Designation: B 782 – 00

Standard Specification for Iron Graphite Sintered Bearings (Oil-Impregnated)[1]

This standard is issued under the fixed designation B 782; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers iron-base sintered metal powder, oil-impregnated bearings. There are two grades, depending on the level of combined carbon (see Table 1):

1.1.1 *Grade 1, Iron Graphite*—low combined carbon and

1.1.2 *Grade 2, Iron Graphite*—high combined carbon.

1.2 The values stated in inch-pound units are the standard. The metric equivalents of inch-pound units may be approximate.

NOTE 1—Definitions of powder metallurgy terms can be found in Definitions B 243. Additional useful information is available in the Related Material section of Vol 02.05 of the *Annual Book of ASTM Standards*.

NOTE 2—Information on design, permissible loads, dimensional tolerances, and recommended press fits and running clearances are provided in Appendix X1.

2. Referenced Documents

2.1 *ASTM Standards:*

B 243 Terminology of Powder Metallurgy[2]

B 328 Test Method for Density, Oil Content, and Interconnected Porosity of Sintered Powder Metal Structural Parts and Oil-Impregnated Bearings[2]

E 9 Test Methods of Compression Testing of Metallic Materials at Room Temperature[3]

E 1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel and in Iron, Nickel, and Cobalt Alloys[4]

3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

3.1.1 Grade (Table 1),

3.1.2 Dimensions, and

3.1.3 Certification (see Section 13).

TABLE 1 Chemical Requirements

Element	Composition, %	
	Grade 1	Grade 2
Iron, min	94.5	94.5
Graphite	2.0 to 3.0	1.5 to 2.5
Total other elements by difference, max	2.0	2.0
Combined carbon	0 to 0.5	0.5 to 1.0

4. Materials and Manufacture

4.1 Bearings shall be made by cold compacting and sintering metal powders, with or without sizing, to produce finished parts conforming to the requirements of this specification.

5. Chemical Composition

5.1 The material shall conform to the requirements prescribed in Table 1.

6. Physical Properties

6.1 *Density*—The density of bearings supplied fully impregnated with lubricant shall be within the limits prescribed in Table 2. Density determinations shall be made in accordance with Test Method B 328.

6.2 *Oil Content*—Oil content of bearings shall not be less than 18 % for each grade when determined in accordance with Test Method B 328.

7. Mechanical Properties

7.1 *Radial Crushing Force*:

7.1.1 Radial crushing force shall be determined by compressing the test specimen between two flat steel surfaces at a "no load'' speed no greater than 0.2 in./min (5 mm/min), the direction of the load being normal to the longitudinal axis of the specimen. The point at which the load drops as a result of the first crack shall be considered the crushing strength. This test shall be applied to plain cylindrical bearings. Flanged bearings shall be tested by cutting off the flange and compressing the two sections separately. Each section shall meet the minimum strength requirements prescribed in Table 3.

7.1.2 Radial crushing force shall not be less than the value calculated as follows:

$$P = KLT^2/(D - T) \quad (1)$$

[1] This specification is under the jurisdiction of ASTM Committee B-9 on Metal Powders and Metal Powder Products and is the direct responsibility of Subcommittee B09.04 on Bearings.

Current edition approved October 10, 2000. Published December 2000. Originally published as B 782 – 88. Last previous edition B 782 – 94 (1999).

[2] *Annual Book of ASTM Standards*, Vol 02.05.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

[4] *Annual Book of ASTM Standards*, Vol 03.06.

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TABLE 2 Density and Oil Content Requirements

Grade	Density, g/cm^3		Oil Content, Vol
	min	max	min, %
1	5.6	6.0	18
2	5.6	6.0	18

TABLE 3 Strength Constants

Grade	*K* Strength Constant	
	min	max
1	10 000 psi (69 MPa (N/mm^2))	25 000 psi (172 MPa (N/mm^2))
2	16 000 psi (110 MPa (N/mm^2))	45 000 psi (310 MPa (N/mm^2))

where:

P = radial crushing force, lbf (N);
D = outside diameter of bearing, in. (mm);
T = wall thickness of bearing, in. (mm);
K = strength constant as shown in Table 3 for the grade specified, psi (MPa (N/mm^2)); and
L = length of bearings, in. (mm).

7.1.3 Concerning spherical bearings, sample parts from a lot will be machined to a straight wall and radially crushed to calculate the *K* value. Sample parts from the same lot will be radially crushed as is (whole part). By correlation, the minimum radial crush value will be established on the whole bearing and so specified as the minimum radial crush value for the part.

8. Workmanship, Finish, and Appearance

8.1 Bearings shall be uniform in composition. When cut or fractured, the exposed surface shall be of uniform appearance.

9. Sampling

9.1 *Lot*—Unless otherwise specified, a lot shall consist of parts of the same form and dimensions made from powders of the same composition, formed and sintered under the same conditions, and submitted for inspection at one time.

