

NICKEL ALLOYS for Special Applications



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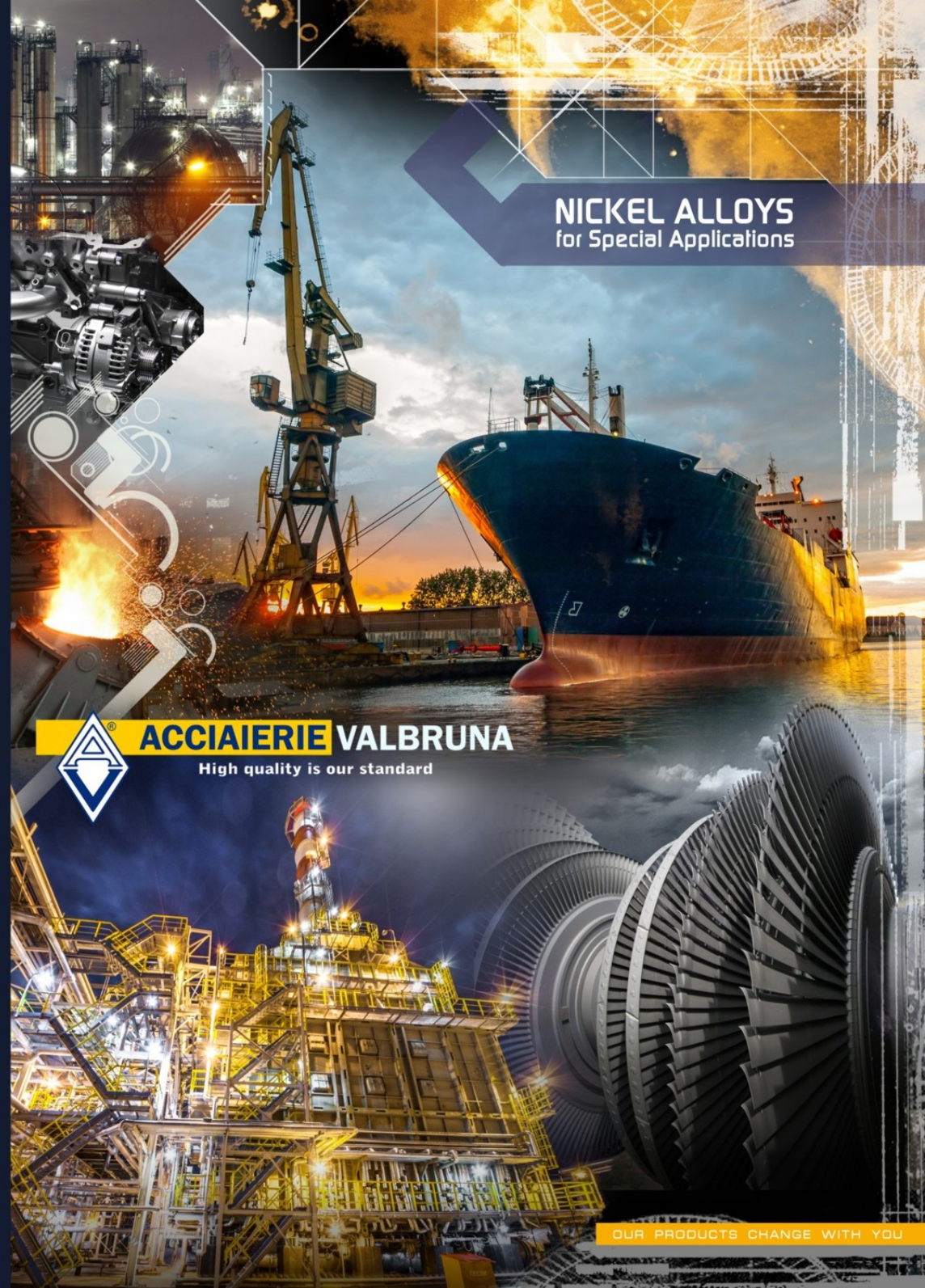
March 2015



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Vicenza plant, Italy



Bolzano plant, Italy



Fort Wayne plant, IN-USA

Valbruna, founded in 1925 and leader in the production of Stainless Steels, Nickel Alloys and Titanium long products, is underpinned by long experience and a highly qualified customer service. Since the seventies, Valbruna has concentrated part of its production on Super-Austenitic Stainless Steels and Nickel Alloys. Today a wide range of Nickel Alloys is produced in billets, bars, wire rod and wire, making Valbruna an ideal partner for all those manufacturing companies involved in oil, chemical, petrochemical, marine, automotive, energy and power generation sectors.



VALBRUNA... SUCH A GREAT REALITY!

Our extensive and strategic distribution network is our corner stone in a global market, granting a worldwide commercial presence with the opportunity for continuous feedback from our customers.



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Nickel Alloys for Special Applications

The development of new technologies and industries often demands materials with enhanced performance and resistance to aggressive environments. These demands have driven the development of highly alloyed iron, nickel and cobalt based.

By varying the combination of different chemical elements a wide range of useful properties can be achieved.

These include exceptional mechanical properties, high creep and rupture strength, enhanced toughness, better metallurgical stability, improved fatigue and thermal shock properties, superior corrosion resistance across a broad spectrum of temperatures while maintaining good fabricability.

Nickel alloys can be easily cold worked to enhance mechanical properties.

Heat treatments can also raise mechanical properties in some nickel alloys and can be used to improve corrosion resistance.

Typical heat treatment of these alloys are:

- Solution treating
- Annealing
- Stress Relieving
- Age Hardening

The heat treatment (temperature, soaking and cooling practice) depends on chemistry, profiles & dimensions, manufacturing process, and final application.



