CARPENTER TECHNOLOGY

DATASHEET

NI-CU K500

Applicable specifications: AMS 4676, ASTM B865, QQ-N-286 Revision E, F, and G
Associated identifiers: DIN 2.4375, UNS N05500

Type analysis

Single figures are nominal except where noted.

Nickel	Min 63.00 %	**Copper**	30.00 %	**Aluminum**	Max 3.15 %
Iron	Max 2.00 %	**Manganese**	Max 1.50 %	**Titanium**	Max 0.85 %
Silicon	Max 0.50 %	**Carbon**	Max 0.17 %	**Sulfur**	Max 0.006 %

Forms manufactured

Bar	**Wire**

Description

Ni-Cu K500 is an age hardenable nickel-copper alloy combining high strength with excellent resistance to many corrosion environments. Ni-Cu K500 has similar corrosion resistance to Ni-Cu 400, but with greater strength and hardness capabilities arising from Ni_3 (Ti, Al) precipitation. As a result, Ni-Cu K500 is used in corrosive environment applications that require higher load capacity.

Ni-Cu K500 has been widely used in many applications:

- Marine: Fasteners, shafts, pump and valve components
- Oil and gas: Downhole tools, sour-service valves and components
- Chemical processing: Pumps, valves, corrosion-resistant hardware
- Industrial: High-strength, non-magnetic components

Key Properties:

- High strength and hardness
- Excellent corrosion resistance
- Retains toughness and low magnetic permeability

Markets:

- Aerospace
- Consumer
- Defense
- Energy
- Industrial

Applications:

- Fasteners and shafts
- Pump and valve components
- Components for chemical processing, oil and gas, and marine applications

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Corrosion resistance

Corrosion behavior is similar to Ni-Cu 400 in most environments. Ni-Cu K500 is resistant to most alkalis, salts, waters (including saline or brackish), food products, organic substances, and atmospheric conditions at normal and elevated temperatures. This alloy is not useful in highly oxidizing acids, such as nitric and nitrous. In the age-hardened condition, susceptibility to stress corrosion cracking may increase in specific environments. Application-specific testing should be considered during design review.

Oxidizing impurities, such as ferric chloride, ferric sulfate, chromates, nitrates, peroxides, and cupric salts, can cause attack in a medium that would otherwise be relatively mild for the alloy.

IMPORTANT NOTE:
The following 4-level rating scale is intended for comparative purposes only. Corrosion testing is recommended; factors that affect corrosion resistance include temperature, concentration, pH, impurities, aeration, velocity, crevices, deposits, metallurgical condition, stress, surface finish, and dissimilar metal contact.

Nitric Acid	Restricted	**Sulfuric Acid**	Good
Phosphoric Acid	Good	**Hydrochloric Acid**	Moderate
Sodium Hydroxide	Excellent	**Salt Spray (NaCl)**	Good
Sea Water	Good	**Sour Oil/Gas**	Good
Humidity	Good		

Physical properties

PROPERTY	At or From	English Units	Metric Units
DENSITY	—	0.3060 lb/in^3	—
MEAN COEFFICIENT OF THERMAL EXPANSION (SOLUTION ANNEALED + AGED CONDITION)	77 to 200°F (25 to 93°C)	7.41 x 10^{-6} in/in/°F	13.3 x 10^{-6} length/length/°C
	77 to 400°F (25 to 204°C)	7.94 x 10^{-6} in/in/°F	14.3 x 10^{-6} length/length/°C
	77 to 600°F (25 to 316°C)	7.99 x 10^{-6} in/in/°F	14.4 x 10^{-6} length/length/°C
	77 to 800°F (25 to 427°C)	8.27 x 10^{-6} in/in/°F	14.9 x 10^{-6} length/length/°C
	77 to 1000°F (25 to 538°C)	8.58 x 10^{-6} in/in/°F	15.4 x 10^{-6} length/length/°C
	77 to 1200°F (25 to 649°C)	8.86 x 10^{-6} in/in/°F	15.9 x 10^{-6} length/length/°C
	77 to 1400°F (25 to 760°C)	9.40 x 10^{-6} in/in/°F	16.9 x 10^{-6} length/length/°C
MODULUS OF ELASTICITY	Room temperature	26 x 10^3 ksi	—

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Typical mechanical properties

Ni-Cu K500 may be supplied in annealed, cold worked, or aged conditions. Mechanical properties vary significantly with processing and aging treatment. Typical commercial applications utilize solution-annealed plus aged material unless otherwise specified.

