29.6	205.4	128	120	17.4	18.27	10.15
1,200	2,192	634	0.151	30.6	212.3	129	113	16.4	18.74	10.41

Mechanical properties

The following properties are applicable to Nickel Alloy 800 H and Nickel Alloy 800 HP in the annealed condition in the following size ranges:

- Sheet, plate up to 50 mm (1.97 in)
- Strip up to 3 mm (0.12 in)
- Rod, bar and forgings up to 250 mm (9.84 in)

For larger dimensions, the properties are to be agreed separately. The values are valid for longitudinal and transverse samples.

Temperature		Yield strength $R_{p\,0.2}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	%
20	68	170	24.7	450-700	65.3-101.5	Longit. 35 Transverse 30
100	212	140	20.3	425[1)]	61.6	
200	392	115	16.7	400[1)]	58	
300	572	95	13.8	390[1)]	56.6	
400	762	85	12.3	380[1)]	55.1	
500	932	80	11.6	360[1)]	52.2	
600	1,112	75	10.9	300[1)]	43.5	

[1)] Average, for information only

Product form	Dimensions	Yield strength $R_{p\,0.2}$	Tensile strength R_m	Elongation A
	mm	MPa	MPa	%
Sheet, plate, strip	≤ 50	≥ 170	450-700	≥ 30
Rod, bar	≤ 160	≥ 170	450-700	≥ 30
Forging	≤ 250	≥ 170	450-700	≥ 30

Temperature		Creep strength $R_m/10^5$ h			
		UNS N08810[1)]	UNS N08811[1)]	VdTÜV 412	VdTÜV 434
°C	°F	MPa	MPa	MPa	MPa
600	1,112	114		114	77
650	1,202	75		73	53
700	1,292	50	57	47	36
750	1,382	33	37	30	24
800	1,472	22	26	19	16
850	1,562	15	18	10	10.5
900	1,652	10	11	4	7
950	1,742		7		

[1)] Nickel Alloy Metals calculation, based on ASME Code Case 1987; for 950 °C (1,742 °F) based on ASME Code Case 1988

NICKEL ALLOY 200/201

Nickel® Nickel 200 and Nickel® Nickel 201 are unalloyed nickel with a nickel concentration of at least 99.2%. Nickel® Nickel 201 is the low carbon version of Nickel® Nickel 200.

They are characterized by:

- Excellent resistance in alkaline media,
- High ductility in a wide temperature range,
- Ferromagnetism,
- High electrical and thermal conductivity.

The materials are offered under the name Nickel® Nickel 205 with a higher guaranteed nickel concentration of 99.6%.

Standard	**Material designation**	
	VDM Nickel 200	**VDM Nickel 201**
EN	2.4066	2.4068 LC-Ni 99.2
UNS	N02200	N02201

Standards

Product form	**DIN**	**VdTÜV**	**ISO**	**ASTM**	**ASME**	**Others**
Bar	17752[2)] 17740[2)]	345[2)]		B 160 B 564[2)]	SB 160 SB 564[2)]	
Sheet	17740 17750	345[2)]		B 162	SB 162 SA 578[1)]	EN 10029[1)] SAE AMS 5553[2)]
Strip	17740	345[2)]	6208	B 162 B 730[2)]	SB 162[2)]	SAE AMS 5553[2)] SAE AMS 5555[2)]
Wire	17740					

[1)] only valid for Nickel Alloy Nickel 200

[2)] only valid for Nickel Alloy Nickel 201

Chemical composition

Nickel Alloy 200

	C	S	Ni	Mn	Si	Ti	Cu	Fe	Mg
Min.			99.2						
Max.	0.1	0.005		0.35	0.15	0.1	0.25	0.4	0.15

Due to technical reasons the alloy may contain more elements than listed

Nickel Alloy 201

	C	S	Ni	Mn	Si	Ti	Cu	Fe	Mg
Min.			99.2						
Max.	0.02	0.005		0.35	0.15	0.1	0.25	0.4	0.15

Due to technical reasons the alloy may contain more elements than listed

Physical properties

Density	Melting range	Curie temperature	Saturation flux density
8.9 g/cm³ bei 20°C 556 lb/ft^3 at 68°F	1,435 – 1,445°C (2,610 – 2,630°F)	360°C (68 °F)	0,61 T