Classification

Nickel Alloys could be classified according to their chemistry or properties:

CHEMICAL CLASSIFICATION:

- Ni Alloys
- Ni-Cu Alloys
- Ni-Si Alloys
- Ni-Cr-Fe Alloys
- Ni-Cr-Mo Alloys
- Ni-Cr-Fe-Mo-Cu Alloys
- Cu-Ni Alloys

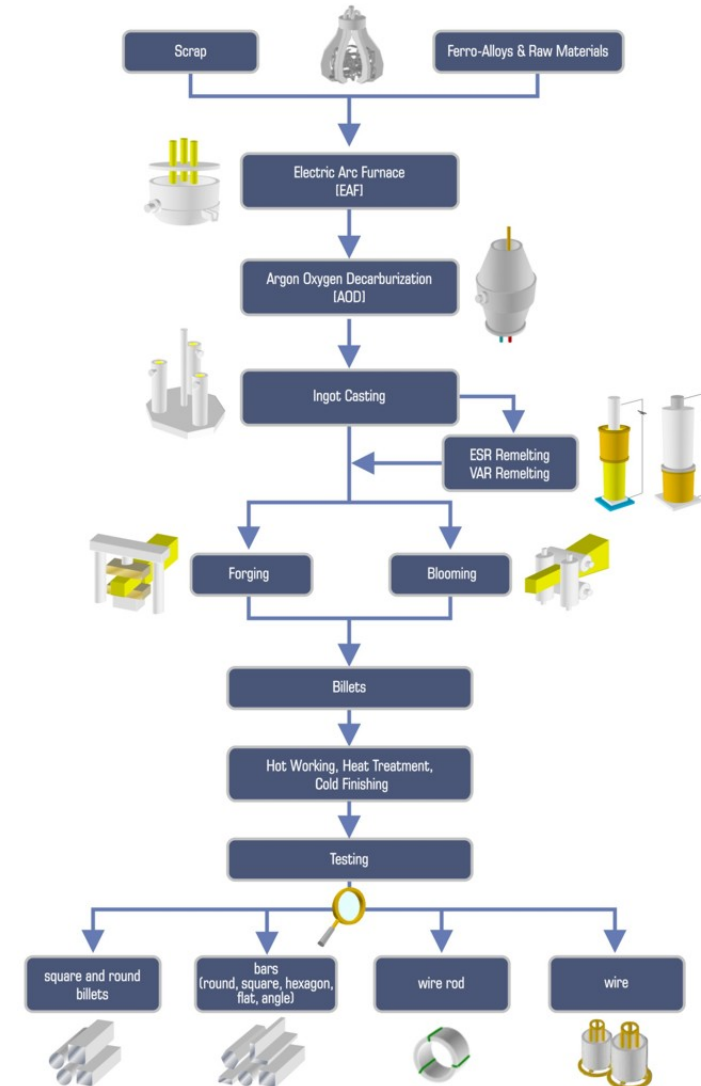
PROPERTIES CLASSIFICATION:

- Corrosion Resistance
- Heat Resistance

Based on aforesaid assumptions, special alloys could be used for:

- Thermal Processing
- Automotive Industry
- Chemical/Petrochemical Industry
- Power Generation
- Marine Engineering
- Oil & Gas Extraction
- Aerospace Engineering
- Pollution Control & Waste Processing
- Electrical Resistance
- Welding
- Electronic

NICKEL ALLOYS PRODUCTION FLOW CHART



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OUR NICKEL ALLOYS

VALBRUNA GRADE	COMMERCIAL NAME	UNS	W.N.	BS	INTERNATIONAL DESIGNATION	DESCRIPTION	MELTING PRATICES		
							ADD	ESR	VAR
AN1	Alloy 800 Alloy 800H Alloy 800HT	N08800 N08810 N08811	1.4876	NA15 NA15(H)	X10NiCrAlTi32-21; X10NiCrAlTi32-20	Alloy 800 is an austenitic Fe-Ni-Cr alloy with controlled Al, Ti, Si and Mn additions. It is characterized by high strength for service temperatures up to 540° C, very good resistance to oxidation and to carburization up to 1093° C and corrosion resistance in many corrosive and aqueous media. Alloy 800H is a high Carbon version of alloy 800 which guarantees higher creep and rupture resistance for temperature above 600° C. These properties are also due a higher heat treatment temperature than alloy 800's one that provides an average grain size 5 or coarser. Alloy 800H is preferred for prolonged exposure at high temperatures. Alloy 800HT is a modified chemistry of alloy 800H which guarantees a higher creep and stress rupture for service temperatures above 700° C because of controlled C, Al and Ti additions (C=0.06-0.10%, Al+Ti=0.85-1.20%) and a higher solution annealing temperature grain size 5 or coarser is requested. 800HT is used specially at temperature above 800° C.	✓		
AN2	Alloy 825 Alloy 65	N08825 N08065	2.4858	NA16 NA41	NiCr21Mo NiFe30Cr21Mo3	Alloy 825 is a Ti-stabilized fully austenitic Ni-Fe-Cr alloy with Mo and Cu additions. It is characterized by excellent resistance to stress-corrosion cracking, good resistance to pitting, crevice corrosion and to oxidizing and reducing acids. Its mechanical properties are good from cryogenic to moderately high temperature, but at temperature above 540° C this alloy shows a lower ductility and impact strength. It is not recommended for high-temp. services where creep-rupture resistance is requested.	✓		
AN3	Alloy DS	-	1.4862	NA17	X8NiCrSi38-18	Alloy DS is a Ni-Fe-Cr alloy. It is considered a variation of alloy 330 with improved carburization resistance. This grade is characterised by good mechanical properties at high temperature and good resistance to oxidation (up to 1000° C) and to carburization. Its chemical analysis hinders sigma-phase precipitation in the 600-900° C range. Alloy DS is also used for heating elements in industrial furnace up to 1150° C.	✓		
AN3CB	Alloy 330Cb	-	-	-	-	Alloy 330Cb is an austenitic Fe-Ni-Cr alloy with controlled Nb (alias Cb) additions. The presence of Nb greatly increases the creep rupture resistance at high temperature. This alloy exhibits a resistance to carburization thanks to the poor tendency to form Cr-carbides.	✓		
AN3US	Alloy 330	N08330	-	-	-	Alloy 330 is a Fe-Ni-Cr alloy with Si and Mn additions. This alloy is characterised by good corrosion resistance to oxidation (up to 1000° C), to carburization, to nitridation and by good mechanical properties at high temperature. It is not recommended for application where high creep-rupture strength is requested.	✓		
AN4	Alloy 904L	N08904	1.4539	904S14	X1NiCrMoCu25-20-5	Alloy 904L is a superaustenitic Stainless Steel with high Mo, Cu additions and extremely low carbon content. This alloy provides high resistance to pitting, crevice corrosion, stress-corrosion cracking and inter-crystalline corrosion, excellent resistance to moderately aggressive reducing acids such as sulphuric and phosphoric acids, as well as to many chloride-containing media. It has vastly superior properties to those of conventional acid-resistant SS.	✓		
AN5	Alloy 660 Alloy A286	S66286	1.4980	286S31	X6NiCrTiMoVB25-15-2	Alloy 660/A286 is a precipitation hardenable superalloy. It is a Fe-Ni-Cr alloy with additions of Mo and Ti. In aged condition this alloy shows high mechanical properties and good creep-rupture, corrosion resistance to oxidation at temperatures up to 700° C. In accordance to different solution treat. temperatures and the quenching, Alloy 660/A286 could be classified in different types or classes provided by the specifications; for instance: solution treatment at 980° C gives the highest creep-rupture strength in precipitation-hardened material, solution treatment at 900° C instead results in improved ductility and room-temperature tensile strength.	✓	✓	
AV20	Alloy 20	N08020	2.4660	-	NiCr20CuMo	Alloy 20 is a low carbon, Nb stabilized austenitic Ni-Fe-Cr alloy with addition of Cu and Mo. It is characterized by an excellent resistance to acid and other aggressive media, to pitting, to crevice corrosion, to intergranular corrosion and to stress corrosion.	✓		
AVC276	Alloy C276	N10276	2.4819	-	NiMo16Cr15W	Alloy C276 is a Ni-Cr-Mo alloy with low Carbon, W and Si. This alloy is characterized by high corrosion resistance in a wide range of media, by resistance to pitting, crevice corrosion and stress corrosion cracking.	✓	✓	
AV718CRV AV718HTV	Alloy 718	N07718	2.4668	NA51	NiCr19Fe19Nb5Mo3; NiCr19NbMo	Alloy 718 is a precipitation-hardening austenitic Ni-base superalloy. High strength and corrosion resistance (at high and low temperature) are its stand out features. It is also characterized by good oxidation resistance up to 1000° C, good mechanical properties at temperature below 0° C and good resistance to stress-corrosion cracking and pitting.	✓		✓
AV925	Alloy 925	N09925	-	-	-	Alloy 925 is an age-hardenable Ni-Fe-Cr alloy with Mo, Cu, Ti and Al additions, characterized by high strength (up to 540° C) and corrosion resistance to pitting, crevice corrosion and stress-corrosion-cracking.	✓	✓	
EG1	Alloy 400	N04400	(2.4360)	NA13	NiCu30Fe	Alloy 400 is a Ni-Cu alloy characterized by corrosion resistance in marine and chemical applications (hydrofluoric acid, non-oxidizing dilute acids, alkalis and salt solutions, organic acids, dry gases such as chlorine and to hydrogen chloride), high strength and toughness from temperatures below 0° C up to 550° C. The mechanical properties can be improved only by cold working.	✓		
EG2	Alloy K-500	N05500	(2.4375)	NA18	NiCu30Al	Alloy K-500 is a precipitation hardening alloy with Al and Ti additions. This alloy is characterised by the same excellent corrosion resistance as alloy 400 but with higher mechanical properties that are maintained for a wide range of temperature (from -200° C up to 650° C). It has a greater tendency toward stress-corrosion cracking in some environments than alloy 400 and in the aged condition it has low magnetic permeability to temperature below to -120° C.	✓		



