Wrought Wear-Resistant Alloys | Plate, Sheet and Bar

Stellite® 6B

Stellite® 6K

Deloro Stellite®

Deloro Stellite® is a global provider of innovative solutions to challenging wear problems. Our specialist products and services help extend the life of components in demanding environments where heat, corrosion and abrasion limit their life.

Deloro Stellite® is ISO certified and carries many other industry based approval ratings. Please see our website **www.stellite.com** for a current list.

Deloro Stellite® has been providing specialty wear resistant products for more than 100 years.

Stellite® 6B meets the requirements of Aerospace Material Specification AMS 5894. **Stellite® 6B** products are accompanied by full material certifications and are DFARS compliant.

Stellite® Alloys 6B and 6K

Stellite® Alloys are available in many different grades (chemical compositions) and several different processes or methods of manufacture. These different processes include casting, powder metal, hardfaced deposit, and wrought. The wrought or hot forging method of production gives the resulting material improved properties in the areas of:

- mechanical properties
- toughness
- wear resistance
- corrosion resistance

The following information describes the two wrought grades of Stellite® - **Stellite® 6B** and **Stellite® 6K**

Stellite® Alloy 6B *(Aerospace Material Specification AMS 5894)*

When it comes to tough wear resistant materials with **"guaranteed"** mechanical properties, **Stellite® 6B** is in a class by itself. Unlike many other materials that sacrifice toughness for wear resistance, **Stellite® 6B** offers both. The key is the extensive hot working processing of the material which transforms a brittle wear resistant ingot into tough wear resistant **Stellite® 6B**. With its excellent wear characteristics, hot hardness, good corrosion resistance, and superior mechanical properties, **Stellite® 6B** has been the material of choice for the most demanding wear applications. Whether your application involves high impact pulp agitators, critical directional drilling tools, or aerospace components, **Stellite® 6B** can offer superior wear resistance and the mechanical properties needed to withstand the toughest of applications. When it comes to your equipment, don't settle for anything less, use genuine **Stellite® 6B**.

Stellite® 6B is stocked in standard mill forms of **flat stock** ranging from 0.031" to 1.0" thick and **round bar** ranging from 0.312" through 6.0" diameter. Special sizing is available on request.

Stellite® Alloy 6K - *The Cutting Edge!!!*

Stellite® 6K has similar properties to **Stellite® 6B**, but is slightly harder and less ductile. **Stellite® 6K** is excellent for cutting or scraping applications such as knives or scraper blades. **Stellite® 6K** is a custom rolled material and can be produced to a gauge and sheet size uniquely suited to your application.

Stellite® 6K is available in flat stock ranging from 0.045" to 0.375" thick.

Available Forms

Stellite® 6B and **Stellite® 6K** are available in the form of sheet, plate, and fabricated shapes. **Stellite® 6B** is also available as bar stock. Deloro Stellite Inc. has the capability of providing components made from these materials to your drawing, machined to your specification. Ask us about our in house machine shop capabilities.

Resist Seizing and Galling

Stellite® 6B is resistant to the effects of seizing or galling. In many cases, its low coefficient of friction allows sliding contact with other metals without damage by metal pick-up. **Stellite® 6B** has been used in equipment where no lubricants were used because of the nature of the product being handled. Sleeves made of **Stellite® 6B** move smoothly, with a minimum of resistance, even when operating in contact with other metal parts. They have been useful in inaccessible areas where efficient lubrication is impossible. Sleeves and bushings have resisted seizing even when lubricants were diluted by gasoline, cleaning fluids, and other liquids that wash out an oil film. They have operated at peak efficiency even when lubricants decomposed under heat or were destroyed by abrasive particles.

Resist Erosive Wear

Parts made of **Stellite® 6B** have had long service life, even under constant erosive conditions. This material has outstanding resistance to cavitation-erosion. The wrought structure results in improved abrasion wear resistance comparable to much harder cast materials. **Stellite® 6B** used for steam turbine erosion shields has protected the blades of turbines for over 30 years of continuous service.

