

GRAPHALLOY®

TECHNICAL SPECIFICATIONS
AND DESIGN INFORMATION



- | SELF-LUBRICATING
- | SOLID LUBRICATION
- | LOW, CONSTANT COEFFICIENT OF FRICTION
- | LONG WEARING
- | NON-CORROSIVE
- | NO FUMES
- | SUBMERSIBLE



Graphite Metallizing Corporation
www.graphalloy.com
+1.914.968.8400

TYPICAL APPLICATIONS OF GRAPHALLOY® BUSHINGS

Aerospace	Current-carrying, instruments, aircraft, fuel control valves, fuel pumps, HVAC.
Board	Plywood, particle board, gypsum board, paper board.
Cement/Ceramic	Kilns.
Combustion	Combustion controls, blowers, fans, louvers, dampers.
Conveyor	Roller, high temperature, chain, traction wheel, overhead, screw.
Dryer	High temperature, roller and conveyor, veneer, plywood, paint, gypsum board.
Electronic	Current-carrying bearings, rolling contacts, welders, platers, switchgear, potentiometers, relays.
Explosives	Non-sparking, conveyors.
Food and Drug	Agitators, conveyors, mixers, ovens, coolers, dryers, foot bearings, canning, packaging and packing, steam cleaning and washer equipment.
Forest Products	Refuse burners, sawmills, veneer dryers, saw guides.
Foundries	Kiln cars.
Glass	Lehrs, stirrers, conveyors.
Instrument	Relays, timers, recorders, no meniscus drag.
Liquid Gas	Cryogenic pumps, valves.
Machinery	Conveyors, power transmission, textile, mixers, printing, pumping, plating, refrigeration, and washing equipment.
Metering	Gasoline, JP-4 and water meters, flow meters.
Mining	Conveyors, pumps.
Mixing	Submerged bearings.
Nuclear	Radioactive and contaminated areas, demineralized water, high temperature water, pumps.
Oven and Furnace	Baking, heat treating, annealing, drying, kiln cars, idler sprockets, conveyors, doors.
Paint	Spraying, conveyors, dryers.
Paper and Pulp	Submerged bushings, dryers, pulpers, agitators, pumps, liquids, Fourdriniers, dry cans.
Petrochemical	Pumps, reactors, mixers.
Plastics and Rubber	Extruders, mold bushings.
Power Generation	Boiler feed, condensate, reactor coolant, circulating water and general service water pumps, dampers, louvers, air control, trash screens, conveyors and soot blowers.
Printing	Feed rolls, paper cutting, folding, delivery.
Pump	Bearings, seals, blades, JP-4, gasoline, fuel oil, water, chemicals, liquid gases and metals, deep well, horizontal, vertical, multistage, sump, irrigation pumps.
Scale	Conveyor weighing and stationary.
Steel	High temperature and submerged, continuous casting machines, pulleys, cooling beds.
Textile	Dyeing, washing, looms, redoublers, spinners, twisters, winders, drying, expanding, mercerizing, singeing, slashing, picking, tufting, quilting, sanforizing and finish equipment.
Turbine	Steam, hydraulic, gas, valve bushings, control linkages.
Valve	Stem, support, control.
Ventilating	Louvers, ventilating ducts, exhaust systems, blowers, fans.
Water Treatment	Water and sewage.
Wire	Drawing, japanning, insulating, baking, tinning.



GRAPHALLOY® | WORKS WHERE OTHERS WON'T

TECHNICAL SPECIFICATIONS AND DESIGN INFORMATION

GRAPHALLOY can be the solution to your toughest bearing, bushing, thrust washer, cam follower, or pillow block bearing design problems.

GRAPHALLOY, a graphite/metal alloy, is a family of materials used to manufacture bearings, bushings and other components for machinery, pumps and process equipment.

These materials are solid, uniform, self-lubricating, non-galling and operate in temperature extremes from -400° F (-240° C) to 1000° F (535° C) with a low coefficient of friction. GRAPHALLOY consists of graphite in solid form, the pores of which have been filled with metal. These bearings contain no oil and require no oil, but depend on the combined metallic and graphite structures for their lubrication and durability.

GRAPHALLOY bearings are long-lasting. Operating where oil and grease lubricated bearings seize and where plastics fail, GRAPHALLOY materials provide lifetime cost savings and significant operating advantages over conventional bearing materials. In some applications, these bearings have operated for up to 20 years without maintenance.

GRAPHALLOY is available in over 100 grades with specific properties that meet a wide range of engineering solutions and specifications.