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VALBRUNA GRADE	COMMERCIAL NAME	UNS	W.N.	BS	INTERNATIONAL DESIGNATION	DESCRIPTION	MELTING PRATICES		
							ADD	ESR	VAR
EG3	Alloy 60	N04060	2.4377	NA33	SG-NiCu 30 MnTi UP-NiCu 30 MnTi	Alloy 60 is used for MIG and TIG techniques. It is used for welding alloys such as 400 and K-500. Its properties - as welded - are similar to base alloy. Nevertheless this alloy is not precipitation hardenable.	✓		
EG4	Alloy 401	N04401	2.0842	-	-	Alloy 401 is a Cu-Ni alloy. It is used for electrical and electronic applications and for welding.	✓		
GL1	Alloy 600	N06600	2.4816	NA14	NiCr15Fe	Alloy 600 is a Ni-Cr-Fe alloy with excellent corrosion resistance to oxidation up to 980° C, to carburization and to stress corrosion cracking at elevated temperatures. It also provides corrosion resistance by many organic and inorganic compounds. This alloy is characterized also by good mechanical properties from temperature below-zero up to 700° C, high creep-rupture properties and by good workability. This set of properties suggests the use of alloy 600 for services from cryogenic to high temperatures (above to 1090° C).	✓		
GL2	Alloy 80A	N07080	2.4952	NA20	NiCr20TiAl	Alloy 80A is a Ni-Cr precipitation hardenable alloy. It is characterized by good mechanical properties and resistance to creep at high temperature. Alloy 80A exhibits also good corrosion and oxidation resistance and high fatigue resistance in several conditions. This alloy is used for services up to 815° C.	✓	✓	
GL3	Alloy 625	N06625	2.4856	NA21	NiCr22Mo9Nb	Alloy 625 is a low-carbon Ni-Cr-Mo alloy with Nb addition. This alloy is characterized by good mechanical properties (due to effect of Mo and Nb in the matrix structure), excellent resistance to pitting and crevice corrosion, high resistance to stress-corrosion. Also it resists in a wide range of organic and mineral acids and at high temperature as well to oxidation and to carburization. In accordance to heat treat. temperatures it is classified as grade 1 (annealed) or grade 2 (solution ann.). Grade 2 is recommended for applications where good resistance to creep or rupture up to 1000° C is requested. Grade 1 is recommended for applications up to 840° C when finer grain size and high mechanical properties are requested.	✓	✓	✓
GL3/EL	Alloy 625	N06625	2.4831	NA43	SG-NiCr21Mo9Nb UP-NiCr21Mo9Nb	Alloy 625 for welding is a Ni-Cr-Mo alloy with low C & Fe contents. It is used for welding alloy 625 components or other grades such as alloy 825, 926 and 20.	✓		
GL4	Alloy 82	N06082	2.4806	NA35	SG-NiCr20Nb UP-NiCr20Nb	Alloy 82 is a Ni-Cr-Fe filler metal used for MIG, TIG. It is used for welding alloys such as 600, 601, 800/H/HT, and 330. It exhibits high strength and good corrosion resistance also at high temperature.	✓		
GL5	Alloy 601	N06601	2.4851	NA49	NiCr23Fe	Alloy 601 is a Ni-Cr-Fe alloy with high resistance to corrosion and to high temperature oxidation. Generally it is used for thermal and chemical processing, pollution control, aerospace and power generation.	✓		
SG1	Alloy 200 Alloy 201	N02200 N02201	2.4068	NA11 NA12	LC-Ni99.0	Alloy 200 is basically a commercially-pure Ni grade that shows excellent corrosion resistance to many corrosive media (especially to caustic alkalis, halides and a large number of organic compounds). It also provides a good combination of mechanical, magnetic properties and low electrical resistivity. Alloy 201 is a low carbon version (C max 0.02%) preferred for applications at temperatures above 315° C in order to avoid graphite precipitation.	✓		
SG2	Alloy 55	W82002	(2.4560)	NA47	S-NiFe 40	Alloy 55 is used for welding cast-irons to various materials (mild steels, stainless steels, wrought alloys or high-Ni alloys). Weld deposits are machinable.	✓		
SG3	Alloy 55 Ti	-	-	-	-	Alloy 55 Ti is a variation of alloy 55 with addition of Ti.	✓		
SG4	Alloy 212	N02212	2.4110	-	NiMn 2	Alloy 212 is a very high-Ni alloy with addition of Mn. It is used for electrical and electronic applications	✓		
SG5	Alloy 36	K93601	1.3912	-	Ni36	Alloy 36 is a binary Ni-Fe alloy. Due to its low coefficient of expansion it maintains a constant dimension for a wide range of temperature (from -250° C to 200° C). It also exhibits good mechanical properties at temperature below 0° C. At temperature above 280° C it is non-magnetic. This alloy is ductile and it shows enough corrosion resistance in dry air.	✓		
SG6	Alloy 61	N02061	2.4155	NA32	SG-NiTi 4	Alloy 61 is a high-Ni filler metal used for MIG, TIG or PAW welding. It is used for welding of alloys such as 200 & 201 to themselves or to stainless steels, as well as 600, 400, and Cu-Ni alloys.	✓		
VAL40	Alloy 40	-	1.4860	-	NiCr 30 20 (X16NiCr30-20)	Alloy 40 is a Ni-Cr alloy with high resistivity and good oxidation resistance. It is used at temperature up to 1100° C.	✓		
VAL60	Alloy 60/40	N06004	2.4867	-	NiCr6015	Alloy 60/40 is a Ni-Cr electrical resistance alloy. It is used in service up to 1100° C.	✓		
VAL80	Alloy 80/20	N06003	2.4869	-	NiCr80-20	Alloy 80/20 is a Ni-Cr resistance alloy. It is used for service up to 1200° C because of its properties of resistance to oxidation and thermal fatigue.	✓		
VAL4529	Alloy 926	N08926	1.4529	-	X1NiCrMoCuN25-20-7	Alloy 926 is a superaustenitic stainless steel with increased Mo and N contents compared to 904L. This alloy exhibits exceptional resistance to pitting, crevice corrosion and to stress-corrosion cracking in aggressive media.	✓		
	Alloy 367	N08367	-	-	-	Alloy 367 is a corrosion resistant iron-base austenitic stainless steel. It is chemically balanced in order to provide thermal stability and resistance to stress corrosion cracking.	✓		

