BERYLLIUM COPPER ALLOY 172 HIGH HARD

Performance Alloy Data Sheet

voestalpine High Performance Metals
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GENERAL

Beryllium Copper Alloy 172 High Hard can attain mechanical properties up to 200 KSI UTS and hardness of Rockwell C45. At a moderate conductivity of 22%, these alloys offer the best wear resistance, fatigue strength, and hardness available in the copper alloy system.

Material is delivered in a hardness range of 36-45 HRC.*

*NOTE: In applications where a more ductile version or higher thermal conductivity of Alloy 172 is required, the low hard (LH) version is available. Hardness is 30 HRC. Thermal conductivity at room temperature is 90 BTU/(hr ft°F) (155 W/m°K).

Please contact your voestalpine High Performance Metals Inside Sales Representative with questions.

Chemical composition

Composition	Weight %	Outstanding characteristics
Be Ni+Co Cu	1.8-2.0 0.20 minimum Balance	High strength High fatigue strength Good conductivity Wear resistance Non-magnetic

Specifications

Standards Organization	Specification References
ASTM	B196 17200
Federal Military	QQC 530 C17200 (obsolete: refer to ASTM specifications) MIL-C-46087
SAE	AMS 4650 (rod, bar) AMS 4651 (rod, bar)
(Unified numbering system) CDA	C17200

Color Code: Black/Gold

FORMS AVAILABLE

Rounds, flats, plate, finished components

APPLICATION

Applications and characteristics of Beryllium Copper alloys

Application	Characteristics
Oil Patch Energy Exploration	Alloy 172 HH has good resistance to galling, high strength, high fatigue strength, non-magnetic property and good corrosion resistance. Ideal material for drill string applications: drill collars, saver subs, wire line, sheathing, etc.
Bushings	Alloy 172 HH has good wear, resistance to galling and high strength. Therefore, it is excellent for bushings for aircraft, drilling and machine tool industry.
Molds	Alloy 172 HH is an excellent choice for plastic injection molding, blow molding and continuous casting metals because of its high strength, good conductivity, and wear resistance.

MACHINABILITY

Beryllium copper can be machined into intricate shapes. Its machinability in the age hardened condition is comparable to many other copper base alloys and better than stainless steels. Its dimensional stability is far superior to any other copper base alloy.

GRINDING

Conventional grinding wheels can be used when grinding. Surface grinding, use A 54LV-type of wheels. Cylindrical grinding, use A 60 LV-type of wheels.

All grinding should be done wet to avoid breathing metal dust.

ABRASIVE WEAR RESISTANCE

Beryllium copper offers attractive wear resistance properties compared to other copper base alloys and many ferrous alloys because of its complex oxide transfer wear films. The high strength of age hardened parts makes them capable of sustaining bearing loads far in excess of other copper based alloys and gives the added advantage of compatibility with hardness ferrous alloy shafts.

CORROSION RESISTANCE

Beryllium copper has corrosion resistance nearly equal to nickel silver, is not susceptible to hydrogen embrittlement, and it resists corrosion in seawater, most organic solutions, nonoxidizing acids, and dilute alkalis. It resists stress corrosion cracking in sulfide and chloride solutions, although it will discolor. It is not recommended for use with ammonium hydroxide or strongly oxidizing acids.

HIGH FATIGUE STRENGTH

Beryllium copper is known to have high fatigue strength because of its toughness and resistance to local deformation.

OTHER CHARACTERISTICS

The non-magnetic characteristic of beryllium copper alloys makes them extremely useful for housing sensitive detectors affected by magnetic fields. In addition, the material is nonsparking, making it useful in environments where risk of fire and explosions is a concern.

Beryllium Copper Alloy 172 HH retains its strength at low temperatures, making it ideal for cryogenic applications.

Physical Data

	20°C (68°F)	200°C (390°F)
Density kg/m^3 lb/in^3	 8,350 0.302	 8,276 0.299
Modulus of Elasticity N/mm^2 psi	 131,100 19×10^6	 124,000 18 x 106
Modulus of Rigidity (Torsion) N/mm^2 psi	 49,423 7.2×10^6	 - -
Thermal Coefficient of Expansion From 20°C From 68°F	 - -	 17.5×10^{-6} 9.7×10^{-6}
Thermal Conductivity W/m°K BTU/(hr•ft°F)	 104 60	 145 84
Thermal Capacity (Specific Heat) J/kg/°C BTU/lb/°F	 418 .1	 477 .114
Electrical Conductivity %IACS @ 20°C % IACS @ 68°F	 22 22	 - -
Magnetic Permeability μ	1.0025	1.0025

HEAT TREATMENT

The following heat treatment discussion is provided for informational purposes. **Material is supplied in the age hardened condition.**

Heat treatment is the most important process for this alloy system. While all copper alloys are hardenable by cold working, beryllium copper is unique in being hardenable by a simple low temperature thermal treatment. It involves two basic steps. The first is called solution annealing and the second, precipitation or age hardening.