Temperature		Specific heat capacity[1]		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion	
°C	°F	$\frac{J}{Kg \cdot K}$	$\frac{Btu}{lb \cdot °F}$	μΩ · cm	GPa	10^6 psi	$\frac{10^{-6}}{K}$	$\frac{10^{-6}}{°F}$
-200	-328	150	0.0358	2	227	32.9	10.1	5.61
-100	-148	355	0.0848	4.5	218	31.6	11.3	6.28
0	32	426	0.102	8.5	207	30.0	-	-
20	68	456	0.109	9	205	29.7	-	-
100	212	475	0.113	13	200	29.0	13.3	7.39
200	392	500	0.119	19	196	28.4	13.9	7.72
300	572	570	0.136	26	190	27.6	14.3	7.94
400	752	530	0.172	33	182	26.4	14.8	8.22
500	932	525	0.125	37	175	25.4	15.2	8.44
600	1,112	535	0.128	40	165	23.9	15.6	8.67
700	1,292	550	0.131	43	153	22.2	15.8	8.78
800	1,472	565	0.135	45	140	20.3	16.2	9.0
900	1,652	580	0.139	48	134	19.4	16.5	9.17
1,000	1,832	590	0.141	51			16.7	9.28

[1] The specific heat capacity has a distinct maximum at 358°C (676.4°F).

Temperature		Thermal conductivity of Nickel 200		Thermal conductivity of Nickel 201[1]	
°C	°F	$\frac{W}{m \cdot K}$	$\frac{Btu \cdot in}{sq.\ ft \cdot h \cdot °F}$	$\frac{W}{m \cdot K}$	$\frac{Btu \cdot in}{sq.\ ft \cdot h \cdot °F}$
-200	-328	79	45.6	93	53.7
-100	-148	75	43.3	87	50.3
0	32	72	41.6	81	46.8
20	68	71	41.0	79	45.6
100	212	67	38.7	73	42.2
200	392	62	35.8	67	38.7
300	572	57	32.9	60	34.7
400	752	56	32.4	57	32.9
500	932	58	33.5	59	34.1
600	1,112	60	34.7	61	35.2
700	1,292	62	35.8	63	36.4
800	1,472	64	37.0	66	38.1
900	1,652	67	38.7	68	39.3
1,000	1,832	69	39.9	71	41.0

[1] Thermal conductivity is lower in contaminated material. This effect is extremely strong in the very deep temperature range. Above the Curie point, the thermal conductivity indicates a change of direction.

Mechanical properties

The following mechanical properties apply to Nickel 200 and Nickel 201 in annealed condition and in the specified semi-finished forms and dimensions. The properties for larger dimensions must be agreed separately.

Mechanical properties of Nickel 200

Temperature		Yield strength $R_{p\ 0.2}$		Yield strength $R_{p\ 1,0}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	MPa	ksi	%
20	68	100	14.5	125	15.1	370	53.7	40

Mechanical properties of Nickel 201

Temperature		Yield strength $R_{p\ 0.2}$		Yield strength $R_{p\ 1,0}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	MPa	ksi	%
20	68	80	11.6	105	15.2	340	49.3	40
100	212	70	10.2	95	13.8	290	42.1	
200	392	65	9.43	90	13.1	275	39.9	
300	572	60	8.7	85	12.3	260	37.7	
400	752	55	7.98	80[2)]	11.6	240	34.8	
500	932	50	7.25	75[2)]	10.9	210	30.5	
600	1,112	40	5.8	65[2)]	9.43	150	21.8	

2) These values are above the point of intersection with the long term creep limit

Product form	Dimensions		Yield stress $R_{p\ 0,2}$		Yield stress $R_{p\ 1,0}$		Tensile strength R_m		Elongation A
	mm	in	MPa	ksi	MPa	ksi	MPa	ksi	%
Sheet	50	1.96	80		105		340		50