CORROSION RESISTANT ALLOYS

In several environments (wide spectrum of acids, alkalis and salts) where the corrosion resistance is the most important criteria for material selection that has to be considered, the choice of the nickel alloys is recommended. These alloys exhibit also good mechanical properties. The corrosion resistance is proved in terms of limited metal loss and in the ability to better withstand localized attack, notably pitting/crevice corrosion, intergranular attack and stress corrosion cracking.

CORROSION RESISTANT ALLOYS - Designations

VALBRUNA GRADE	COMMERCIAL NAME	UNS	W.N.	BS	INTERNATIONAL DESIGNATION	ASTM	ASME	AMS	EN	DIN	BS	Other
SG1	Alloy 200 Alloy 201	N02200 N02201	2.4068	NA11 NA12	LC-Ni99.0	B160 B564	SB160 SB564	-	-	17740	3076	-
AN2	Alloy 825 Alloy 65	N08825 N08065	2.4858	NA16 NA41	NiCr21Mo NiFe30Cr21Mo3	B425 B564	SB425 SB564	-	-	17744 1736	3076 2901	A5.14 ERNiFeCr-1
AV925	Alloy 925	N09925	-	-	-	-	-	-	-	-	-	NACE MR0175
AN4	Alloy 904L	N08904	1.4539	904S14	X1NiCrMoCu25-20-5	A182	SB649	-	10088-3 10272	-	-	-
VAL4529	Alloy 926	N08926	1.4529	-	X1NiCrMoCuN25-20-7	B472 B649	SB649	-	10088-3	-	-	SEW 400
	Alloy 367	N08367	-	-	-	A182 B472 B564 B691	SB564	-	-	-	-	-
AN5	Alloy 660 Alloy A286	S66286	1.4980	286S31	X6NiCrTiMoVB25-15-2	A638 A453	-	5731 5732 5734 5737	10269 10302	-	-	-
AV20	Alloy 20	N08020	2.4660	-	NiCr20CuMo	B473 B472	SB473	-	-	-	-	-
EG1	Alloy 400	N04400	(2.4360)	NA13	NiCu30Fe	B164 B564	SB164 SB564	4674	-	(17743) (17752)	3076	QQ-N-281 D/2
EG2	Alloy K-500	N05500	(2.4375)	NA18	NiCu30Al	B865	-	4676	-	(17743) (17752)	3076	QQ-N-286 E/2
GL3	Alloy 625	N06625	2.4856	NA21	NiCr22Mo9Nb	B446 B564	SB446 SB564	5666	17744	-	3076	-
AVC276	Alloy C276	N10276	2.4819	-	NiMo16Cr15W	B564 B574	SB564	-	-	-	-	-
AV718CRV	Alloy 718	N07718	2.4668	NA51	NiCr19Fe19Nb5Mo3; NiCr19NbMo	B637*	SB637*	-	-	-	-	API6A718
AV718HTV	Alloy 718	N07718	2.4668	NA51	NiCr19Fe19Nb5Mo3; NiCr19NbMo	B637	SB637	5662 5663	-	-	-	-

* Only for chemistry



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CORROSION RESISTANT ALLOYS - Mechanical properties

