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Plain bearings — Copper alloys —

Part 1:
Cast copper alloys for solid and multilayer thick-walled plain bearings

Paliers lisses — Alliages de cuivre —

Partie 1: Alliages de cuivre moulés pour paliers lisses à paroi épaisse, massifs et multicouches

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 2, *Materials and lubricants, their properties, characteristics, test methods and testing conditions.*

This third edition cancels and replaces the second edition (ISO 4382-1:1991), which has been technically revised.

The main changes compared to the previous edition are as follows:

— Clause 2 "Normative references" has been updated;

— Clause 3 "Terms and definitions" has been implemented;

— Table 1 and Table 2 have been updated.

A list of all parts in the ISO 4382 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Plain bearings — Copper alloys —

Part 1: Cast copper alloys for solid and multilayer thick-walled plain bearings

1 Scope

This document specifies requirements for cast copper alloys for use in solid and multilayer thick-walled plain bearings. It gives a limited selection of alloys currently available for general purposes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4384-1, *Plain bearings — Hardness testing of bearing metals — Part 1: Multilayer bearings materials*

ISO 4384-2, *Plain bearings — Hardness testing of bearing metals — Part 2: Solid materials*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Requirements

4.1 General

If the purchaser's requirements necessitate limits for any element not specified, or limits different from those already specified, these should be agreed upon between supplier and purchaser.

WARNING — Lead's (Pb) toxicity has been recognized, and its use has since been phased out of many applications. However, many countries still allow the sale of products that expose humans to lead. Lead is a neurotoxin (see Figure 1).

GHS 07

GHS 08

GHS 09

Figure 1 — Reach compliance symbols

4.2 Chemical composition

The chemical composition shall be within the limits specified in Table 1 and Table 2, where single figures denote maximum values.

4.3 Analysis

Methods of analysis for alloying elements or impurities shall either be as specified in relevant International Standards or as mutually agreed between supplier, purchaser and any mutually acceptable arbitrator.

5 Material properties

5.1 General

The minimum tensile strength and elongation values quoted in Table 1 and Table 2 are included as properties which may assist designers. Brinell hardness is the mandatory quality control check. If tensile strength and elongation tests are required, this should be stated by the purchaser at the time of ordering.

For finished bearings, Brinell hardness will normally be checked.

Table 1 — Copper/lead/tin and copper/aluminium casting alloys for solid and multilayer thick-walled plain bearings

Chemical elements and properties	Chemical composition % mass fraction				
	CuPb9Sn5	CuPb10Sn10[a]	CuPb15Sn8	CuPb20Sn5	CuAl10Fe5Ni5
Cu	Remainder	Remainder	Remainder	Remainder	Remainder
Sn	4 to 6	9 to 11	7 to 9	4 to 6	0,2
Pb	8 to 10	8 to 11	13 to 17	18 to 23	0,1
Zn	2	2	2	2	0,5
Fe	0,25	0,25	0,25	0,25	3,5 to 5,5
Ni	2	2	2	2,5	3,5 to 6,5

GS : Sand

GM : Permanent mould

GZ : Centrifugal

GC : Continuous

[a] The chemical composition of this alloy differs from that of thin-walled multilayer plain bearings (see ISO 4383).

[b] For continuous casting, the phosphorus content may be increased to a maximum of 1,5 % by agreement.

[c] For hardness testing, see ISO 4384-1 and ISO 4384-2.

Table 1 *(continued)*

Chemical elements and properties		Chemical composition % mass fraction				
		CuPb9Sn5	**CuPb10Sn10[a]**	**CuPb15Sn8**	**CuPb20Sn5**	**CuAl10Fe5Ni5**
Sb		0,5	0,5	0,5	0,75	—
P		0,1[b)]	0,05[b]	0,1[b]	0,1[b]	—
Al		0,01	0,01	0,01	0,01	8 to 11
Mn		0,2	0,2	0,2	0,2	3
Si		0,01	0,01	0,01	0,01	0,1
S		0,1	0,1	0,1	0,1	—
Cu+ Fe+ Ni+ Al+ Mn		—	—	—	—	> 99,2
Material properties of test bar						
Brinell hardness[c] HBW 2,5/62,5/10, min.	**GS**	55	65	60	45	140
	GM	60	65	60	50	140
	GZ	60	70	65	50	140
	GC	60	70	65	50	140
Tensile strength R_m N/mm^2, min.	**GS**	160	180	170	150	600
	GM	200	220	200	170	600
	GZ	220	220	220	180	680
	GC	230	220	220	180	680
Elongation after fracture A %, min.	**GS**	7	7	5	5	10
	GM	5	3	3	5	12
	GZ	6	6	8	7	12
	GC	9	6	8	7	12
0,2 % proof stress $R_{p0,2}$ N/mm^2, min.	**GS**	60	80	80	60	250
	GM	80	140	100	80	250
	GZ	80	110	100	80	280
	GC	130	110	100	80	280
Elastic modulus E kN/mm^2 ≈		85	90	85	75	120
Linear thermal expansion coefficient α_l 10^{-6}/K ≈		18	18	18	19	16
Thermal conductivity λ, at 15 °C W/(m·K) ≈		71	47	47	59	60
Density, ρ kg/dm^3 ≈		9	9	9,1	9,3	7,6

GS : Sand

GM : Permanent mould

GZ : Centrifugal

GC : Continuous

[a] The chemical composition of this alloy differs from that of thin-walled multilayer plain bearings (see ISO 4383).

