INTERNATIONAL STANDARD

ISO 4381

Second edition
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Plain bearings — Lead and tin casting alloys for multilayer plain bearings

Paliers lisses — Alliages moulés de plomb et d'étain pour paliers lisses multicouches

Reference number
ISO 4381:1991(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 4381 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 4381:1981), of which it constitutes a technical revision.

Annexes A and B of this International Standard are for information only.

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Plain bearings — Lead and tin casting alloys for multilayer plain bearings

1 Scope

This International Standard specifies requirements for bearing metals based on lead and tin casting alloys for multilayer plain bearings.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 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 4386-2:1982, *Plain bearings — Metallic multilayer plain bearings — Part 2: Destructive testing of bond for bearing metal layer thicknesses equal to or greater than 2 mm.*

3 Requirements

3.1 Chemical composition

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

The chemical analysis is decisive for the acceptance of the bearing metals.

3.2 Material properties

Material properties shall be in accordance with tables 1 and 2 .

The Brinell hardness at 20 °C is regarded as the test and acceptance value. All other indicated values are mean values or ranges and are regarded as typical values for the designer. In view of the range of possible alloy compositions and the marked influence exerted by the cooling conditions on the mechanical properties, relatively large deviations from the indicated values are to be expected in individual cases.

3.3 Guide to selection of material

A guide to the uses of bearing metals and for the hardness of the mating bearing part (shaft) is given in annex A.

4 Designation

EXAMPLE

Designation of the bearing metal having the symbol PbSb15Sn10:

Bearing metal ISO 4381 - PbSb15Sn10

Table 1 — Lead casting alloys

Chemical elements and properties		Chemical composition, % (m/m) PbSb15SnAs	PbSb15Sn10	PbSb14Sn9CuAs	PbSb10Sn6
Pb		Remainder	Remainder	Remainder	Remainder
Sb		13,5 to 15,5	14 to 16	13 to 15	9 to 11
Sn		0,9 to 1,7	9 to 11	8 to 10	5 to 7
Cu		0,7	0,7	0,7 to 1,5	0,7
As		0,8 to 1,2	0,6	0,3 to 1	0,25
Cd		—	—	0,3 to 0,7	
Ni		—	—	0,2 to 0,6	—
Bi		0,1	0,1	0,1	0,1
Fe		0,1	0,1	0,1	0,1
Al		0,01	0,01	0,01	0,01
Zn		0,01	0,01	0,01	0,01
Total others		0,2	0,2	0,2	0,2
Material properties of test bar					
Brinell hardness [1] HB 10/250/180	20 °C min.	18	21	22	16
	50 °C ≈	15	16	22	16
	120 °C ≈	14	14	16	14
	150 °C ≈	10	10	10	8
0,2 % Proof stress, $R_{p0,2}$ N/mm²	20 °C ≈	39	43	46	39
	50 °C ≈	37	32	39	32
	100 °C ≈	25	30	27	27
Bond strength, R_{Ch}, between bearing metal (limiting value; see ISO 4386-2) and steel with C = 0,1 % (m/m) bearing metal thickness ⩾ 6 mm N/mm² ≈		60	70	67	65
Rotating bending fatigue, R_{rbf}, 10^7 cycles N/mm² ≈		± 24	± 25	± 26	± 21
Linear thermal expansion coefficient, a_l 10^{-6} /K ≈		25	24	24,7	25,3
Melting range °C ≈		240 to 350	240 to 270 [2]	240 to 420	240 to 260 [2]
Casting range °C ≈		450 to 500	480 to 520	480 to 520	480 to 520
Density, ϱ kg/dm³ ≈		9,7	9,9	9,7	10,3

1) For hardness testing, see ISO 4384-1 and ISO 4384-2.

2) The upper limit of the melting range will be 380 °C if the copper content is higher than 0,5 % (m/m).