VALBRUNA GRADE	COMMERCIAL NAME	Condition	Mechanical Properties at room Temperature requested by standard specifications			
			T.S. min [MPa]	Y.S. min [MPa]	E4d min [%]	HB
SG1	Alloy 200	Cold Drawn - As Hot Worked	510-550	345-415	10-15	min 112
		Hot Worked - As Hot Worked	415	105	35	min 112
		Cold Drawn - Annealed	380	105	40	min 112
	Alloy 201	Hot Worked - Annealed	380	105	40	min 112
		Hot Worked - As Hot Worked	345	70	35	min 112
		Cold Drawn - Annealed	345	70	35	min 112
AN2	Alloy 825	Hot Worked - Annealed	345	70	40	min 112
AV925	Alloy 925	Cold Drawn - Sol Annealed	586	241	30	176-325
		Hot Worked - Sol Annealed	586	241	30	176-325
		Hot Worked - Sol Annealed	517	240	56	-
AN4	Alloy 904L	Cold Worked - Sol Annealed - Aged	965	724	25	max 341
		Hot Worked - Sol Annealed - Aged	965	758	25	max 341
		Cold Drawn - Sol Annealed	600	400	20	max 330
VAL 4529	Alloy 926	Hot Worked - Sol Annealed	530	230	35	max 230
		Cold Drawn - Sol Annealed	650	295	35	194-316
		Hot Worked - Sol Annealed	490	220	35	max 250
	Alloy 367	Cold Drawn - Sol Annealed	650	295	35	194-316
		Hot Worked - Sol Annealed	490	220	35	max 250
		Hot Worked - Sol Annealed (class A)	580	260	40	-
AN5	Alloy 660 Alloy A286	Hot Worked - Sol Annealed and Aged (class A)	895	585	15	248-341
		Hot Worked - Sol Annealed (class B)	580	260	40	-
		Hot Worked - Sol Annealed and Aged (class B)	895	585	15	248-341
		Hot Worked - Sol Annealed (class D)	580	260	40	-
		Hot Worked - Sol Annealed and Aged (class D)	895	725	15	248-325
AV20	Alloy 20	Cold Drawn - Sol Annealed	551	241	30	min 165
EG1	Alloy 400	Hot Worked - Sol Annealed	551	241	30	164-300
		Cold Drawn - As Hot Worked	760	585	8	-
		Cold Drawn - Stress Relieved	580-600	345-415	10-20	max 320
		Hot Worked - Hot Worked	515-550	276	30	max 320
		Hot Worked - Stress Relieved	515-550	276	30	max 320
		Cold Drawn - Sol Annealed	480	170	35	max 320
		Hot Worked - Sol Annealed	480	170	35	145-325
		Hot Worked - High Tensile (Stress Relieved)	580-680	415-480	20-25	-
		Hot Worked - As Hot Worked	620	300	40	max 245
		Cold Drawn - As Hot Worked	830	600	15	max 280
EG2	Alloy K-500	Cold Drawn - Sol Annealed	600	210	20	max 185
		Hot Worked - Sol Annealed	580	200	40	max 185
		Cold Drawn - Aged	930-1000	655-760	15-20	255-300 min
		Hot Worked - Aged	965	689	20	265 min
		Cold Drawn - Sol Annealed - Aged	896	586-655	20	max 250
GL3	Alloy 625	Hot Worked - Sol Annealed - Aged	896	586-655	20	max 250
		Hot Worked - Annealed (grade1)	760-830	345-415	25-30	max 325
		Cold Worked - Annealed (grade1)	760-830	345-415	25-30	max 325
		Hot Worked - Sol Annealed (grade2)	690	276	30	max 325
		Cold Worked - Sol Annealed (grade2)	690	276	30	max 325
		Hot Worked - Sol Annealed	690	283	40	-
AVC276	Alloy C276	Hot Worked - Sol Annealed	-	-	-	max 277
AV718HTV	Alloy 718	Hot Worked - Sol Annealed - Aged	1275	1035	12	331 min
AV718CRV	Alloy 718	Hot Worked - Sol Annealed - Aged	1034	827-1000	≥ 20	300 - 363

VALBRUNA GRADE	COMMERCIAL NAME	C [%]	Mn [%]	Si [%]	S [%]	P [%]	Ni [%]	Cr [%]	Fe [%]	Mo [%]	Cu [%]	Ti [%]	Al [%]	Co [%]	Others [%]
SG1	Alloy 200 Alloy 201	max 0,02	max 0,35	max 0,35	max 0,010	-	min 99	-	max 0,40	-	max 0,25	max 0,10	-	max 2,00	Mg max 0,20
AN2	Alloy 825 Alloy 65	max 0,05	max 1,00	max 0,50	max 0,030	max 0,030	38-46	19,50-23,50	min 22	2,5-3,5	1,5-3,0	0,6-1,2	max 0,20	max 2,00	-
AV925	Alloy 925	max 0,03	max 1,00	max 0,50	max 0,030	-	42-46	19,50-22,50	min 22	2,5-3,5	1,5-3,0	1,9-2,4	0,10-0,50	-	Nb 0,5 max
AN4	Alloy 904L	max 0,02	max 2,00	max 0,70	max 0,030	max 0,030	24-26	19-21	min 49	4,0-5,0	1,20-2,0	-	-	-	N max 0,15
VAL4529	Alloy 926	max 0,02	max 2,00	max 0,50	max 0,010	max 0,030	24-26	19-21	min 47	6,0-7,0	0,5-1,5	-	-	-	N 0,15-0,25
	Alloy 367	max 0,03	max 2,00	max 1,00	max 0,030	max 0,040	23,5-25,50	20-22	min 47	6,0-7,0	max 0,75	-	-	-	N 0,18-0,25
AN5	Alloy 660 Alloy A286	max 0,08	max 2,00	max 1,00	max 0,025	max 0,025	24-27	13,5-16	balance	1,0-1,50	max 0,50	1,9-2,30	max 0,35	max 1,00	V 0,10-0,50 B 0,003-0,010
AV20	Alloy 20	max 0,07	max 2,00	max 1,00	max 0,035	max 0,045	32-38	19-21	-	2-3	3-4	-	-	-	Nb + Ta max 1,0
EG1	Alloy 400	max 0,20	max 2,00	max 0,50	max 0,015	max 0,020	min 63	-	max 2,5	-	28-34	-	max 0,50	max 2,00	Pb max 0,006 Sn max 0,006 Zn max 0,02
EG2	Alloy K-500	max 0,25	max 1,50	max 0,50	max 0,010	-	min 63	-	max 2,0	-	27-33	0,35-0,85	2,3-3,15	max 2,00	-
GL3	Alloy 625	max 0,10	max 0,50	max 0,50	max 0,015	max 0,015	min 58	20-23	max 5,0	8,0-10	max 0,50	max 0,40	max 0,40	max 1,00	Nb + Ta 3,15-4,15 Ta max 0,50 Nb 3,15-4,15
AVC276	Alloy C276	max 0,01	max 1,00	max 0,08	max 0,030	max 0,040	balance	14,5-16,5	4-7	15-17	-	-	-	max 2,50	W 3,0-4,50 V max 0,35
AV718CRV/ AV718HTV	Alloy 718	max 0,08	max 0,35	max 0,35	max 0,015	max 0,015	50-55	17-21	15-21	2,8-3,3	max 0,30	0,65-1,15	0,20-0,80	max 1,00	Nb 4,75-5,50 Ta max 0,05 B max 0,006 Pb max 5 ppm Se max 3 ppm Bi max 0,3 ppm