FDA accepted grades are available for food contact equipment. NSF® International has certified grades for use in municipal well and water treatment applications.

Standard designs are available as pillow blocks, cam followers and bushings. More often, bushings are custom designed to the unique requirements of a specific OEM or retro-fit application.

GRAPHALLOY is the registered name for graphite/metal alloy materials manufactured by Graphite Metallizing Corporation under ISO 9001 certification.

GRAPHALLOY is designed for the wide variety of bushing applications where true self-lubrication is vital. Various grades of Babbitt, Copper, Bronze, Iron and Nickel GRAPHALLOY are employed as materials for pump bushings, rotating shaft seal rings, pump vanes and similar applications where they must operate

submerged in water, gasoline, hydrocarbons, cleaning fluids, hot oil, acids, alkalies or dyes.

For high-temperature applications such as ovens, oven conveyors and annealing furnaces, where ordinary lubricants would fail, GRAPHALLOY bushings are well known for their long life and trouble-free operation. There are GRAPHALLOY installations that have been in operation for over twenty years.

For moderate to very low temperatures, GRAPHALLOY bushings are equally effective for their dependability. They have been used in liquid gas applications to -452° F (-269° C).

In remote locations and in applications where lubrication is difficult or impossible to supply, such as cam rollers, vertical shaft guide bushings or dampers, GRAPHALLOY bushings are widely used. Where oil lubrication must not be used because of contamination of the food or other products being processed, GRAPHALLOY bushings provide a solution. With GRAPHALLOY there is no production loss as the result of bushing failure, product spoilage, replacement cost or maintenance cost.



ADVANTAGES OF GRAPHALLOY® BUSHINGS

Self-Lubricating: During operation, GRAPHALLOY bushings deposit a thin film of GRAPHALLOY on the shaft. This thin film supplies lubrication which is maintained for years of continuous operation (no oil is required).

Extremely Durable: GRAPHALLOY bushings have been in continuous service on many applications for ten to twenty years without replacement. Their dependability has been thoroughly demonstrated.

No Fumes: Operating at the recommended temperatures and loads, GRAPHALLOY bushings do not produce fumes or odors. They can be used with confidence where oil or other lubricants might cause contamination.

Low and High-Temperature Operation: GRAPHALLOY bushings are in regular use at temperatures as high as 750°F (400°C) and as low as the temperature of liquid helium. At such temperatures, most oils tend to carbonize (high) or solidify (low). These temperatures far exceed the range of plastic bushings.

Fire Preventive: GRAPHALLOY bushings are invaluable for use where oil might ignite or where sparks might cause explosion.

Low Coefficient of Friction: GRAPHALLOY bushings have a constant and low coefficient of friction. This coefficient changes little with use because GRAPHALLOY is not a surface treatment. GRAPHALLOY contains nothing to dry out or to become viscous or gummy.

Submersible: GRAPHALLOY bushings operate extremely well in fresh or salt water, gasoline, jet fuels, cleaning fluids, solvents, bleaches, caustic solutions, dyes, hydrocarbons, liquid gases and most chemicals where ordinary bushings would corrode or seize. GRAPHALLOY does not swell.

Low Coefficient of Expansion: Because they are composed of a large proportion of graphite, GRAPHALLOY bushings have a coefficient of linear thermal expansion about one-half of steel. Accordingly, a correctly designed GRAPHALLOY bushing will not seize the shaft over a wide range of operating temperatures.

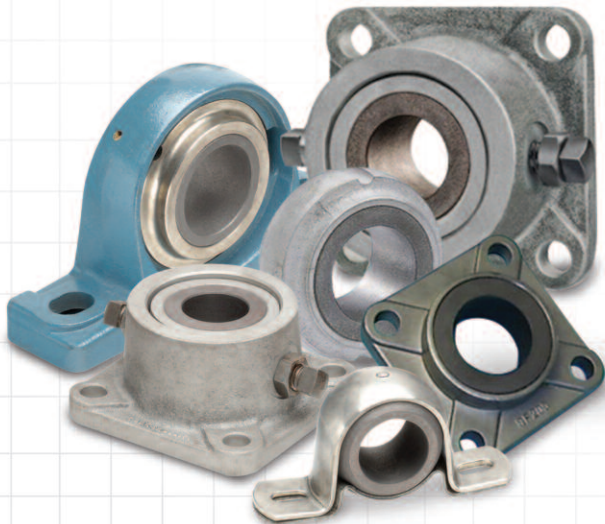
High Speeds: Speeds to 200,000 RPM have been attained with air or gas lubrication.