Good Impact and Thermal Shock Resistance

Stellite® 6B combines wear and corrosion resistance with good impact strength and resistance to thermal shock. The toughness of the wrought alloy depicted by its charpy impact energy goes up almost four fold compared to the cast version.

Resist Heat and Oxidation

High temperatures have little effect on the hardness, toughness, and dimensional stability of these alloys. They are highly resistant to atmospheric oxidation at ordinary temperatures, and have good resistance to oxidation at elevated temperatures.

Excellent Hot Hardness

Stellite® 6B retains high hardness, even at red heat. Once cooled back to room temperature, it recovers its full original hardness.

Corrosion Resistance

In addition to its wear-resistance, **Stellite® 6B** has good resistance to a variety of corrosive media. This combination of properties makes **Stellite® 6B** particularly useful in such applications as food handling machinery, chemical equipment, and others where both wear and corrosion resistance are necessary.

Heat Treatment

Wrought forms of **Stellite® 6B** and **Stellite® 6K** are supplied in the solution heat-treated condition unless otherwise specified. The standard heat treatment is at 2250°F (1232°C) followed by air cooling.

Available forms

	Stellite® 6B	Stellite® 6K
Round Bar Diameters	0.312 to 6.0 inches	Not Available in Bar Stock
Flatstock	Thickness = 0.031 – 1.0 inches Sheet Size = up to 36” x 96”	Thickness = 0.045 – 0.375 inches Sheet Size = custom rolled sizes

Certified Mechanical Properties.

Covers **Stellite®6B** in the form of sheet and plate up to 1 inch thickness and round bar up to 3.5" diameter.

Minimum Properties of Wrought Stellite® 6B

Property	Value
Tensile Strength	130 ksi (896 MPa) MIN
Yield Strength at 0.2% offset	70 ksi (483 MPa) MIN
Elongation in 4D	5% MIN
Reduction in Area	7% MIN
Hardness	33-43 HRC

Properties Data

The properties listed in this booklet are typical or average values based on laboratory tests conducted by the manufacturer. They are indicative only of the results obtained in such tests and should not be considered as guaranteed maximums or minimums. Materials must be tested under actual service conditions to determine their suitability for a particular purpose. All data represent the average of four or less tests unless otherwise noted. The secondary units (metric) used in this booklet are those of the SI system.

Chemical Composition, Percent

Stellite®	Cobalt	Nickel	Silicon	Iron	Manganese	Chromium	Molybdenum	Tungsten	Carbon
6B	Bal.	3.00*	2.00*	3.00*	2.00*	28.00-32.00	1.50*	3.50-5.50	0.90-1.40
6K	Bal.	3.00*	2.00*	3.00*	2.00*	28.00-32.00	1.50*	3.50-5.50	1.40-1.90