Selection Criteria of Nickel Alloys for Corrosion Environments at High Temperature

	CORROSION MEDIA	Ni	Ni-Cu	Ni-Fe-Cr	Ni-Cr-Mo
Low Concentration	Pure Sulfuric Acid		x	x	x
	Pure Hydrochloric Acid				
	Pure Hydrofluoric Acid				
	Pure Phosphoric Acid			x	x
	Pure Nitric Acid			x	x
Medium Concentration	Caustic Soda & Caustic Potash	x	x		x
	Pure Sulfuric Acid				
	Pure Hydrochloric Acid				
	Pure Hydrofluoric Acid				
	Pure Phosphoric Acid			x	x
High Concentration	Pure Nitric Acid			x	
	Pure Sulfuric Acid				x
	Pure Hydrochloric Acid				
	Pure Hydrofluoric Acid				
	Pure Phosphoric Acid			x	x
	Caustic Soda & Caustic Potash	x		x	

High Temperature (from 79°C up to boiling)

Selection Criteria of Nickel Alloys for Corrosion Environments at Medium Temperature

	CORROSION MEDIA	Ni	Ni-Cu	Ni-Fe-Cr	Ni-Cr-Mo
Low Concentration	Pure Sulfuric Acid		x	x	x
	Pure Hydrochloric Acid				x
	Pure Hydrofluoric Acid		x		x
	Pure Phosphoric Acid		x	x	x
	Pure Nitric Acid			x	x
Medium Concentration	Caustic Soda & Caustic Potash	x	x		x
	Pure Sulfuric Acid		x	x	x
	Pure Hydrochloric Acid				x
	Pure Hydrofluoric Acid		x		x
	Pure Phosphoric Acid		x	x	x
High Concentration	Pure Nitric Acid			x	x
	Pure Sulfuric Acid				x
	Pure Hydrochloric Acid				
	Pure Hydrofluoric Acid		x	x	x
	Pure Phosphoric Acid			x	
	Caustic Soda & Caustic Potash	x	x		

Medium Temperature (from 52°C up to 79°C)

Selection Criteria of Nickel Alloys for Corrosion Environments at Low Temperature

	CORROSION MEDIA	Ni	Ni-Cu	Ni-Fe-Cr	Ni-Cr-Mo
Low Concentration	Pure Sulfuric Acid		x	x	x
	Pure Hydrochloric Acid		x	x	x
	Pure Hydrofluoric Acid		x	x	x
	Pure Phosphoric Acid		x	x	x
	Pure Nitric Acid			x	x
Medium Concentration	Caustic Soda & Caustic Potash	x	x		x
	Pure Sulfuric Acid		x	x	
	Pure Hydrochloric Acid				x
	Pure Hydrofluoric Acid		x		x
	Pure Phosphoric Acid		x	x	x
High Concentration	Pure Nitric Acid			x	x
	Pure Sulfuric Acid			x	x
	Pure Hydrochloric Acid				x
	Pure Hydrofluoric Acid		x		x
	Pure Phosphoric Acid		x	x	x
	Caustic Soda & Caustic Potash	x	x		

Low Temperature (from room temp. up to 52°C)

LEGEND	VALBRUNA GRADE
Ni Alloys	SG1
Ni-Cu Alloys	EG1; EG2
Ni-Fe-Cr Alloys	AV20; AN5; AV925; AV718CRV; AN2; AN4; VAL4529
Ni-Cr-Mo Alloys	AVC276; GL3

There are some applications at elevated temperatures (such as aircraft components, chemical plant and petrochemical equipment) where a good combination of high strength and corrosion resistance is requested.

For these kinds of applications Nickel alloys could provide the most suitable compromise between different properties such as:

Good resistance to corrosion, creep, fatigue, thermal fatigue, thermal shock, impact, cavitation and erosion, good fracture properties, forming characteristics and weldability.



HIGH TEMPERATURE ALLOYS - Designations

VALBRUNA GRADE	COMMERCIAL NAME	UNS	W.N.	BS	INTERNATIONAL DESIGNATION	ASTM	ASME	AMS	EN	DIN	BS	Other
AN1	Alloy 800 Alloy 800H Alloy 800HT	N08800 N08810 N08811	1.4876	NA15 NA15(H)	X10NiCrAlTi32-21 X10NiCrAlTi32-20	B408 B564	SB408 SB564	5766	10095	-	3076	SEW 470
AN3	Alloy DS	-	1.4862	NA17	X8NiCrSi38-18	-	-	-	10095	-	3076	-
AN3US	Alloy 330	N08330	-	-	-	B511	-	5716	-	-	-	-
AN3CB	Alloy 330Cb	-	-	-	-	-	-	-	-	-	-	-
GL1	Alloy 600	N06600	2.4816	NA14	NiCr15Fe	B166 B564	SB166 SB564	5665	10095	17742 17752	3076	-
GL2	Alloy 80A	N07080	2.4952	NA20	NiCr20TiAl	B637	SB637	-	10302 10269 10090	17480 17240 17742	3076	-
GL5	Alloy 601	N06601	2.4851	NA49	NiCr23Fe	B166 B564	SB166 SB564	5715	10095	17742 17752 1736	2901-5	-



HIGH TEMPERATURE ALLOYS



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HIGH TEMPERATURE ALLOYS - Chemical Composition

VALBRUNA GRADE	COMMERCIAL NAME	C [%]	Mn [%]	Si [%]	S [%]	P [%]	Ni [%]	Cr [%]	Fe [%]	Mo [%]	Cu [%]	Ti [%]	Al [%]	Co [%]	Others [%]
AN1	Alloy 800 Alloy 800H Alloy 800HT	0,06-0,10	max 1,50	max 1,00	max 0,015	max 0,030	30-34	19-23	min 39,50	-	max 0,75	0,15-0,60	0,15-0,60	-	-
AN3	Alloy DS	max 0,10	0,80-1,50	1,90-2,60	max 0,030	-	34,5-41	17-19	min 41	-	max 0,50	max 0,20	-	-	-
AN3US	Alloy 330	max 0,80	max 2,00	0,75-1,50	max 0,030	max 0,030	34-37	17-20	min 41	-	max 1,0	-	-	-	Sn max 0,025 Pb max 0,0050 Nb 1,0-2,0
AN3CB	Alloy 330Cb	max 0,15	max 2,00	1,00-2,00	max 0,015	max 0,030	33-37	20-23	min 41	-	-	-	-	-	-
GL1	Alloy 600	max 0,15	max 1,00	max 0,50	max 0,015	max 0,020	min 72	14-17	6,0-10,0	-	max 0,50	max 0,30	max 0,30	max 1,00	-
GL2	Alloy 80A	0,04-0,10	max 1,00	max 1,00	max 0,015	max 0,020	min 65	18-21	max 3,0	-	max 0,20	1,8-2,70	1,00-1,80	max 1,00	B max 0,008
GL5	Alloy 601	0,03-0,10	max 1,00	max 0,50	max 0,015	max 0,020	58-63	21-25	max 18	-	max 0,50	max 0,50	1,00-1,70	max 1,50	B max 0,006