High Loads: Where grease would be squeezed out or vibrated out and where plastics would deform, GRAPHALLOY remains in place and does not cold flow.

Non-Galling: GRAPHALLOY bushings will not gall or weld in high speed contact, unlike some metallic combinations.

Linear Motion: Linear motion wipes away oil or grease lubrication and collects contaminants. GRAPHALLOY stays in place and lubricates.

Corrosion: The thin film of GRAPHALLOY deposited on the shaft inhibits corrosion of the shaft.



GENERAL FAMILIES OF GRAPHALLOY®

TECHNICAL SPECIFICATIONS AND DESIGN INFORMATION

BABBITT GRAPHALLOY: For operating temperatures up to 300° F (150° C) and applications in inaccessible places or where oil or grease cannot be used. Babbitt GRAPHALLOY excels in medium load-medium speed or medium load-high speed applications, pump bushings, thrust washers and rotary seal rings.

COPPER GRAPHALLOY: For higher operating temperatures up to 750° F (400° C), Copper GRAPHALLOY is ideally suited for applications where ordinary lubrication cannot be used. It is most commonly used in low speed-heavy load applications such as drying oven conveyor bushings, high temperature stirring shafts and agitators. As a material for current-carrying bushing applications, Copper GRAPHALLOY is an excellent solution.

BRONZE GRAPHALLOY: This material is used for many special applications and is particularly useful for miniature bushings and water wells. Bronze GRAPHALLOY provides a higher temperature limit with most of the benefits of Babbitt GRAPHALLOY.

SILVER GRAPHALLOY: This material is recommended for many of the most difficult self-lubricating bushing and current carrying applications. Although it is primarily an electrical contact and brush material, it can be used as a bushing material in chemical solutions which attack other lubricants or metallic bushings.

ANTIMONY GRAPHALLOY: For low friction applications at higher temperatures.

NICKEL GRAPHALLOY: For chemical and other applications requiring broad chemical inertness with exceptional toughness. Nickel GRAPHALLOY is widely used in industrial pumps.

SPECIAL GRAPHALLOYS: For special conditions, new types of GRAPHALLOY are being developed to meet the needs of a wide variety of industries.

- GMGDG-2 for temperatures above 750° F (400° C) in air. GRAPHALLOY grades, specially treated with antioxidants, provide extended life.
- FDA Acceptable Food Contact machinery grades have been developed to meet these challenging requirements.
- NSF approved grades are available for drinking water systems.



Typical Physical Characteristics of Some of the More Commonly Used GRAPHALLOY Grades

GRAPHALLOY Material	Maximum Ambient Temperature In Air	In Non-Oxidizing Atmospheres or Submerged	Typical Coefficient of Thermal Expansion x10 ⁻⁶ in/in/°F
BABBITT	300° F (150° C)	300° F (150° C)	3.0
COPPER	750° F (400° C)	1700° F (925° C)	3.1
BRONZE	750° F (400° C)	1600° F (875° C)	3.1
NICKEL	750° F (400° C)	1700° F (925° C)	3.7
SILVER	750° F (400° C)	1500° F (810° C)	3.7
GRAPHALLAST	150° F (65° C)	150° F (65° C)	N/A
ANTIMONY	550° F (285° C)	550° F (285° C)	3.2

Coefficient of Friction: When a GRAPHALLOY bushing runs dry in contact with a well polished shaft, the friction coefficient varies from .1 to .4, depending on the grade. The coefficient is quite constant for varying speeds. When submerged in water, gasoline, hydrocarbons, and most liquids, the coefficient of friction drops to about 1/10 that of the dry coefficients given above.

Hardness: The Scleroscoped "D" Hardness is within the range of 30 to 100 depending on the grade.

Tensile Strength: 3000 to 6000 psi, depending on the grade

Compressive Strength: 12,000 to 25,000 psi, depending on the grade.

Density: The density of GRAPHALLOY varies from 1.7 to 3.5, depending on the grade.

SPEED vs LOAD

Bearings designed within the limits of the following formula will give satisfactory service in most dry applications:

$$\frac{\text{RPM} \times \text{W}}{\text{L}} < 46,000$$

Where: **RPM** = Shaft speed
W = Total shaft load (in lbs, not psi)
L = Bushing length, inches

The formula is based on a conservative "PV" factor of approximately 12,000, where P is in psi bearing load and V is in feet per minute shaft surface speed. However, for many special combinations of speed and load, the values given by the formula can be considerably exceeded. For submerged bushings, running on a liquid film, the values can usually be increased by a factor of 7 to 10. GRAPHALLOY bushings have been operated at 60,000 RPM submerged. With gas lubrication, speeds of 200,000 RPM have been attained.

