HPA ALLOYS High Performance Cobalt Base Wear Alloy

HPAlloys Cobalt 6B

March 2001 Volume 5, Issue 2

HPAlloys Cobalt 6B Product Description

Cobalt 6B CoCrW
UNS R30016 AMS 5894
MCS 1012 PWA 1196 XLO-PD-1089

Cobalt 6B is a cobalt based chromium, tungsten alloy for wear environments where seizing, galling and abrasion are present. 6B is resistant to seizing and galling and with its low coefficient of friction, allows sliding contact with other metals without damage by metal pick up in many cases. Seizing and galling can be minimized in applications without lubrication or where lubrication is impractical. Metal seizing is similar to one metal piece building heat against another and they become "welded" together. Galling is when these "weld" areas break off and form an abrasive debris which creates additional abrasion problems.

Alloy 6B has outstanding resistance to most types of wear. Its wear resistance is inherent and not the result of cold working, heat treating or any other method. This inherent property reduces the amount of heat treating and post machining.

6B has outstanding resistance to cavitation erosion. Steam turbine erosion shields from 6B have protected the blades of turbines for years of continuous service. 6B has good impact and thermal shock resistance resists heat and oxidation, retains high hardness even at red heat (when cooled, recovers full original hardness) and has resistance to a variety of corrosive media. 6B is useful where both wear and corrosion resistance are needed.

General Data

Solution Annealed 2250 °F, Air Cooled
Density 0.303 lb/in^3
Specific Heat (@ 72 °F) 0.101 Btu/lb-°F
Thermal Conductivity (32 to 212 F)
103 Btu-in./sq. ft.-hr.-°F
Electrical Resistivity (68 °F)
546 Ohms/ cir mil ft
Melting Range 2310 to 2470 °F
Electrical Conductivity compared to Copper 1.90%
Reflecting Power 57 - 70%
Mean Coefficient of Thermal Expansion

32-212°F	7.7 microinches/in.°F
32-932°F	8.3 microinches/in.°F
32-1472°F	9.1 microinches/in.°F
32-1832°F	9.7 microinches/in.°F

Applications

Applications for alloy 6B include half sleeves and half bushings in screw conveyors, tile making machines, rock crushing rollers and cement and steel mill equipment. Alloy 6B is well suited for valve parts, pump plungers shafting and sleeves.

Wrought alloy 6B offers the ductility, fatigue resistance and toughness of a hot worked microstructure, with the heat corrosion and wear resistance of cobalt based alloy. High Performance Alloys, Inc. inventories bar, sheet, and plate. Bar is stocked from 3/8" through 6" diameter. Bar can be supplied in random lengths or cut to order. Sheet and plate are offered as whole plates, can be abrasive cut, or processed further using waterjet services.

Other applications are steam turbine erosion shields, chain saw guide bars, high temperature bearings, furnace fan blades, valve stems, food processing equipment, needle valves, centrifuge liners, hot extrusion dies, forming dies, nozzles, extruder screws, & many other miscellaneous wear surfaces.

Chemistry

Co	Cr	W	Mo	Ni	Mn	Fe	C
Bal.	28-32%	3.5-5.5%	1.5% Max	3% Max	2% Max	3% Max	0.90-1.40% Max

Mechanical Properties

Ultimate (ksi)	Yield (ksi)	Elongation (%)	Hardness (Rockwell)
145	90	12	C 36

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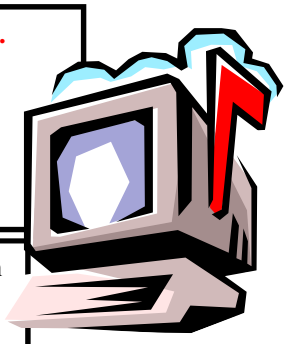

Specifications Listed

UNS	R30016	Co-Cr-W
Bar	AMS 5894	MCS 1012
	PWA 1196	XLO-PD-1089
Sheet	AMS 5894	MCS 1012
	PWA 1196	XLO-PD-1089
Plate	AMS 5894	MCS 1012
	PWA 1196	XLO-PD-1089

The typical properties listed on page one can be provided in rounds, sheet, strip & plate. We have the equipment to produce small quantities in special sizes to meet our customers' exacting needs.

See our GFM Edition Bulletin for further details on lead times & size capacities for production requirements.