HIGH TEMPERATURE ALLOYS - Mechanical properties

VALBRUNA GRADE	COMMERCIAL NAME	Condition	Mechanical Properties at room Temperature requested by standard specifications			
			T.S. min [MPa]	Y.S. min [MPa]	E4d min [%]	HB
AN1	Alloy 800	Hot Worked - As Hot Worked	550	240	25	-
		Hot Worked - Sol Annealed	515	205	30	-
		Cold Worked - Sol Annealed	515	205	30	155-268
	Alloy 800H	Cold Worked - Sol Annealed	450	170	30	155-268
		Hot Worked - Sol Annealed	450	170	30	155-192
	Alloy 800HT	Cold Worked - Sol Annealed	450	170	30	155-268
AN3	Alloy DS	Hot Worked - Sol Annealed	450	170	30	155-192
		Hot Worked - As Hot Worked	600	250	30	-
		Hot Worked - Sol Annealed	600	250	30	-
AN3US	Alloy 330	Cold Worked - Sol Annealed	600	250	30	-
AN3CB	Alloy 330Cb	Hot Worked - Sol Annealed	483	207	30	-
		Hot Worked - Sol Annealed	500	100	40	-
GL1	Alloy 600	Cold Worked - As Hot Worked	725-825	550-620	7-12	-
		Hot Worked - As Hot Worked	585-655	240-310	20-30	-
		Hot Worked - Sol Annealed	550	240	30	-
		Cold Worked - Sol Annealed	550	240	30	-
		Hot Worked - Sol Annealed	1000	620	18	-
GL2	Alloy 80A	Hot Worked - Sol Annealed-Aged	1180	760	18	-
		Hot Worked - Sol Annealed-Stabilized-Aged	1150	710	12	-
		Cold Worked - Sol Annealed	1000	620	12	-
		Cold Worked - Sol Annealed-Stabilized-Aged	1000	620	12	-
		Hot Worked - Sol Annealed	550	205	30	-
GL5	Alloy 601	Hot Worked - Sol Annealed	550	205	30	-
		Cold Worked - Sol Annealed	550	205	30	-

HIGH TEMPERATURE ALLOYS - Service temperature

VALBRUNA GRADE	Service temperature		Description
	Min	Max	
AN1 (800)	cryogenic	600° C	good corrosion, heat resistance and mechanical properties
AN1 (800H)	600°	816° C	good creep-rupture properties at T > 700° C
AN1 (800HT)	700°	1000° C	excellent creep strength (but reduced ductility) at T > 700° C
AN3	-	1000° C	good oxidation resistance
AN3US	-	1150° C	good oxidation resistance also at reducing atmospheres
AN3CB	-	1150° C	better creep rupture resistance
GL1	cryogenic	1093° C	high resistance to oxidation atmospheres
GL2	-	815° C	good mechanical properties and outstanding resistance to creep
GL5	540°	1150° C	good corrosion resistance

WELDING ALLOYS

Alloys with special chemical balance for welding



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Nickel Alloys for Special Applications

WELDING ALLOYS - Designations

VALBRUNA GRADE	COMMERCIAL NAME	UNS	W.N.	BS	INTERNATIONAL DESIGNATION	ASTM	ASME	AMS	EN	DIN	BS	Other
GL3/EL	Alloy 625	N06625	2.4831	NA43	SG-NiCr21Mo9Nb UP-NiCr21Mo9Nb	B446	-	-	1736	-	2901	A5.14 ERNiCrMo-3
AN2	Alloy 825 Alloy 65	N08825 N08065	2.4655	NA41	SG-NiCr27Mo	F45	-	-	-	-	2901	A5.14 ERNiFeCr-1
GL4	Alloy 82	N06082	2.4806	NA35	SG-NiCr20Nb UP-NiCr20Nb	-	-	-	1736	-	2901	A5.14 ERNiCr-3
GL5	Alloy 601	N06601	2.4826	NA49	-	B166	-	-	-	1736	2901-5	-
EG3	Alloy 60	N04060	2.4377	NA33	SG-NiCu 30 MnTi UP-NiCu 30 MnTi	-	-	-	1736	-	2901	A5.14 ERNiCu-7
SG2	Alloy 55	W82002 (2.4560)	-	NA47	S-NiFe 40	-	-	-	1736	-	2901-5	A 5.15 ERNiFe-CL A 5.15 ENiFe-CL
SG3	Alloy 55 Ti	-	-	-	-	-	-	-	-	-	-	-
SG6	Alloy 61	N02061	2.4155	NA32	SG-NiTi 4	-	-	-	1736	-	2901	A5.14 ERNi-1

WELDING ALLOYS - Mechanical properties

VALBRUNA GRADE	COMMERCIAL NAME	Condition	Mechanical Properties at room Temperature requested by standard specifications			
			T.S. min (MPa)	Y.S. min (MPa)	E _{4d} min [%]	HB
GL3/EL	Alloy 625	Hot Worked - Sol Annealed	720	276	30	-
AN2	Alloy 65	Hot Worked - Sol Annealed	552	230	25	-
GL4	Alloy 82	Hot Worked - Sol Annealed	650	320	25	-
GL5	Alloy 601	Hot Worked - Sol Annealed	650	320	25	-
EG3	Alloy 60	Hot Worked - Sol Annealed	700	450	30	-
SG2	Alloy 55	Hot Worked - Sol Annealed	350	-	6	-
SG3	Alloy 55Ti	Hot Worked - Sol Annealed	-	-	-	-
SG6	Alloy 61	Hot Worked - Sol Annealed	400	-	18	-