*Maximum

Average Physical Properties

Physical Properties	Temp., degrees C	Metric Units Stellite 6B	Metric Units Stellite 6K	Temp., degrees F	British Units Stellite 6B	British Units Stellite 6K
Hardness Limits	22	33-43 RC	40-42* RC	72	33-43 RC	40-42* RC
Typical		36-40 RC	43-47 RC		36-40 RC	43-47 RC
Density	22	Kg/m^3		72	lb/in.^{3}	
		8387	8387		0.303	0.303
Melting Range		1265 to 1354°C			2310 to 2470 deg. F	
Electrical Resistivity	22	microhm-m		72	microhm-m	
		0.91	-		36	-
Thermal Conductivity	22	watt-cm/sq. cm-deg. C		72	Btu-in/sq.ft.hr.-deg. F	
		0.147	-		103 (546 ohms per cir. mil. ft.)	-
Mean Coefficient of Thermal Expansion		x 10-6/m/m·K			microinches/in.-deg. F	
	0-100	13.9	13.8	32-212	7.7	7.7
	0-200	14.1	13.8	32-392	7.8	7.7
	0-300	14.5	13.8	32-572	8.0	7.7
	0-400	14.7	13.8	32-752	8.2	7.7
	0-500	15.0	13.8	32-932	8.3	7.7
	0-600	15.3	14.0	32-1112	8.5	7.8
	0-700	15.8	14.2	32-1292	8.8	7.9
	0-800	16.3	14.5	32-1472	9.1	8.1
	0-900	16.9	14.9	32-1652	9.4	8.3
	0-1000	17.4	15.5	32-1832	9.7	8.6
Electrical Conductivity Compared to Copper, percent	22	1.90	-	72	1.90	-
Specific Heat (calculated)	Room	J/kg•K	Room		Btu/lb-deg. F	
		423	-		0.101	-
Magnetic Permeability at 200 Oersteds (15.900 A/m)	22	<1.2	<1.2	72	<1.2	<1.2
Reflecting Power, percent		57-70	-		57-70	

*Minimum depending on gauge

Average Hot Hardness

Stellite®	Test Temp., deg. F	(deg. C)	Brinell Hardness at Temperature, Mutual Indentation Method
6B	1000	(538)	226
	1200	(649)	203
	1400	(760)	167
	1600	(871)	102

Average Compressive Strength

Stellite®	Form	Test Temp.	Average Compressive Strength Ksi (MPa)
6B	1/2-in. (12.7 mm), Plate [1]	Room	347 (2392)
6K	Sheet [1]	Room	325 (2241)

Average Modulus of Rupture

Stellite®	Form	Test Temp.	Average Modulus of Rupture Ksi (MPa)
6B	Sheet [1]	Room	338 (2360)

Average Modulus of Elasticity

Stellite®	Form	Test Temp.	Average Modulus of Elasticity psi x 10^6 (MPa)
6B	Sheet [1]	Room	30.4 (210,000)
6B	5/8-in. (15.9 mm), Bar	Room	31.1 (214,000)

Average Izod Impact Strength (un-notched)

Stellite®	Form	Test Temp.	Average Izod Impact Strength (un-notched) ft. lbs.	J
6B	1/2-in (12.7 mm), Plate [1]	Room	62	84

Average Charpy Impact Strength

Stellite®	Test Temp., deg. F (deg. C)	Type of Test	Average Charpy Impact Strength, ft. lbs. (J) Longitudinal		Transverse	
6B 1/2-in. (12.7 mm), Plate [1]	Room	Un-notched	72	(98)	65	(88)
		notched	6	(8)	-	
	1000 (538)	Un-notched	81	(110)	-	
		notched	15	(20)	-	
	1250 (677)	Un-notched	116	(157)	-	
		notched	15	(20)	-	
	1500 (816)	Un-notched	126	(171)	-	
		notched	15	(20)	-	

1 Solution heat-treated at 2250 deg. F (1232 deg. C), air cooled

Average Room Temperature Data - Stellite® 6B

FORM	Condition	Ultimate Tensile Strength, Ksi (MPa)	Yield Strength at 0.2% offset Ksi (MPa)	Elongation in 2 in. 50.8 mm, percent	Hardness, Rockwell C
Sheet, 0.040 in. (1.0 mm), thick	Solution Heat-treated*	145.0 (1000)[a]	90.1 (621)[a]	12[a]	36[a]
Sheet, 0.065 in. (1.7 mm), thick	Solution Heat-treated*	140.8 (971)[a]	86.7 (598)[a]	11[a]	36[a]
Sheet, 0.125 in. (3.2 mm), thick	Solution Heat-treated*	144.7 (998)[a]	89.8 (619)[a]	11[a]	37[a]
Sheet, 0.187 in. (4.8 mm), thick	Solution Heat-treated*	144.5 (996)[a]	89.3 (616)[a]	10[a]	37[a]

* Solution heat-treated at 2250 deg. F (1232 deg. C), air cooled.

a Average of 27-31 tests.