9.2 *Sample for Chemical Analysis*—If required, at least one sample for chemical analysis shall be taken from each lot. A representative sample of chips may be obtained by milling, drilling, or crushing at least two pieces with clean dry tools without lubrication. If the parts are not completely dry, the parts selected for test shall have the oil extracted in accordance with Test Method B 328.

9.3 *Mechanical Tests*—The manufacturer and purchaser shall agree on a representative number of specimens for mechanical tests.

10. Analytical Methods

10.1 *Carbon Analysis*—Carbon analysis is a procedure for determining the total, the graphitic, and the combined carbon in iron-graphite sintered bearings.

10.1.1 *Oil Extraction*—Parts must be dry and free of oil before running tests. The preferred method of oil extraction is by the Soxhlet apparatus method specified in Test Method B 328. Upon agreement between purchaser and supplier, a low-temperature furnace (approximately 1000°F) with a nitrogen or inert atmosphere may be used.

10.1.2 *Total Carbon*—Obtain total carbon in accordance with Test Method E 1019 with the exception of a ¼-g sample may be used upon agreement between customer and supplier.

10.1.3 *Graphitic Carbon*—The amount of graphitic carbon is found using the following procedure: Weigh and transfer a ¼-g sample to a 400-mL beaker. Add 25 mL of distilled water. Carefully add 25 mL of concentrated nitric acid and gently boil until all the iron is in solution. At this point, add five to ten drops of 48 % hydrofluoric acid to ensure complete solubility of all carbides, silicates, and so forth. Filter the solution through a porous combustion crucible, wash with hot water until free of acid, then once with ethyl alcohol. Dry at 100°C for 1 h. After drying, add approximately 1 g of carbon-free iron chips and 1 g of copper chips (or another approved accelerator) and follow the procedure for determining the total carbon.

10.1.4 *Combined Carbon*—To obtain the amount of combined carbon, subtract the amount of graphitic carbon from the total carbon.

10.1.5 *Alternative Method of Determining Combined Carbon*—The combined carbon may be a metallographic estimate of the carbon in the material.

11. Inspection

11.1 Unless otherwise specified, inspection of parts supplied on contract shall be made by the purchaser at the destination.

12. Rejection

12.1 Rejection based on tests made in accordance with this specification shall be reported in writing to the manufacturer within 30 days of receipt of shipment; however, the rejected parts should not be returned without authorization from the producer.

13. Certification

13.1 A certification based on the manufacturer's quality control that the material conforms to the requirements of this specification shall be the basis of shipment of the material. A certificate covering the conformance of the material to these specifications shall be furnished by the manufacturer upon request of the purchaser.

14. Keywords

14.1 density; iron graphite bearings; *K* strength constant; oil content; oil-impregnated; porosity

APPENDIX

(Nonmandatory Information)

X1. EXPLANATORY INFORMATION

X1.1 Design Information

X1.1.1 In calculating permissible loads, the operating conditions, housing conditions, and construction should be considered. In general, this material has less resistance to seizure and corrosion than copper-base material. The maximum static bearing load should not exceed 11 000-psi (76-MPa (N/mm^2)) Grade 1 or 15 000-psi (104-MPa (N/mm^2)) Grade 2 of projected bearing area (length times inside diameter of bearing) for this material. This figure is 75 % of the value for the compression deformation limit (yield strength permanent set of 0.001 in. (0.025 mm) for specimens 1⅛in. (28.6 mm) in diameter and 1 in. (25.4 mm) in length) as determined in accordance with Test Methods E 9.

X1.2 Permissible Loads

X1.2.1 Permissible loads for various operating conditions are given in Table X1.1.

X1.3 Dimensional Tolerances

X1.3.1 Commercial dimensional tolerances are given in Table X1.2.

X1.4 Press Fits

X1.4.1 Plain cylindrical journal bearings are commonly installed by press fitting the bearing into a housing with an insertion arbor. For housings rigid enough to withstand the press fit without appreciable distortion and for bearings with wall thickness approximately one eighth of the bearing outside diameter, the press fits shown in Table X1.3 are recommended.

X1.5 Running Clearance

X1.5.1 Proper running clearance for sintered bearings depends to a great extent on the particular application. Therefore, only minimum recommended clearances are listed in Table X1.4. It is assumed that ground steel shafting will be used and that all bearings will be oil impregnated.

TABLE X1.1 Permissible Loads

Shaft Velocity, ft/min (m/min)	Permissible Loads, psi (MPa (N/mm^2))
	Grade 1, 2
Slow and intermittent	3600 (25)
25 (7.6)	1800 (12)
50 to 100 (15.2 to 30.4), incl	450 (3.1)
Over 100 to 150 (30.4 to 45.7), incl	300 (2.1)
Over 150 to 200 (45.7 to 61), incl	225 (1.6)
Over 200 (61)	[A]

[A] For shaft velocities over 200 ft/min, the permissible loads may be calculated as follows:

$$P = 50\,000/V$$

where:
P = safe load, psi of projected area and
V = shaft velocity, ft/min (m/min).