ROOM TEMPERATURE, COLD WORKED

COLD WORK	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 4D	REDUCTION OF AREA
%	ksi	MPa	ksi	MPa	%	%
0	45	312	100	691	46	70
5	68	469	107	735	38	67
15	103	712	120	828	25	63
25	136	938	139	959	14	57
28	143	984	144	994	13	57

ROOM TEMPERATURE, COLD WORKED + AGED[1]

COLD WORK	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 4D	REDUCTION OF AREA	HARDNESS
%	ksi	MPa	ksi	MPa	%	%	HRC
0	117	803	166	1146	25	47	33
5	125	860	170	1172	23	49	36
15	143	988	181	1245	19	46	37
25	162	1118	193	1329	16	42	39
28	168	1161	197	1358	15	38	39

[1] *Aged at 1100°F (593°C) for 16 hours, furnace cool to 1000°F (538°C) for 6 hours, furnace cool to 900°F (482°C), air cool.*

ROOM TEMPERATURE, BAR, VARIOUS CONDITIONS

CONDITION	0.2% YIELD STRENGTH		ULTIMATE TENSILE STRENGTH		ELONGATION IN 4D	REDUCTION OF AREA	HARDNESS
	ksi	MPa	ksi	MPa	%	%	
Hot Finished	60	414	116	800	44	65	85 HRB
Hot Finished, Aged[1]	116	801	165	1138	25	46	28 HRC
Hot Finished, Annealed[2]	46	315	92	636	39	62	80 HRB
Hot Finished, Annealed,[2] Aged[1]	106	733	152	1048	23	40	25 HRC
Cold Drawn, Annealed[2]	40	275	92	634	40	64	80 HRB
Cold Drawn, Annealed,[2] Aged[1]	95	655	147	1013	25	42	25 HRC

[1] *Aged at 1100°F (593°C) for 16 hours, furnace cool to 1000°F (538°C) for 6 hours, furnace cool to 900°F (482°C), air cool.*
[2] *Annealed at 1600°F (871°C), water quench.*

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Magnetic and low-temperature behavior

Ni-Cu K500 exhibits low magnetic permeability and retains non-magnetic behavior at sub-ambient temperatures. This is relevant for downhole, marine, and instrumentation use.

Heat treatment

Annealing	Solution annealing is commonly carried out at temperatures in the range of 1600 to 1900°F (871 to 1038°C) followed by a rapid quench to avoid formation of detrimental phases. Time at temperature should be kept to a minimum to avoid excessive grain growth.
Age	Material is commonly aged by holding at 1100°F (593°C) for 16 hours, followed by a furnace cool at 15 to 25°F (-9 to -4°C) per hour to 900°F (482°C). Once the material reaches 900°F (482°C), material can be air cooled or quenched. Modified aging cycles can be utilized but are dependent upon starting condition, desired properties, and process limitations.

Workability

Hot working	The maximum recommended hot working temperature for Ni-Cu K500 is 2100°F (1149°C). The recommended hot working range is from 1600 to 2100°F (871 to 1149°C). Material should be water quenched from hot working temperatures to avoid precipitation of second phases, which may result in degraded properties and/or result in splitting or tearing.
Cold working	Ni-Cu K500 can be cold worked using standard procedures.
Joining	Ni-Cu K500 may be joined by conventional processes. It is preferred that welding be completed prior to age hardening. Several filler metal options are commercially available, depending on requirements of the weldment.
Machinability	Machining is easiest in the annealed condition. Dimensional changes during aging should be considered in part design and method of manufacturing.

For additional information, please contact your nearest sales office:
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