Average Tensile Data

Test Temp. (°F)	Tensile (ksi)	0.2% Yield (ksi)	Elon. in 2" (%)
Room	146.0	91.6	11
1500	73.9	45.4	17
1600	55.8	39.2	18
1800	32.6	19.8	36
2000	19.5	10.9	44
2100	13.3	7.7	22

Average Stress Rupture and Creep Data

Test Temp	Stress	Initial Elongation	Life	Time in Hours for Total Elongation, % of:			Elongation at Rupture
(°F)	(ksi)	(%)	(Hrs.)	0.5	1.0	2.0	(%)
1000	60	0.70	192.8[1]	-	-	-	0.8
1200	50	0.45	361.4	0.5	113.8	-	3.0
1400	35	0.35	59.3	0.4	3.8	16.3	5.1
1500	25	0.35	70.6	0.2	4.3	19.9	4.7
1600	19	0.10	57.9	0.5	2.2	11.1	4.3
1700	12	0.19	104.0	1.8	20.9	89.9	2.6
1800	8	0.05	113.4	5.1	22.7	57.6	5.5
2000	2	0.004	116.7	4.4	-	-	13.3

[1]Test discontinued before rupture.

Average Compressive Strength

Form	Temp	Average Compressive Strength
1/2" Plate	Room	347 Ksi

Average Hot Hardness

Test Temperature	Brinell Hardness
1000°F	226
1200°F	203
1400°F	167
1600°F	102

Fusion Welding

Alloy 6B can be welded by gas tungsten-arc (TIG) with an argon flow of 25 CFH, gas metal-arc (MIG), shielded metal-arc (coated electrode), and oxy-acetylene in this order of preference. The oxy-acetylene method should be used with discretion and care in that alloy 6B will "boil" during welding which may cause porosity. Use a 3X reduction flame to minimize oxidation, penetration and inter-alloying.

Alloy 6B should be preheated and maintained at 1000ºF minimum to prevent cracking during welding and then still air cooled. Fixturing which would chill the weld rapidly should not be used. Standard weld joints are recommended. Alloy No. 25 filler metal is recommended for joining alloy 6B to softer materials such as carbon steel or stainless steel, while the harder cobalt-base filler metals such as No. 6 and No. 21 are recommended for joining alloy 6B to itself, especially if wear resistance is required in the weld areas. In the latter case, No. 25 may be used for the root passes and then be overlayed with the harder materials. Gas shielding of the root side of the gas tungsten-arc weldments is not mandatory but it is recommended in order to improve weld penetration.

High Performance Alloys can make hot rolled, cold worked, & strain hardened High Performance Stainless steel bars in house now. Ask for our GFM Bulletin for more information about our bar processing capabilities. We have expanded to enhance product availability. HPA also does a full line of high strength Nickel based Alloys.

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Brazing

Alloy 6B is readily joined to other materials by brazing. All forms of surface dirt such as paint, ink, oil, chemical residues, etc., must be removed from the mating parts by etching, solvent scrubbing, degreasing, or other means. In addition, fluxing will be required during torch brazing operations when using silver brazing filler metal, to help clean the joint and allow the filler metal to flow more freely over the mating surfaces. Brush joining areas generously with brazing flux prior to heating. When torch or induction brazing, as soon as the brazing filler melts, the source of heat should be removed and the parts positioned. The assembly should then be pressed together to squeeze out the excess flux and still air-cooled. The parts should not be quenched.

Other brazing filler metals (i.e., gold, palladium, or nickel-base alloys) are satisfactory for joining alloy 6B. Brazing filler metal selection depends on the service conditions expected.

A close fit of the mating surfaces is recommended. The finished joints will have greater strength if the filler metal is very thin, generally 0.001-0.005" thick.

Brazing, with high-temperature filler materials, is generally performed in a furnace. Induction and resistance heating with salt-bath and metal-bath dip brazing have limited application. Vacuum furnaces held at less than one micron pressure or controlled atmosphere furnaces, having adequate moisture control at brazing temperatures, produce the most satisfactory results. Controlled atmospheres such as hydrogen or cracked ammonia are suitable for brazing alloy 6B base materials.

Machining

Alloy 6B is generally machined with tungsten-carbide tooling, and will produce a finish of about 200-300 RMS. Carbide inserts are used with a 5-degree (0.9 rad.) negative tool holder and a 30-degree (0.52 rad.) or 45-degree (0.79 rad.) lead angle. Tools for facing or boring are essentially the same except for when greater clearances are needed. For best results in drilling, the drill web should be kept thin. Screw machine length, carbide tipped drills should be used. In reaming, a 45-degree (0.79 rad.) cutting lead angle should be used. High speed taps are not recommended for Alloy 6B but threads can be produced by EDM techniques. For better surface finish, this alloy should be ground.

6B is ground to obtain close tolerances with excellent finish properties. Do not quench dry ground material, as this may cause surface imperfections.