Average Tensile Data [1]

Stellite®	Form	Test Temp., deg. F	Test Temp., (deg. C)	Ultimate Tensile Strength Ksi	Ultimate Tensile Strength (MPa)	Yield Strength at 0.2% offset, Ksi	Yield Strength at 0.2% offset, (MPa)	Elongation in 2 in. 50.8 mm, percent
6B	0.063 in. (1.6 mm), Sheet	Room		146.0	(1007)	91.6	(632)	11
		1500	(816)	73.9	(509)	45.4	(313)	17
		1600	(871)	55.8	(385)	39.2	(270)	18
		1800	(982)	32.6	(225)	19.8	(137)	36
		2000	(1093)	19.5	(134)	10.9	(75)	44
		2100	(1149)	13.3	(92)	7.7	(53)	22
	1/2 in. (12.7 mm), Plate	Room		148.0	(1020)	88.0	(607)	7
		1000	(538)	133.0	(917)	58.5	(403)	9
		1250	(677)	115.0	(793)	60.6	(418)	9
	5/8 in. (15.9 mm), Bar	Room		154.1	(1063)	92.6	(638)	17*
		600	(316)	147.8	(1019)	74.5	(514)	30*
		1000	(538)	129.1	(890)	67.3	(464)	28*
		1500	(816)	75.4	(520)	46.5	(321)	28
		1600	(871)	58.3	(402)	37.9	(261)	34*
6K	0.063 in. (1.6 mm), Sheet	Room		176.5	(1217)	102.7	(708)	4
		1200	(649)	146.0	(1007)	-	-	8
		1500	(816)	70.2	(484)	44.5	(307)	17
		1800	(982)	34.1	(235)	19.3	(133)	28
		2000	(1093)	17.4	(120)	8.6	(59)	53

1 Solution heat-treated at 2250 deg. F (1232 deg. C), air cooled.

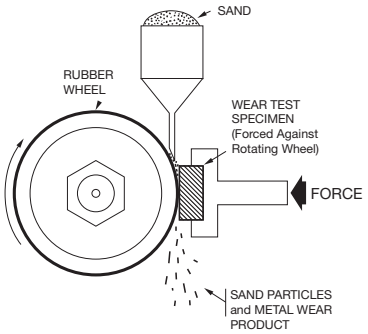
* Elongation, percent in 1 in. (25.4 mm).

Average Cavitation-Erosion Data

Alloy	Test Duration, hrs.	Weight loss, mg.
Stellite® 6B	100	42.3
Type 304 Stainless Steel	7	39.9

Average Abrasive Wear Data

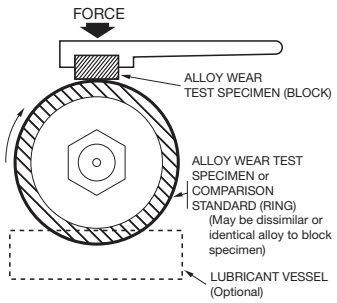
Alloy	Condition	Volume Loss, mm^3	Hardness, Rockwell	Wear Coefficient[1]
Stellite® 6B	Mill annealed	8.2	C-38	0.471×10^{-3}
Stellite® 6K	Mill annealed	13.3	C-46	0.946×10^{-3}
Stellite® 25	Mill annealed	53.0	C-24	2.00×10^{-3}
1090 Steel	1 hr. at 1600 deg. F (871 deg. C) water quenched + 4 min, at 900 deg. F (482 deg. C)	37.2	C-55	8.00×10^{-3}
Type 316 Stainless Steel	As received sheet	81.4	B-86	2.0×10^{-3}
Type 304 Stainless Steel	As received sheet	102.1	B-92	3.00×10^{-3}



