Designation: B438 – 21

Standard Specification for Bronze-Base Powder Metallurgy (PM) Bearings (Oil-Impregnated)[1]

This standard is issued under the fixed designation B438; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers porous metallic sleeve, flange, thrust, and spherical bronze-base bearings that are produced from mixed metal powders utilizing powder metallurgy (PM) technology and then impregnated with oil to supply operating lubrication.

1.2 Included are the specifications for the chemical, physical, and mechanical requirements of those bronze-base PM materials that have been developed and standardized specifically for use in the manufacture of these self-lubricating bearings.

1.3 This specification is applicable to the purchase of bronze-base bearings (oil-impregnated) that were formerly covered by military specifications and are intended for government or military applications. Those additional government requirements that only apply to military bearings are listed in the Supplementary Requirements section of this specification.

1.4 This specification accompanies Specification B439 that covers the requirements for Iron-Base Powder Metallurgy (PM) Bearings, (Oil-Impregnated).

1.5 Typical applications for bronze-base bearings are listed in Appendix X1.

1.6 Bearing dimensional tolerance data are shown in Appendix X2, while engineering information regarding installation and operating parameters of PM bearings is included in Appendix X3. Additional useful information on self-lubricating bearings can be found in MPIF Standard 35, ISO 5755 and the technical literature.[2]

1.7 With the exception of the values for density and the mass used to determine density, for which the use of the gram per cubic centimetre (g/cm^3) and gram (g) units is the industry standard, the values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.8 *The following safety hazards caveat pertains only to the test methods described in this specification. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

B243 Terminology of Powder Metallurgy

B439 Specification for Iron-Base Powder Metallurgy (PM) Bearings (Oil-Impregnated)

B939 Test Method for Radial Crushing Strength, ***K***, of Powder Metallurgy (PM) Bearings and Structural Materials

B946 Test Method for Surface Finish of Powder Metallurgy (PM) Products

B962 Test Methods for Density of Compacted or Sintered Powder Metallurgy (PM) Products Using Archimedes' Principle

B963 Test Methods for Oil Content, Oil-Impregnation Efficiency, and Surface-Connected Porosity of Sintered Powder Metallurgy (PM) Products Using Archimedes' Principle

E9 Test Methods of Compression Testing of Metallic Materials at Room Temperature

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

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[2] *Machine Design Magazine*, Vol 54, #14, June 17, 1982, pp. 130-142.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E1019 Test Methods for Determination of Carbon, Sulfur, Nitrogen, and Oxygen in Steel, Iron, Nickel, and Cobalt Alloys by Various Combustion and Inert Gas Fusion Techniques

2.2 *MPIF Standard:*[4]
MPIF Standard 35 Materials Standards for PM Self-Lubricating Bearings

2.3 *ISO Standards:*[5]
ISO 2795 Plain Bearings Made from Sintered Material—Dimensions and Tolerances
ISO 5755 Sintered Metal Materials - Specifications

2.4 *Government Standards:*[6]
MIL-PRF-6085 Lubricating Oil: Instrument, Aircraft, Low Volatility
MIL-PRF-17331 Lubrication Oil, Steam Turbine and Gear, Moderate Service
QPL-6085 Lubricating Oil Instrument, Aircraft, Low Volatility
QPL-17331 Lubricating Oil, Steam Turbine and Gear, Moderate Service

3. Terminology

3.1 *Definitions*—The definitions of the terms used in this specification are found in Terminology B243. Additional descriptive information is available under "General Information on PM" on the ASTM B09 web page.

4. Classification

4.1 This specification uses the established three-part alpha-numeric PM Material Designation Code to identify the non-ferrous materials used for self-lubricating PM bearings. The complete explanation of this classification system is presented in Annex A1.