Wear Data

Average Abrasive Wear Data

Alloy	Condition	Wear Factor	Hardness
HPAlloys 6B	Annealed	0.072	Rc 38
L605	Annealed	0.535	Rc 24
1090 Steel	1 hr. 1600 ºF, WQ, 4 min. 900 ºF	0.368	Rc 55
316 SS	Annealed	0.796	Rb 86
304 SS	Annealed	0.914	Rb 92

Wear factor determined by dividing material wear rate by wear rate of 1020 hot rolled steel

Average Cavitation - Erosion Data

Alloy	Test Duration, hrs.	Weight loss, mg
HPAlloys 6B	100	42.3
304 SS	7	39.9

Average Coefficients of Static Friction for Common Materials

Material Against	HPAlloy 6B	Cast Iron	Bronze	Aluminum	Lead
HPAlloys 6B	0.119	0.123	0.125	0.138	0.119
Cast Iron	0.123	0.199	0.245	0.213	0.225
Bronze	0.125	0.245	0.231	0.257	0.249
Aluminum	0.138	0.213	0.257	0.213	0.328
Lead	0.119	0.225	0.249	0.328	0.290

Coefficient represents tangent of angle of repose. Test on dry surfaces having better than 120 grit finishes. All values based on averages and are to be used comparatively and not as absolute values.

Stock Sizes

Alloy	Bar	Sheet	Plate
6B	3/8" - 6"	0.062" - 0.125"	3/16" - 1/2"
6BH	Special Order	0.062" - 0.125"	5/32" - 3/16"

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HPAlloys Cobalt 6BH Product Description

Cobalt 6BH CoCrW
UNS R30016

Surpasses 6K with better ductility, with same good hardness. Cobalt 6BH is the same composition of Cobalt 6B, except the material is hot rolled and then age hardened. The direct age-hardening after hot rolling provides the maximum hardness and wear resistance. The advantages this creates are increased wear life, retained edge characteristics, and increased hardness. These properties are in addition to the galling and seizing resistance of the regular Cobalt 6B. Cobalt 6BH is known in the industry as a metal that retains its cutting edge. The economic advantages are in its long wear time, less down time, and fewer replacements.

Chemistry

Co	Cr	W	Mo	Ni	Mn	Fe	C
Bal.	28-32%	3.5-5.5%	1.5% Max	3% Max	2% Max	3% Max	0.90-1.40% Max

Mechanical Properties

Ultimate (ksi)	0.2% Yield (ksi)	Elongation (%)	Hardness (Rockwell)
195	121	4.5	C 42 - 49

General Data

HPA Cobalt 6BH Wear Resistant
UNS R30016 Co-Cr-W
Hot Worked, Aged, Air Cooled
Density 0.303 lb/in
Specific Heat (@ 72ºF) 0.101 Btu/lb/Deg F
Thermal Conductivity (32 to 212ºF) 103 Btu-in./sq. ft.-hr.-ºF
Electrical Resisitivity (68ºF) 546 Ohms/ cir mil ft

Applications

Applications for alloy 6BH include tile making machines, rock crushing rollers and cement and steel mill equipment. Alloy 6BH is well suited for valve parts, pump plungers, shafting and sleeves.

Food preparation machinery that cuts, chops, slices, dices and shreds uses Cobalt 6BH for its wear life, and minimal metal loses. The F.D.A. has issued approval for food contact due to its minimal metal loss, and government approval of cobalt containing equipment.

Cobalt 6BH is also use in non-food applications such as tire cord cutting, carpet cutting, trimming knives for ceramics, leather knives, surgical blades, and Kevlar. Other applications include saw blade tips, scrapper blades, chippers, shredders and other cutting edges.

Wrought alloy 6BH offers the fatigue resistance and toughness of a hot worked microstructure, with the heat corrosion and wear resistance of cobalt based alloy. High Performance Alloys, Inc. inventories sheet, and plate. Bar can be produced 1/2" through 2-1/2" diameter. Bar can be supplied in random lengths or cut to order. Sheet and plate offered as whole plates, or can be abrasive cut, or processed further using waterjet services.

Other applications are steam turbine erosion shields, chain saw guide bars, high temperature bearings, valve stems, food processing equipment, needle valves, centrifuge liners, hot extrusion dies, forming dies, nozzles, extruder screws, & many other miscellaneous wear surfaces.

Machining

Alloy 6BH is generally machined with tungsten-carbide tooling, and will produce a finish of about 200-300 RMS. Carbide inserts are used with a 5-degree (0.9 rad.) negative tool holder and a 30-degree (0.52 rad.) or 45-degree (0.79 rad.) lead angle. Tools for facing or boring are essentially the same except for greater clearances where needed. For best results in drilling, the drill web should be kept thin. Screw machine length, carbide tipped drills should be used. In reaming, a 45-degree (0.79 rad.) cutting lead angle should be used. High speed taps are not recommended for Alloy 6BH but threads can be produced by EDM techniques. For better surface finish, this alloy should be ground.

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