WELDING ALLOYS - Chemical Composition

VALBRUNA GRADE	COMMERCIAL NAME	C [%]	Mn [%]	Si [%]	S [%]	P [%]	Ni [%]	Cr [%]	Fe [%]	Mo [%]	Cu [%]	Ti [%]	Al [%]	Co [%]	Others [%]
GL3/EL	Alloy 625	max 0,06	max 0,25	max 0,20	max 0,015	max 0,010	min 58	21-22,5	max 0,40	8,5-10	max 0,30	0,10-0,30	max 0,40	max 0,50	Nb + Ta 3,4-3,8 Pb max 0,005
AN2	Alloy 65	max 0,05	max 1,00	max 0,50	max 0,030	-	38-46	19,50-23,50	min 22	2,5-3,5	1,5-3,0	0,6-1,2	max 0,20	max 2,00	-
GL4	Alloy 82	max 0,10	2,50-3,50	max 0,50	max 0,015	max 0,030	min 67	18-22	max 3,0	-	max 0,50	max 0,75	-	-	Nb + Ta 2,0-3,0
GL5	Alloy 601	0,03-0,10	max 1,00	max 0,50	max 0,015	max 0,020	58-63	21-25	max 18	-	max 0,50	max 0,50	1,00-1,70	max 1,50	B max 0,006
EG3	Alloy 60	max 0,15	max 4,0	max 1,25	max 0,015	max 0,020	62-69	-	max 2,5	-	balance	1,50-3,00	max 1,25	-	-
SG2	Alloy 55	max 0,03	0,60-0,80	max 0,15	max 0,010	max 0,015	54-55	-	43-45	-	-	-	-	-	-
SG3	Alloy 55 Ti	max 0,03	0,60-0,80	max 0,15	max 0,015	max 0,015	52-55	-	42-47	-	-	0,05-0,25	-	-	-
SG6	Alloy 61	max 0,05	max 0,80	max 0,75	max 0,010	max 0,030	min 93	-	max 0,70	-	max 0,05	2,0-3,5	max 1,00	-	-

WELDING PROCESS

	Very Good	Good	Satisfactory
TIG	GL3EL, GL4, GL5, EG3, SG6		AN2
MIG		GL3EL, GL4, EG3, AN2, SG6	
PAW	GL3EL, GL4, GL5, EG3, SG6		



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ELECTRICAL RESISTANCE AND ELECTRONIC INSTRUMENT ALLOYS

These alloys are mostly used for the manufacture of heating elements for industrial furnaces and domestic devices.

Alloys with special physical properties, such as a low coefficient of expansion, are requested for applications that include precision components in magnetic shields, integrated circuits, and glass-to-metal seals.



ELECTRICAL RESISTANCE AND ELECTRONIC INSTRUMENT ALLOYS - Designations

VALBRUNA GRADE	COMMERCIAL NAME	UNS	W.N.	BS	INTERNATIONAL DESIGNATION	ASTM	ASME	AMS	EN	DIN	BS	Other
SG4	Alloy 212	N02212	2.4110	-	NiMn 2	-	-	-	-	17741	-	-
EG4	Alloy 401	N04401	2.0842	-	-	F30	-	-	17644	-	-	-
SG5	Alloy 36	K93601	1.3912	-	Ni 36	-	-	-	-	17745	-	SEW 385
VAL40	Alloy 40	-	1.4860	-	NiCr 30 20 (X16NiCr30-20)	-	-	-	-	17470	-	-
VAL60	Alloy 60/40	N06004	2.4867	-	NiCr6015	B344	-	-	-	17742	-	-
VAL80	Alloy 80/20	N06003	2.4869	-	NiCr80-20	B344	-	-	-	17742	-	-
X21AL®	CrAl20-5	-	1.4767	-	-	B603	-	-	17470	-	-	-
X22AL®	CrAl25-5	-	1.4765	-	-	B603	-	-	17470	-	-	-

*Cr-Al Alloys

Nickel Alloys for Special Applications

ELECTRICAL RESISTANCE AND ELECTRONIC INSTRUMENT ALLOYS - Mechanical properties

VALBRUNA GRADE	COMMERCIAL NAME	Condition	Mechanical Properties at room Temperature requested by standard specifications			
			T.S. min (MPa)	Y.S. min (MPa)	E4d min [%]	HB
SG4	Alloy 212	Hot Worked - Sol Annealed	-	-	-	-
EG4	Alloy 401	Hot Worked - Sol Annealed	420	130	48	-
SG5	Alloy 36	Hot Worked - Sol Annealed	450	200	30	max 220
VAL40	Alloy 40	Hot Worked - Sol Annealed	700	350	35	-
VAL60	Alloy 60/40	Hot Worked - Sol Annealed	-	-	-	-
VAL80	Alloy 80/20	Hot Worked - Sol Annealed	650	280	30	-
X21AL®	CrAl20-5	Hot Worked - Sol Annealed	-	-	-	-
X22AL®	CrAl25-5	Hot Worked - Sol Annealed	-	-	-	-

*Cr-Al Alloys



ELECTRICAL RESISTANCE AND ELECTRONIC INSTRUMENT ALLOYS - Chemical Composition

VALBRUNA GRADE	COMMERCIAL NAME	C [%]	Mn [%]	Si [%]	S [%]	P [%]	Ni [%]	Cr [%]	Fe [%]	Mo [%]	Cu [%]	Ti [%]	Al [%]	Co [%]	Others [%]
SG4	Alloy 212	max 0,50	1,50-2,50	max 0,20	max 0,010	-	min 97	-	max 0,30	-	max 0,20	-	-	-	Ni+Co min 97 Mg max 0,15
EG4	Alloy 401	max 0,10	0,50-2,00	max 0,30	max 0,020	-	40-45	-	max 0,50	-	min 58	-	-	max 0,50	Zn max 0,20 Pb max 0,010
SG5	Alloy 36	max 0,10	max 0,60	max 0,50	-	-	35-37	-	balance	-	-	-	-	-	-
VAL40	Alloy 40	max 0,15	max 1,00	1,00-3,00	max 0,010	-	34-37	18-21	balance	-	-	-	-	max 1,00	Ni+Co 34-37
VAL60	Alloy 60/40	max 0,15	max 1,00	0,75-1,75	max 0,010	-	min 57	14-18	min 20	-	-	-	-	max 1,00	Ni+Co min 57
VAL80	Alloy 80/20	max 0,15	max 1,00	0,75-1,75	max 0,010	-	76-80	19-21	max 1,0	-	-	-	-	max 1,00	-
X21AL®	CrAl20-5	max 0,10	max 1,00	max 1,00	max 0,030	max 0,045	max 0,20	19-22	balance	-	-	-	4,00-5,00	-	-
X22AL®	CrAl25-5	max 0,10	max 0,06	max 1,00	max 0,030	max 0,045	max 0,20	22-25	balance	-	-	-	4,50-6,00	-	-

*Cr-Al Alloys



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