Temperature		Creep limit R_m /10^4 h		Creep limit $R_{p1.0}$ /10^4 h	
°C	°F	MPa	ksi	MPa	ksi
380	716	85	12.3	70	10.2
400	752	75	10.9	60	8.7
420	788	67	9.72	52	7.54
440	824	59	8.56	44	6.38
460	860	51	7.4	36	5.22
480	896	43	6.24	29	4.21
500	932	35	5.08	23	3.34
520	968	28	4.06	17	2.47
540	1,004	22	3.19	13	1.89
560	1,040	17	2.47	9	1.31
580	1,094	13	1.89	7	1.02
600	1,112	10	1.45	6	0.87

NICKEL ALLOY 20

Nickel Alloy 20 is a low carbon, niobium stabilised austentic nickel-iron-chromium alloy with alloying additions of copper and molybdenum.

Nickel Alloy 20 is characterized by:

- Excellent resistance to sulphuric and phosphoric acids
- Good resistance to intergranular corrosion
- Very good resistance to chloride-ion induced stress-corrosion cracking
- Good resistance to pitting and crevice corrosion
- Good mechanical properties at both ambient and elevated temperatures, up to approximately 500 °C (930 °F).

Designations and standards

Country National standards	Material designation	Specification							
		Chemical composition	Tube and pipe		Sheet and plate	Rod and bar	Strip	Wire	Forgings
			seamless	welded					
D DIN VdTÜV-Wbl.	**W.-Nr. 2.4660** NiCr20CuMo								
F AFNOR									
UK BS									
USA ASTM ASME ASME Code Case AMS	UNS N08020		B 729	B 464 B 468 B 474 SB 464 SB 468	B 463 SB 463	B 472 B 473 SB 473	B 463 SB 463	B 471 B 473 B 475	B 462 SB 462
ISO	FeNi35Cr20Cu4Mo2								

Table 1 – Designations and standards.

Chemical composition

	Ni	Cr	Fe	C	Mn	Si	Cu	Mo	Nb+Ta	P	S
min.	32	19.0	bal.				3.0	2.0	8 x C		
max.	38	21.0		0.07	2.0	1.0	4.0	3.0	1.0	0.045	0.035

Table 2 – Chemical composition (wt.-%) acc. to UNS N08020

Physical properties

Density	8.1 g/cm³	0.29 lb/in.³
Melting range	1380 – 1420 °C	2520 – 2600 °F
Permeability at 20 °C/68 °F (RT)	< 1.002	

Temperature (T)		Specific heat		Thermal conductivity		Electrical resistivity		Modulus of elasticity		Coefficient of thermal expansion between room temperature and T	
°C	°F	J / kg K	Btu / lb °F	W / m K	Btu in. / ft² h °F	µ Ω cm	Ω circ mil / ft	kN / mm²	10³ ksi	10⁻⁶ / K	10⁻⁶ / °F
20	**68**	456	0.109	11.5	80	107	644	202	29.3		
93	**200**		0.111		89		662		28.7		8.3
100	212	466		13.0		110		198		15.0	
200	392	476		14.8		113		192		15.6	
204	**400**		0.114		103		680		27.8		8.8
300	572	485		16.5		116		185		16.0	
316	**600**		0.116		117		701		26.7		8.9
400	752	492		18.2		119		179		16.4	
427	**800**		0.118		130		719		25.7		9.2
500	932	500		19.8		121		172		16.7	
538	**1000**		0.120		142		734		24.5		9.4
600	1112	508		21.5		123		164		17.1	
649	**1200**		0.122		154		746		23.2		9.6
700	1292	(515)		(23.0)		(125)		(157)		(17.4)	