PREFERRED BUSHING SIZES

If possible, designs should specify bushings in even 1/8" dimensions (1/16" if necessary) to take advantage of available mold sizes. Length is usually 1-1/2, 2, 3, or 4 times OD of shaft. Refer to Data Sheets DS117 and DS453 for typical sizes; available upon request.

WALL THICKNESS

For typical applications, the recommended wall thicknesses are:

1/8" (3mm) for shafts 1/8"-7/16" (3-11mm)
3/16" (4.5mm) for shafts 1/2"-1-1/16" (12-27mm)
1/4" (6mm) for shafts 1-1/8"-1-7/8" (28-49mm)
5/16" (8mm) for shafts above 2" (50mm)

For miniature bushings, the wall thickness should not be less than:

1/16" (1.5mm) for shafts .046"- .090" (1-2.2mm)
5/64" (2mm) for shafts .091"- .125" (2.2-3.1mm)
3/32" (2.5mm) for shafts .126"- .187" (3.1-4.7mm)

For heavy loadings – For bushings where the shaft's loading is between 500 and 1000 psi, the wall thickness should be 3/8" minimum and normally 1/2" to 5/8", depending upon length of the bushing and the load.

Bushings for these relatively high loadings should generally be used with slow-moving shafts, and the shaft speed generally should not exceed the value obtained from the above formula.

INSTALLATION

A GRAPHALLOY® bushing is usually mounted by pressing into a housing by means of an arbor or hydraulic press. The housing ID should have a finish of at least /32 and the ID should be chamfered 1/32 x 45°. See DS1131 (available upon request) or our installation video at www.graphalloy.com/installation.

ALLOWANCES FOR PRESS FIT

Standard practice is to supply GRAPHALLOY bushings oversized on the OD to allow the bushing to be pressed into the housing.

At operating temperature, the press fit should be:

Diameter	Press Fit
less than 3/8" (10mm)	+ .002" to .003" (+.05 to .08mm)
3/8" to less than 2-1/2"	+ .002" to .004" (+.05 to .10mm)
2-1/2" to less than 6"	+ .003" to .005" (+.08 to .13mm)

Inside Diameter

The ID of the bushing shrinks when the OD is pressed into a housing by nearly 100% of the OD press fit. GRAPHALLOY bushings, therefore, are supplied with the bore increased by the amount necessary to provide the correct bore size after installation.

RUNNING CLEARANCES

To provide recommended running clearance after pressing into the housing, bushings are normally supplied with the bore slightly larger.

SPECIAL RUNNING CLEARANCES

For ovens and conveyors, where dust or abrasive particles quickly destroy ordinary bushings, GRAPHALLOY bushings have become practically standard equipment. For these applications, the following clearances are recommended:

Babbitt GRAPHALLOY	.004" to .006" (.10 to .15mm)
Copper GRAPHALLOY	.008" to .010" (.20 to .25mm)
Bronze GRAPHALLOY	.005" to .010" (.13 to .25mm)
Nickel GRAPHALLOY	.005" to .010" (.13 to .25mm)

Submerged GRAPHALLOY bushings are successful where oil lubrication is impossible or where conventional bushings and bearings would quickly break down. For such applications, the following clearances are recommended:

Water, alcohol, plating solutions, etc.	.003" to .005" (.08 to .25mm)
Fish oil and other light oils or hot oils	.008" to .010" (.20 to .25mm)
Very heavy oils or viscous liquids	.015" to .020" (.38 to .50mm)



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Where sludge is likely to be present, clearances of .015" to .020" (.35 to .50mm) should be used. In some extreme cases, longitudinal grooves may be necessary on the ID to enable the liquid to wash through and prevent clogging. ID grooves parallel to the bushing's axis are usually provided. Spiral ID grooves are used to produce pumping or washing action through the bushing.



STANDARD TOLERANCE

For dimensions of less than 6" (150mm), tolerances of $\pm .001$ (.025mm) are standard on OD's and ID's $\pm .005$ (.125mm) on lengths. Tighter tolerances can be provided.

MAXIMUM OD OF GRAPHALLOY BUSHING

The usual maximum OD of bushings is 15" (350mm). Larger sizes can be manufactured under special conditions. Typically, sizes larger than 10" (250mm) in diameter are supplied in housings to reduce the incidence of breakage on installation.

