INTERNATIONAL STANDARD

ISO 4382-1

Second edition
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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
ISO 4382-1:1991(E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4382-1 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Sub-Committee SC 2, *Materials and lubricants, their properties, characteristics, test methods and testing conditions*.

This second edition cancels and replaces the first edition (ISO 4382-1:1982), of which it constitutes a technical revision.

ISO 4382 consists of the following parts, under the general title *Plain bearings — Copper alloys*:

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

— *Part 2: Wrought copper alloys for solid plain bearings*

Annexes A and B of this part of ISO 4382 are for information only.

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Plain bearings — Copper alloys —

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

1 Scope

This part of ISO 4382 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 standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 4382. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 4382 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4383:1991, *Plain bearings — Multilayer materials for thin-walled plain bearings.*

ISO 4384-1:1982, *Plain bearings — Hardness testing of bearing metals — Part 1: Compound materials.*

ISO 4384-2:1982, *Plain bearings — Hardness testing of bearing metals — Part 2: Solid materials.*

ISO 6892:1984, *Metallic materials — Tensile testing.*

3 Requirements

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.

3.1 Chemical composition

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

3.2 Analysis

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

4 Material properties

4.1 General

The minimum tensile strength and elongation values quoted in tables 1 and 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, % (*m*/*m*)				
	CuPb9Sn5	CuPb10Sn10 [1]	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
Sb	0,5	0,5	0,5	0,75	—
P	0,1 [2]	0,05 [2]	0,1 [2]	0,1 [2]	—
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 [3] HB 2,5/62,5/10, min.					
GS — Sand	55	65	60	45	140
GM — Permanent mould	60	65	60	50	140
GZ — Centrifugal	60	70	65	50	140
GC — Continuous	60	70	65	50	140
Tensile strength, R_m N/mm², min.					
GS — Sand	160	180	170	150	600
GM — Permanent mould	200	220	200	170	600
GZ — Centrifugal	220	220	220	180	680
GC — Continuous	230	220	220	180	680
Elongation, percent after fracture, A %, min.					
GS — Sand	7	7	5	5	10
GM — Permanent mould	5	3	3	5	12
GZ — Centrifugal	6	6	8	7	12
GC — Continuous	9	6	8	7	12

Chemical elements and properties	Chemical composition, % (m/m)				
	CuPb9Sn5	CuPb10Sn10 [1]	CuPb15Sn8	CuPb20Sn5	CuAl10Fe5Ni5
Material properties of test bar					
0,2 % Proof stress, $R_{p0,2}$ N/mm², min.					
GS Sand	60	80	80	60	250
GM — Permanent mould	80	140	100	80	250
GZ — Centrifugal	80	110	100	80	280
GC — Continuous	130	110	100	80	280
Elastic modulus, E kN/mm² ≈	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/dm³ ≈	9	9	9,1	9,3	7,6

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

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

3) For hardness testing, see ISO 4384-2.

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

Chemical elements and properties	Chemical composition, % (m/m)				
	CuSn8Pb2	CuSn10P	CuSn12Pb2	CuPb5Sn5Zn5	CuSn7Pb7Zn3
Cu	Remainder	Remainder	Remainder	Remainder	Remainder
Sn	6 to 9	10 to 11,5	11 to 13[1]	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[2]	0,5 to 1	0,05 to 0,4[2], [3]	0,05[2]	0,1[2]
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 [4] HB 2,5/62,5/10, min.					
GS — Sand	60	70	80	60	65
GM — Permanent mould	85	95	—	60	65
GZ — Centrifugal	85	95	90	65	70
GC — Continuous	85	95	90	65	70
Tensile strength, R_m N/mm², min.					
GS — Sand	250	220	240	200	210
GM — Permanent mould	220	310	—	200	210
GZ — Centrifugal	230	330	280	250	260
GC — Continuous	270	360	280	250	260
Elongation, percent after fracture, A %, min.					
GS — Sand	3	3	7	13	12
GM — Permanent mould	2	2	—	13	12
GZ — Centrifugal	4	4	5	13	12
GC — Continuous	5	6	7	13	12

Chemical elements and properties	Chemical composition, % (m/m)				
	CuSn8Pb2	CuSn10P	CuSn12Pb2	CuPb5Sn5Zn5	CuSn7Pb7Zn3
Material properties of test bar					
0,2 % Proof stress, $R_{p0,2}$ N/mm², min.					
GS — Sand	130	130	130	90	100
GM — Permanent mould	130	170	—	90	100
GZ — Centrifugal	130	170	150	100	120
GC — Continuous	130	170	150	100	120
Elastic modulus, E kN/mm² ≈	75	95	95	90	85
Linear thermal expansion coefficient, α_l 10^{-6}/K ≈	18	18	18	18	18
Thermal conductivity, λ, at 15 °C W/(m·K) ≈	47	50	54	71	59
Density, ϱ kg/dm³ ≈	8,8	8,8	8,7	8,7	8,8

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

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

3) The phosphorus content shall be fixed by agreement.

4) For hardness testing, see ISO 4384-2.

4.2 Test methods

4.2.1 Hardness test

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

4.2.2 Tensile test

The tensile test shall be carried out in accordance with ISO 6892. 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 $\pm$ 0,5 mm is recommended.

5 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.

Annex A
(informative)

Guide for uses of bearing metals and for the hardness of the mating bearing part (shaft)

Bearing alloys	Characteristics and principal uses[1]	Minimum hardness of the shaft[2]
CuPb9Sn5 **CuPb10Sn10**	Soft copper-based bearing alloys suitable for moderate loads and moderate to high sliding velocities. Increasing the tin content increases the hardness and wear resistance.	250 HB
CuPb15Sn8	Soft copper-based bearing alloys suitable for moderate loads and moderate to high sliding velocities. Increasing the tin content increases the hardness and wear resistance. Tolerant of water lubrication.	250 HB
CuPb20Sn5	Soft copper-based bearing alloys suitable for moderate loads and moderate to high sliding velocities. Increasing the tin content increases the hardness and water resistance. Suitable for water lubrication.	200 HB
CuAl10Fe5Ni5	Very hard alloy for structural components under sliding conditions. Suitable for marine environments. Hardened shafts essential. Relatively poor embeddability.	55 HRC
CuSn8Pb2 **CuSn7Pb7Zn3**	For non-critical applications with low to moderate loads; adequate lubrication.	300 HB
CuSn10P **CuSn12Pb2**	For hardened shafts with a combination of high load, high sliding velocity, impact loading or pounding; when there is adequate lubrication and good alignment.	55 HRC
CuPb5Sn5Zn5	For non-critical applications with low loads; adequate lubrication.	250 HB

1) Higher lead content improves the tolerance of poor alignment and intermittent lubrication.

2) The shaft hardness should be four times higher than the bearing alloy hardness. The difference in hardness between bearing material and shaft material shall be such that welding of the bearing material under working conditions is safely avoided. The lubrication conditions have considerable influence on the selection of the shaft material, in particular on the hardness. The tabulated hardness values for shaft material are minimum values which are valid for most cases of application.