[b] For continuous casting, the phosphorus content may be increased to a maximum of 1,5 % by agreement.

[c] For hardness testing, see ISO 4384-1 and ISO 4384-2.

Table 2 — Copper/tin/zinc casting alloys for solid plain bearings

Chemical elements and properties		Chemical composition % mass fraction				
		CuSn8Pb2	**CuSn10P**	**CuSn12Pb2**	**CuPb5Sn5Zn5**	**CuSn7Pb7Zn3**
Cu		Remainder	Remainder	Remainder	Remainder	Remainder
Sn		6 to 9	10 to 11,5	11 to 13[a)]	4 to 6	6 to 8
Pb		0,5 to 4	0,25	1 to 2,5	4 to 6	5 to 8
Zn		3	0,05	2	4 to 6	2 to 5
Fe		0,2	0,1	0,2	0,3	0,2
Ni		2,5	0,1	2	2,5	2
Sb		0,25	0,05	0,2	0,25	0,35
P		0,05[b]	0,5 to 1	0,05 to 0,4[b,c]	0,05[b]	0,1[b]
Al		0,01	0,01	0,01	0,01	0,01
Mn		—	0,5	0,2	—	—
Si		0,01	0,02	0,01	0,01	0,01
S		0,1	0,05	0,05	0,1	0,1
Material properties of test bar						
Brinell hardness[d] HBW 2,5/62,5/10, min.	**GS**	60	70	80	60	65
	GM	85	95	—	60	65
	GZ	85	95	90	65	70
	GC	85	95	90	65	70
Tensile strength R_m N/mm^2, min.	**GS**	250	220	240	200	210
	GM	220	310	—	200	210
	GZ	230	330	280	250	260
	GC	270	360	280	250	260
Elongation after fracture A %, min.	**GS**	3	3	7	13	12
	GM	2	2	—	13	12
	GZ	4	4	5	13	12
	GC	5	6	7	13	12
0,2 % proof stress $R_{p0,2}$ N/mm2, min.	**GS**	130	130	130	90	100
	GM	130	170	—	90	100
	GZ	130	170	150	100	120
	GC	130	170	150	100	120
Elastic modulus E kN/mm^2 ≈		75	95	95	90	85

GS : Sand

GM : Permanent mould

GZ : Centrifugal

GC : Continuous

[a] For centrifugal and continuous casting, a tin content of 10,5 % to 13 % is admissible.

[b] For continuous casting, the phosphorus content may be increased to a maximum of 1,5 % by agreement.

[c] The phosphorus content shall be fixed by agreement.

[d] For hardness testing, see ISO 4384-1 and ISO 4384-2.

NOTE Table A.1 gives some general guidance on the characteristics and principal uses of the different bearing alloys.

Table 2 *(continued)*

Chemical elements and properties	Chemical composition % mass fraction				
	CuSn8Pb2	**CuSn10P**	**CuSn12Pb2**	**CuPb5Sn5Zn5**	**CuSn7Pb7Zn3**
Linear thermal expansion coefficient α_l $10^{-6}/K \approx$	18	18	18	18	18
Thermal conductivity λ, at 15 °C W/(m·K) ≈	47	50	54	71	59
Density ρ kg/dm^3 ≈	8,8	8,8	8,7	8,7	8,8
GS : Sand GM : Permanent mould GZ : Centrifugal GC : Continuous [a] For centrifugal and continuous casting, a tin content of 10,5 % to 13 % is admissible. [b] For continuous casting, the phosphorus content may be increased to a maximum of 1,5 % by agreement. [c] The phosphorus content shall be fixed by agreement. [d] For hardness testing, see ISO 4384-1 and ISO 4384-2. NOTE Table A.1 gives some general guidance on the characteristics and principal uses of the different bearing alloys.					

5.2 Test methods

5.2.1 Hardness test

Hardness testing shall be carried out in accordance with ISO 4384-1 and ISO 4384-2. If the specimen size does not permit this, the test method may be agreed between supplier and purchaser. Acceptable minimum values shall then be as agreed.

5.2.2 Tensile test

The tensile test shall be carried out in accordance with ISO 6892-1. If specimen sizes do not permit the use of standard test pieces, then test methods and mandatory values shall be as agreed between supplier and purchaser.

In the case of sand casting and permanent mould casting, the test bars are cast separately. In the case of continuous casting, the test bars are taken from the casting and, in the case of centrifugal casting, they may also be taken from the casting.

The test bars may be tested either as cast or machined.

Cast test bars shall have diameters between 12 mm and 25 mm; machined test bars shall have a finished diameter between 10 mm and 18 mm. In the latter case, a diameter of 14 mm ± 0,5 mm is recommended.

6 Designation and ordering information

The designation is separated into the following types of casting:

GS – Sand

GM – Permanent mould

GZ – Centrifugal

GC – Continuous

The following tests may be requested by the purchaser:

R: Test of tensile strength

RA: Test of tensile strength and elongation

H: Test of Brinell hardness (on cast material or finished solid plain bearing)

EXAMPLE Designation of the bearing metal made of continuous casting (GC) having the symbol CuPb10Sn10, when the test for tensile strength and elongation (RA) is to be carried out on the test bar:

Bearing metal ISO 4382 – GC **– CuPb10Sn10 – RA**

For finished machined material, the dimensions may be selected, for example, from ISO 4379.

For unmachined material, the manufacturer's recommended allowances for machining should be added to the outside diameter and subtracted from the inside diameter.

The purchaser shall indicate whether a certificate of conformance is required.