ABRASIVE WEAR TEST UNIT (Dry Sand)

Average Adhesive Wear Data*

Alloy	Condition	Ring Alloy	Volume Loss, mm^3	Wear Coefficient[1]
Stellite® 6B	Mill annealed	4620 Steel	0.293	3.70×10^{-5}
Stellite® 6K	Mill annealed	4620 Steel	0.561	8.73×10^{-5}
Stellite® 25	Mill annealed	4620 Steel	0.285	2.50×10^{-5}
1090 Steel	1 hr. at 1600 deg. F (871 deg. C) water quenched + 4 min, at 900 deg. F (482 deg. C)	4620 Steel	0.293	6.00×10^{-5}



ADHESIVE WEAR TEST UNIT (Metal to Metal)

Average Coefficients Of Static Friction For Some Common Materials

Material Against	Stellite® 6B	Cast Iron	Bronze	Aluminium	Lead
Stellite® 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
Aluminium	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. Tests made on dry surface having better than 120 grit finishes. All values based on averages and are to be used comparatively and not as absolute values.

* Average of two or more tests against a case-hardened SAE 4620 steel ring (Rockwell C-63).

1 The wear coefficient (K) was calculated using the equation $V = \frac{KPL}{3h}$

where V = Wear volume (mm^3)

P = Load (kg)

L = Sliding distance (mm)

h = Diamond pyramid hardness

A combination of a low wear coefficient and a high hardness is desirable for good wear resistance.

Average Corrosion Data - Stellite® 6B*

Media	Concentration, percent by Weight	Test Temp., deg F (deg. C)	Average Penetration Rate per Year**	
			mils	mm
Acetic Acid	10	Boiling	0.08	0.002
Acetic Acid	30	Boiling	0.04	0.001
Acetic Acid	50	Boiling	0.02	<0.001
Acetic Acid	70	Boiling	0.06	<0.002
Acetic Acid	99	Boiling	0.03	<0.001
Chromic Acid	10	150 (66)	95	2.41
Formic Acid	10	Boiling	20	0.51
Formic Acid	30	Boiling	26	0.66
Formic Acid	50	Boiling	47	1.19
Formic Acid	70	Boiling	50	1.27
Formic Acid	88	Boiling	23	0.58
Hydrochloric Acid	2	Room	0.1	<0.003
Hydrochloric Acid	5	Room	63	1.60
Hydrochloric Acid	10	Room	108	2.74
Hydrochloric Acid	20	Room	93	2.36
Hydrochloric Acid	2	150 (66)	0.1	<0.003
Hydrochloric Acid	5	150 (66)	>1000	>25.4
Hydrochloric Acid	10	150 (66)	>1000	>25.4
Hydrochloric Acid	20	150 (66)	>1000	>25.4
Nitric Acid	10	Boiling	0.15	<0.004
Nitric Acid	30	Boiling	6	0.15
Nitric Acid	50	Boiling	>1000	>25.4
Nitric Acid	70	Boiling	>1000	>25.4
Phosphoric Acid	10	Boiling	Nil	Nil
Phosphoric Acid	30	Boiling	2	0.05
Phosphoric Acid	50	Boiling	19	0.48
Phosphoric Acid	70	Boiling	23	0.58
Phosphoric Acid	85	Boiling	611	15.5
Sodium Hydroxide	30	Boiling	13	0.33
Sulfuric Acid	10	Room	0.02	<0.001
Sulfuric Acid	30	Room	Nil	Nil
Sulfuric Acid	50	Room	0.4	0.01
Sulfuric Acid	77	Room	0.7	0.02
Sulfuric Acid	10	150 (66)	0.02	<0.001
Sulfuric Acid	30	150 (66)	0.09	<0.003
Sulfuric Acid	50	150 (66)	>1000	>25.4
Sulfuric Acid	77	150 (66)	176	4.5
Sulfuric Acid	2	Boiling	31	0.79
Sulfuric Acid	5	Boiling	91	2.31
Sulfuric Acid	10	Boiling	157	3.99
Sulfuric Acid	20	Boiling	360	9.14
Sulfuric Acid	50	Boiling	>1000	>25.4
Sulfuric Acid	30	Boiling	>1000	>25.4
Sulfuric Acid	77	Boiling	>1000	>25.4
Ferric Chloride (10 days without crevice)	10	Room	13	0.33***
Ferric Chloride (10 days with crevice bolt)	10	Room	9**	0.23***
Ferric Chloride + Sodium Chloride (10 days)	5 10	Room	18	0.46***
Potassium Permanganate + sodium Chloride (120 hrs)	2 2	194 (90)	8	0.20