SOLUTION ANNEALING

The material is heated to within about 200°F of the alloy melting temperature. At this point, the contained beryllium is essentially "dissolved" in the copper matrix (Alpha phase). By rapidly quenching to room temperature this solid solution structure is retained. The material at this stage is very soft and ductile and can be readily cold worked by drawing, forming, rolling, or cold heading. The solution annealing operation is part of the process at the mill and is not typically used by the customer.

AGE HARDENING

Age hardening significantly enhances the material's strength. This reaction is generally carried out at temperatures between 500°F (260°C) and 750°F (400°C) depending on the desired characteristics. This cycle causes the dissolved beryllium to precipitate as a beryllium rich (gamma) phase in the matrix and at the grain boundaries. It is the formation of this precipitate which causes the large increase in material strength. The level of mechanical properties attained is determined by the temperature and time at temperature. It should be recognized that beryllium copper has no room temperature aging characteristics.

SURFACE TREATMENT*

Examples of typical surface treatments are shown below:

Treatment	Benefits
Hard Chrome	Wear resistance, corrosion resistance, hardness.
Electroless (Chemical) Nickel	Hardness, wear resistance, surface release, corrosion resistance.
Electroless Nickel with Teflon	Hardness, wear resistance, surface release.
PVD: Titanium Nitride Chromium Nitride	Superior wear resistance, surface release.

Note: Treatment temperatures should not exceed 600 °F (315 °C)

*See eifeler Coatings for more information on Physical Vapor Deposition (PVD) processes: https://www.eifeler.com/northamerica/en/

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Typical mechanical properties in Rounds and Bars, diameters*[A]

Temper: High Hard	Tensile Strength Ksi Min-max[B]	Tensile Strength MPa Min-max[B]	Yield Strength Ksi	Yield Strength MPa	Elongation in 4D %, min[C]	Hardness, HRC[B]	Typical age hardening times at soak temperature
*After age hardening							
Up to .95 cm (.375 inch)	185-215	1270-1480	160	1100	3	39-45	2hr @600°F(315°C)
Over .95-2.54 cm (.375 to 1 inch), incl.	180-210	1240-1450	155	1070	3	38-44	2hr @600°F(315°C)
Over 2.54-7.62 cm (1-3 inch incl.)	177-205	1220-1410	150	1030	4	37-43	2hr @600°F(315°C)
Over 7.62 cm (3 inch)	165-200	1140-1380	130	900	3	36-42	3hr@600°F(315°C)

Notes:

A. This table indicates the range of tempers and corresponding properties available in standard product. When no specification is shown on an order other than the standard alloy and temper designation, the material will be supplied to the requirements of ASTM B196. The values shown in this table shall apply, qualified by the following foot note.

B. The upper limits in tensile strength and hardness are for reference only.

C. Elongation is based on a gauge length four times the diameter of the test specimen.

WELDING

Beryllium copper alloy 172 can easily be welded if good welding practices are followed.

Clean the area thoroughly with degreasing solvent. Remove the oxidized layer using aggressive brushing, sandblasting, or acid pickling prior to welding. Welding consumables are available: discuss with your Uddeholm sales representative for more details.

The weld and the surrounding area will show a lower hardness. Resolution anneal, quench and age harden if the as delivered hardness is required.

Welding operations must comply with 29CFR 1910.252(c)2 and should employ adequate ventilation to eliminate welding fumes or respirators should be used by those in the welding area.

ELECTRICAL DISCHARGE MACHINING (EDM)

While Beryllium Copper's high thermal conductivity makes it slower to EDM than mold steel, EDM'ing presents no significant problem. **Proper ventilation with an effective exhaust system is essential to prevent fumes in the air.**

SAFE HANDLING GUIDELINES

The OSHA standards covering the Beryllium Copper safety, procedural and training requirements are included in the Federal Regulation 29CFR1910.1024. The manufacturers of Beryllium Copper recommend that users consult this document for details.

The potential industrial hygiene problem related to handling beryllium containing alloys, and many other industrial materials, is the generation of finely divided airborne particulate matter that can be inhaled. These situations, particularly in melting and grinding, are conventionally handled with dust collection systems or other engineering controls. If permissible exposure levels as specified in the OSHA standards are exceeded, personal breathing protection such as respirators must be used. A basic review of safe handling procedures before processing beryllium containing alloys is essential.

For more detailed information on health, hygiene and safety requirements, please consult Uddeholm Safety Data Sheet titled "Copper Beryllium Wrought Alloys".

Data provided by NGK Metals Corporation:
https://www.ngkmetals.com/

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