4.2 The following standard oil-impregnated bronze-base bearing material compositions are contained in this specification:

4.2.1 *Prefix CT—Bronze (Low Graphite):*

CT-1000-K19
CT-1000-K26
CT-1000-K37
CT-1000-K40

4.2.2 *Prefix CTG—Bronze-Graphite (Medium Graphite):*

CTG-1001-K17
CTG-1001-K23
CTG-1001-K30
CTG-1001-K34

4.2.3 *Prefix CTG—Bronze (High Graphite):*

CTG-1004-K10
CTG-1004-K15

4.2.4 *Prefix CTG-MOD—Bronze-Lead-Graphite (Military Grade):*

CTG-1001-K23-MOD

4.2.5 *Prefix CFTG—Bronze (Diluted):*

CFTG-3806-K14
CFTG-3806-K22

5. Ordering Information

5.1 Purchase orders or contracts for bronze-base, oil-impregnated bearings covered by this purchasing specification shall include the following information:

5.1.1 A copy of the bearing print showing dimensions and tolerances (Section 10),

5.1.2 Reference to this ASTM Standard, including date of issue,

5.1.3 Identification of bearing material by the PM Material Designation Code (Section 4.2),

5.1.4 Request for Certification and Test Report documents, if required (Section 16),

5.1.5 Type and grade of special lubricating oil, if required (Section 6.2 or S2.2),

5.1.6 Instructions for special packaging, if required (Section 17).

5.1.7 Chemical composition limits (Sections 7.2 and 13.2) if required,

5.1.8 Sampling lot size (Section 12) if required,

5.1.9 Testing procedure and strength requirement for the flanges of flanged oil-impregnated bearings (Section 13.4.1.2) if required,

5.1.10 Bearing breaking load (Section 13.4.2) if required.

5.2 Those additional government requirements necessary on orders for military bearings are prescribed in the Supplementary Requirements section.

6. Materials and Manufacture

6.1 *Porous Metallic Bearing:*

6.1.1 Sintered bronze-base bearings shall be produced by first compacting pre-alloyed bronze or elemental copper and tin powders and any other additives appropriate for the composition to the proper density and bearing configuration.

6.1.2 The green bearings shall then be sintered in a protective atmosphere furnace for a time and temperature relationship that will produce the required sintered bronze-base PM material.

6.1.3 After sintering, the bronze-base bearings are normally sized to achieve the density, dimensional characteristics, concentricity, and surface finish required of the metallic bearing.

6.2 *Oil for Operating Lubrication:*

6.2.1 The surface-connected porosity in the bearings shall be filled to the required volume with lubricating oil, either by an extended soaking in the hot oil or preferably by a vacuum impregnation operation.

6.2.2 A medium viscosity petroleum oil is normally used for most bearing applications, but extreme operating conditions such as elevated temperatures, intermittent rotation, extremely

[4] Available from Metal Powder Industries Federation (MPIF), 105 College Rd. East, Princeton, NJ 08540-6692, http://www.mpif.org.

[5] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

[6] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://dodssp.daps.dla.mil. Electronic copies of military specifications may be obtained from http://assist.daps.dla.mil/.

TABLE 1 Specifications for Bronze-Base Materials used in PM Bearings

Material Designation Code	Chemical Requirements						Physical Requirements		Mechanical Requirements	
									Radial Crushing Strength, K	
	Copper mass %	Tin mass %	Lead mass %	Graphitic Carbon mass %	Iron mass %	All Others mass %	Impregnated Density g/cm^3	Content Oil vol %	10^3 psi	(MPa)
Bronze (Low Graphite)										
CT-1000-K19	bal	9.5-10.5	—	0.3 max	1.0 max	1.0 max	6.0-6.4	24 min[A,G]	19 min	(130 min)
CT-1000-K26	bal	9.5-10.5	—	0.3 max	1.0 max	1.0 max	6.4-6.8	19 min[G]	26 min	(180 min)
CT-1000-K37	bal	9.5-10.5	—	0.3 max	1.0 max	1.0 max	6.8-7.2	12 min[G]	37 min	(260 min)
CT-1000-K40	bal	9.5-10.5	—	0.3 max	1.0 max	1.0 max	7.2-7.6	9 min[G]	40 min	(280 min)
Bronze (Medium Graphite)										
CTG-1001-K17	bal	9.5-10.5	—	0.5-1.8	1.0 max	1.0 max	6.0-6.4	22 min[B,G]	17 min	(120 min)
CTG-1001-K23	bal	9.5-10.5	—	0.5-1.8	1.0 max	1.0 max	6.4-6.8	17 min[G]	23 min	(160 min)
CTG-1001-K30	bal	9.5-10.5	—	0.5-1.8	1.0 max	1.0 max	6.8.7.2	9 min[G]	30 min	(210 min)
CTG-1001-K34	bal	9.5-10.5	—	0.5-1.8	1.0 max	1.0 max	7.2-7.6	7 min[G]	34 min	(230 min)
Bronze (High Graphite)										
CTG-1004-K10	bal	9.2-10.2	—	2.5-5.0	1.0 max	1.0 max	5.8-6.2	11 min[G,I]	10 min	(70 min)
CTG-1004-K15	bal	9.2-10.2	—	2.5-5.0	1.0 max	1.0 max	6.2-6.6	[C,G]	15 min	(100 min)
Bronze-Lead-Graphite (Military Grade)										
CTG-1001-K23-MOD[D]	bal	9.5-10.5	2.0-4.0	0.5-1.75	1.0 max	0.5 max	6.4-6.8	17 min[G]	23 min	(160 min)
Bronze (Diluted)										
CFTG-3806-K14	bal	5.5-6.5	—	[E]	36.0-40.0[F]	2.0 max	5.6-6.0	22 min[H]	14-35	(100-240)
CFTG-3806-K22	bal	5.5-6.5	—	[E]	36.0-40.0[F]	2.0 max	6.0-6.4	17 min[H]	22-50	(150-340)