SHAFT MATERIAL

A rough or worn shaft will reduce the life of the bushing. Smooth cold-rolled shafting is satisfactory for use with the precision bore of GRAPHALLOY bushings and without any further polishing of the shaft for normal applications. However, a hardened, ground shaft is preferable. In general, the better the shaft finish, the longer the life of the bushing. For most applications, the recommended hardness for longest life is R/C 55-60, with surface finish 8 to 16 microinches.

Where moisture is present and the shaft rotation is intermittent, a stainless steel or bronze shaft is recommended to prevent the steel shaft from rusting and becoming rough. When bronze shafts are to be run dry, special GRAPHALLOY grades are recommended. If a chrome-plated shaft is to be used, it should be ground after plating, to insure the smoothest possible bearing surface.



STEEL SLEEVES

Where a shaft is rough or worn, steel sleeves can be fitted over the shaft. Steel sleeves (or stainless steel sleeves), should be hardened and polished.

GROOVES

Bushings can be supplied with straight or spiral grooves to help assure liquid passes through the ID of the bushing and/or that abrasive particles are removed. Standard grooves are .06" deep (1.5mm radius x 1.5mm deep). Grooves should always have a round cross section.

SPECIAL BUSHINGS

Split bushings can be supplied where bushings must be installed in halves.



Double-flanged bushings are split to assemble over a shaft.



Metal-backed bushings are available for applications where press-fitted bushings are not practical. These are usually used where a set screw or keyway is necessary to hold the bushing in place.



Pillow blocks fitted with GRAPHALLOY bushings can be supplied in most standard sizes. Stainless steel pillow blocks are available. See DS995, available upon request.



ORDERING INFORMATION

While the above information will serve as a guide in specifying or ordering GRAPHALLOY materials, best results will usually be obtained by using the Inquiry Form on our website - www.graphalloy.com - or by contacting our engineers at 914-968-8400 or at sales@graphalloy.com. We are glad to make specific recommendations based on our many years of industrial application experience. In most cases, samples can be supplied for immediate tests.

TYPICAL APPLICATIONS OF GRAPHALLOY® BUSHINGS

GRAPHALLOY is a family of materials manufactured by Graphite Metallizing Corporation. GRAPHALLOY offers superior performance in thousands of mechanical and electrical applications. Graphite Metallizing Corporation offers a complete line of standard and custom-designed GRAPHALLOY products. For more information, call our sales engineers or visit our website.

GRAPHALLOY PRODUCTS

117

General Purpose Bushings



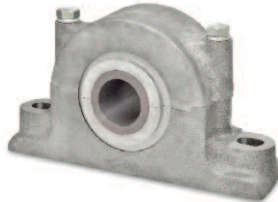
317

Flange Type Bushings



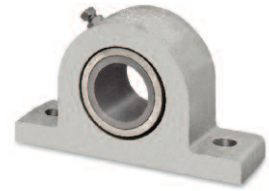
414

2-Bolt "Split" Self-Aligning Pillow Block for Shafts 5/8" to 3-1/4"



448-3

2-Bolt Pillow Block Self-Aligning for Shafts 5/8" to 2-1/4"



448-5

Flange-Type 4-Bolt Self-Aligning Pillow Block for Shafts 5/8" to 2-1/4"



453

High-Temperature Bushings



517

Flange-Type 3-Bolt Self-Aligning Bushing Assembly for Shafts 1/2" to 2-1/2"



553

High-Temperature Thrust Washers



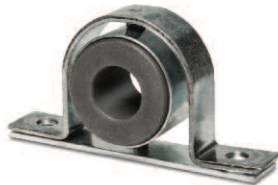
563

Flange-Type 4-Bolt Pillow Block for Shafts 1/2" to 2"



675

Strap Type 2-Bolt Self-Aligning Pillow Block for Shafts 1/2" to 1-1/4"



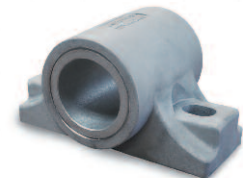
845

Spherical Inserts for Standard Flange Blocks & Pillow Blocks



963

Stainless Steel 2-Bolt Pillow Block for Shafts 1" to 1-5/16"



Experienced Designers Specify GRAPHALLOY Bushings

- Self-Lubricating • Extremely Durable • Non-Fuming
- Low Coefficient of Expansion • Low and Constant Coefficient of Friction
- Operate in Extremely High or Low Temperatures
- Operate in Water, Petrochemicals, and Most Chemical Solutions



Graphite Metallizing Corporation

1050 Nepperhan Avenue
Yonkers, New York 10703 USA
+1.914.968.8400
sales@graphalloy.com

www.graphalloy.com

ISO 9001 Certified • NSF Certified Grades • FDA Acceptable Grades

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