TABLE X1.2 Dimensional Tolerances

NOTE 1—This table is intended for bearings with a 3 to 1 maximum length to inside diameter ratio and a 20 to 1 maximum length to wall thickness ratio. Bearings having greater ratios than these are not covered by the table.

Inside Diameter and Outside Diameter		Total Diameter Tolerance[A]			
		Inside Diameter		Outside Diameter	
in.	mm	in.	mm	in.	mm
Up to 0.760	up to 19.31	0.001	0.025	0.001	0.025
0.761 to 1.510	19.32 to 38.36	0.0015	0.025	0.0015	0.04
1.511 to 2.510	38.37 to 63.76	0.002	0.05	0.002	0.05
2.511 to 3.010	63.77 to 76.46	0.003	0.08	0.002	0.08
3.011 to 4.010	76.47 to 101.86	0.004	0.10	0.004	0.10
4.011 to 5.010	101.87 to 127.26	0.005	0.13	0.005	0.13
5.011 to 6.010	127.27 to 152.65	0.006	0.15	0.006	0.15

Length		Total Length Tolerance[B]	
in.	mm	in.	mm
Up to 1.495	up to 37.97	0.010	0.25
1.496 to 1.990	37.98 to 50.54	0.015	0.38
1.991 to 2.990	50.55 to 75.96	0.020	0.51
2.991 to 4.985	75.97 to 126.61	0.030	0.76

Outside Diameter		Wall Thickness, max		Concentricity Tolerance[C]	
in.	mm	in.	mm	in.	mm
Up to 1.510	up to 38.36	up to 0.355	9.02	0.003	0.08
1.511 to 2.010	38.37 to 51.06	up to 0.505	12.83	0.004	0.10
2.011 to 4.010	51.07 to 101.86	up to 1.010	25.65	0.005	0.13
4.011 to 5.010	101.87 to 127.26	up to 1.510	38.35	0.006	0.15
5.011 to 6.010	127.27 to 152.65	up to 2.010	51.05	0.007	0.18

[A] Total tolerance on the inside diameter and outside diameter is a minus tolerance only.
[B] Total tolerance is split into plus and minus.
[C] Total indicator reading.

TABLE X1.3 Recommended Press Fits

Outside Diameter of Bearing		Press Fit			
		Min		Max	
in.	mm	in.	mm	in.	mm
Up to 0.760	up to 19.31	0.001	0.025	0.003	0.08
0.761 to 1.510	19.32 to 38.36	0.0015	0.04	0.004	0.10
1.511 to 2.510	38.37 to 63.76	0.002	0.05	0.005	0.13
2.511 to 3.010	63.77 to 76.45	0.002	0.05	0.006	0.15
Over 3.010	over 76.45	0.002	0.05	0.007	0.18

X1.6 Flange and Thrust Bearing Specifications

X1.6.1 Diameter and thickness specifications for flange and thrust washers are shown in Table X1.5.

X1.7 Lubrication

X1.7.1 It was found that a circulating-type oil containing rust and oxidation inhibitors is the most desirable type of oil to be used. The viscosity should be specified by the user in accordance with the application.

TABLE X1.4 Running Clearances

Shaft Size		Clearance, min	
in.	mm	in.	mm
Up to 0.760	up to 19.31	0.0005	0.01
0.761 to 1.510	19.32 to 38.36	0.001	0.025
1.511 to 2.510	38.37 to 63.76	0.0015	0.04
Over 2.510	over 63.76	0.002	0.05

TABLE X1.5 Flange and Thrust Bearings Diameter and Thickness Tolerances[A]

Flange Bearings, Flange Diameter Tolerances					
Diameter Range		Standard		Special	
in.	mm	in.	mm	in.	mm
0 to 1½	0 to 38	±0.005	±0.13	±0.0025	±0.06
Over 1½ to 3	39 to 76	±0.010	±0.25	±0.005	±0.13
Over 3 to 6	77 to 152	±0.025	±0.64	±0.010	±0.25
Flange Bearings, Flange Thickness Tolerances					
Diameter Range		Standard		Special	
in.	mm	in.	mm	in.	mm
0 to 1½	0 to 38	±0.005	±0.13	±0.0025	±0.06
Over 1½ to 3	39 to 76	±0.010	±0.25	±0.007	±0.18
Over 3 to 6	77 to 152	±0.015	±0.38	±0.010	±0.25
Thrust Bearings (¼ in. (6.35 mm) Thickness Tolerances, All Diameters[B]					
Standard		Special			
in.	mm	in.		mm	
±0.005	±0.13	±0.0025		±0.06	
Parallelism on Faces, max					
Diameter Range		Standard		Special	
in.	mm	in.	mm	in.	mm
0 to 1½	0 to 38	0.005	0.13	0.003	0.08
Over 1½ to 3	39 to 76	0.007	0.18	0.005	0.13
Over 3 to 6	77 to 152	0.010	0.25	0.007	0.18

[A]Standard and special tolerances are specified for diameters, thickness, and parallelism. Special tolerances should not be specified unless required since they require additional or secondary operations and, therefore, are costlier.

[B]Outside diameter tolerances same as for flange bearings.

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