[A] For an oil content of 27 % min, density range will be 5.8-6.2 g/cm^3 and radial crushing strength will be 15 000 psi (100 MPa) minimum.
[B] For an oil content of 25 % min, density range will be 5.8-6.2 g/cm^3 and radial crushing strength will be 13 000 psi (90 MPa) minimum.
[C] At maximum graphite (5 %) and density (6.6 g/cm^3), this material will contain only a trace of oil. At 3 % graphite and 6.2-6.6 g/cm^3 density, it will contain 8 vol % (min.) of oil.
[D] Additional chemical requirements are: Zinc–0.75 % max, Nickel–0.35 % max, Antimony–0.25 % max.
[E] Graphitic carbon content is typically 0.5-1.3 %; total carbon shall be 0.5-1.3 %.
[F] The iron portion may contain 0.5 % max metallurgically combined carbon.
[G] Minimum oil content will decrease with increasing density. Those shown are valid at the upper-limit of the density given.
[H] These data are based on material in the finished condition.
[I] At 3 % graphite, it will contain 14 % min oil content.

low speeds, or heavy loads may require a synthetic lubricant or an oil with a different viscosity.

6.2.3 Unless otherwise specified by the purchaser, a high-grade turbine oil with antifoaming additives and containing corrosion and oxidation inhibitors, having a kinematic viscosity of 280 to 500 SSU [(60 × 10^{-6} to 110 × 10^{-6} m^2/s), (60 to 110 cSt)] at 100 °F (38 °C) is normally used as a general purpose lubricating oil.

7. Chemical Composition

7.1 *Chemical Composition Specifications*—Each bronze-base PM bearing material shall conform to the chemical requirements prescribed in Table 1 when determined on a clean test sample from oil-free bearings.

7.2 *Limits on Nonspecified Elements*—By agreement between the purchaser and the producer, limits may be established and chemical analyses required for elements or compounds not specified in Table 1.

8. Physical Properties

8.1 *Oil Content*—For each bearing material, the oil content of the as-received bearing shall not be less than the minimum percentage listed in Table 1.

8.2 *Impregnation Efficiency*—A minimum of 90 % of the surface-connected porosity in the as-received bearings shall be impregnated with lubricating oil.

8.3 *Impregnated Density*—The density of the sample bearings, when fully impregnated with lubricating oil, shall meet the requirements prescribed in Table 1 for each bearing material.

9. Mechanical Properties

9.1 *Radial Crushing Strength*—The radial crushing strength of the oil-impregnated bearing material determined on a plain sleeve bearing or a test specimen prepared from a flange or spherical bearing shall meet the minimum and maximum (if required) strength values listed in Table 1.

10. Dimensions, Mass, and Permissible Variations

10.1 This standard is applicable to bronze-base PM sleeve and flange bearings having a 4 to 1 maximum length to inside diameter ratio and a 24 to 1 maximum length to wall thickness ratio.

10.2 Sleeve, flange, thrust, and spherical PM bearings covered by this specification are illustrated by Figs. 1-4. Most PM bearings are small and weigh less than one-quarter pound