* Determined in laboratory tests. It is recommended that samples be tested under actual plant conditions.

** Corrosion rates for all duplicate samples based on an average of 4-24 hour test periods.

*** Samples pitted during test.

Average Stress Rupture and Creep Data

Stellite®	Test Temp.,		Stress		Initial Elongation, percent	Life, hrs.	Time in hours for total Elongation, % of:			Elongation at Rupture, percent
	deg. F	(deg. C)	Ksi	(MPa)			0.5	1.0	2.0	
	1000	(538)	60	(414)	0.70	192.8[1]	-	-	-	0.8
	1200	(649)	50	(345)	0.45	361.4	0.5	113.8	-	3.0
6B	1400	(760)	35	(241)	0.35	59.3	0.4	3.8	16.3	5.1
0.063 in. (1.6	1500	(816)	25	(172)	0.35	70.6	0.2	4.3	19.9	4.7
mm),	1600	(871)	19	(131)	0.10	57.9	0.5	2.2	11.1	4.3
Sheet[2]	1700	(927)	12	(83)	0.19	104.0	1.8	20.9	89.9	2.6
	1800	(982)	8	(55)	0.05	113.4	5.1	22.7	57.6	5.5
	2000	(1093)	2	(14)	0.004	116.7	4.4	-	-	13.3

1 Test discontinued before rupture.

2 Specimens were solution heat-treated at 2250 deg. F (1232 deg. C) and air cooled prior to testing.

Fusion Welding

Stellite® 6B and **Stellite® 6K** 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 Stellite will "boil" during welding which may cause porosity. Use a 3x reducing flame to minimize oxidation, penetration, and inter-alloying.

Stellite® 6B and **Stellite® 6K** should be preheated and maintained at 1000°F (358°C) 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. **Inconel®** 82, 92, or 625 filler metals are recommended for joining **Stellite® 6B** to softer materials such as carbon steel or stainless steel, while the harder cobalt-base filler metals such as **Stellite® 6** and **Stellite® 21** are recommended for joining **Stellite® 6B** to itself, especially if wear resistance is required in the weld areas. In the latter case, **Inconel®** 82, 92, or 625 may be used for 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 is recommended in order to improve weld penetration.

Adequate ventilation is required to control exposure to airborne dust, fumes, and particulate when machining, grinding or welding Stellite alloys. MSDS sheets are available.

Brazing

Stellite® 6B and **Stellite® 6K** are 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 metal 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-based alloys) are satisfactory for joining **Stellite® 6B** and **Stellite® 6K**. 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" (0.03 - 0.13 mm) 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 (less than 60° F (15°C) dew point), produce the most satisfactory results. Controlled atmospheres such as hydrogen or cracked ammonia are suitable for brazing **Stellite® 6B** and **Stellite® 6K** base materials.

Sketch / Notes:

CUSTOMER SERVICE

For immediate service, call us toll free!
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www.stellite.com

- **Deloro Stellite®** provides full in-house machining capabilities.
- Stock-to-dock, many items may be shipped from stock.
- Waterjet and laser cutting equipment allows for custom shapes from sheet and plate stock.

Deloro Stellite®

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