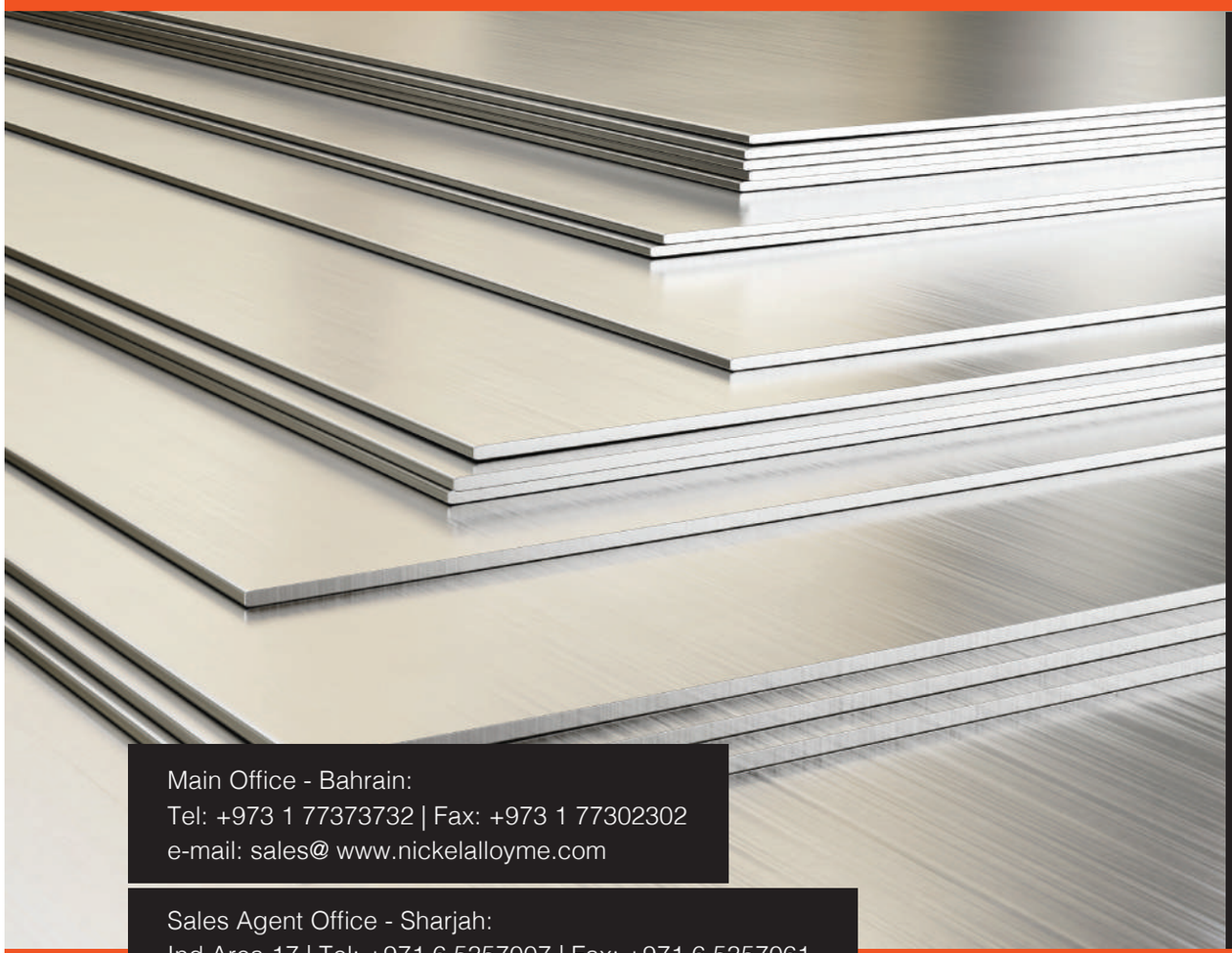
Table 3 – Typical physical properties at room temperature or as indicated.

Mechanical properties

The following mechanical properties are applicable to Nickel Alloy 20 in the stabilized-annealed condition.

Temperature (T)		Yield strength $R_{p0.2}$		Yield strength $R_{p1.0}$		Tensile strength R_m		Elongation A_5	Hardness Brinell
°C	°F	N/mm²	ksi	N/mm²	ksi	N/mm²	ksi	%	HB max.
20	**68**	240	35	280	40.6	550	80	30	≤ 217
93	**200**		30.5		35.8		75.8		
100	212	210		250		520		30	
149	**300**		28.3		34.1		73.2		
150	302	195		235		505		30	
200	392	180		220		495		30	
212	**400**		26.1		31.9		71.5		
250	482	170		210		480		30	
260	**500**		24.2		29.9		69.2		
300	572	160		200		470		30	
316	**600**		22.5		28.3		66.7		

Minimum mechanical properties of Nickel alloy 20 (plate thickness up to 25 mm [1 in.]).



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