Table 2 — Tin casting alloys

Chemical elements and properties		Chemical composition, % (m/m) SnSb12Cu6Pb	SnSb8Cu4	SnSb8Cu4Cd
Sn		Remainder	Remainder	Remainder
Sb		11 to 13	7 to 8	7 to 8
Cu		5 to 7	3 to 4	3 to 4
Cd		—	—	0,8 to 1,2
Pb		1 to 3	0,35	0,35
As		0,1[1]	0,1[2]	0,5
Ni		—	—	0,1 to 0,5
Bi		0,08	0,08	0,08
Fe		0,1	0,1	0,05
Al		0,01	0,01	0,01
Zn		0,01	0,01	0,01
Total others		0,4	0,2	0,2
Material properties of test bar				
Brinell hardness [3] HB 10/250/180	20 °C min.	25	22	28
	50 °C ≈	20	17	25
	120 °C ≈	12	11	19
	150 °C ≈	8	8	13
0,2 % Proof stress, $R_{p0,2}$ N/mm²	20 °C ≈	61	47	62
	50 °C ≈	60	44	44
	100 °C ≈	36	27	30
Bond strength, R_{Ch}, between bearing metal (limiting value; see ISO 4386-2) and steel with C = 0,1 % (m/m) bearing metal thickness ≥ 6 mm N/mm² ≈		40	80	90
Rotating bending fatigue, R_{rbf}, 10^7 cycles N/mm² ≈		± 28	± 31	± 34
Linear thermal expansion coefficient, a_l 10^{-6} /K ≈		22,7	23,9	23,9
Melting range °C ≈		183 to 400	233 to 360	233 to 360
Casting range °C ≈		480 to 520	440 to 460	440 to 460
Density, ϱ kg/dm³ ≈		7,4	7,3	7,3

1) In special cases a maximum of 0,8 % (m/m) is permissible.

2) In special cases a maximum of 0,5 % (m/m) is permissible.

3) For hardness testing, see ISO 4384-1 and ISO 4384-2.

Annex A
(informative)

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

Bearing alloys	Characteristics and principal uses	Minimum hardness of the shaft[1)]
PbSb15SnAs	Suitable only for pure sliding stresses at low load and low sliding velocities in the hydrodynamic range; good embeddability. Almost exclusively cast onto steel strip by means of continuous casting processes resulting in an extremely high cooling speed. Used for wrapped bushes and thin-walled bearing liners with a wall thickness of up to about 3 mm as well as for thrust washers. Bushes for camshafts in internal combustion engines, gear bushes, connecting rod and main bearings in smaller piston compressors.	160 HB
PbSb15Sn10	Suitable for pure sliding stresses at mean loads and mean sliding velocities in the hydrodynamic range; low impact stress; good embeddability. Used at mean stresses for plain bearings, tilting pads, crossheads and cone breakers.	
PbSb14Sn9CuAs	Good sliding properties, use in mixed friction range possible, suitable for high to low sliding velocities in the hydrodynamic range; mean impact stress, less sensitive to edge compression, good heat conductor. Highest thermal loadability of lead-based bearing materials. Used for plain bearings for electric machines, gears, rolling mills, for segments and connecting rod bearings.	
PbSb10Sn6	Suitable for pure sliding stresses at low load and mean sliding velocities in the hydrodynamic range, moderate impact stress; good embeddability.	
SnSb12Cu6Pb	Good sliding properties at mean load and high to low sliding velocities in the hydrodynamic range; good impact stress; sensitive to reversed bending stress and edge compression; high wear resistance in the case of rough journals (grey cast iron). Used for plain bearings for turbines, compressors, electric machines and gears.	
SnSb8Cu4	Good sliding properties, conformability and high toughness; good embeddability; suitable for high sliding velocities in the hydrodynamic range, mean load; impact stress at low frequency; insensitive to reversed bending stress. Used for high loaded rolling mill bearings; for the production of wrapped bushes, thin-walled bearing liners with a wall thickness of up to about 3 mm and thrust washers.	
SnSb8Cu4Cd	Good sliding properties, suitable for high sliding velocities in the hydrodynamic range at high load, low sensitivity to edge compression, high impact stress at high frequency; insensitive to reversed bending stress; good embeddability. Used for main and connecting rod bearings, cross-head bearings for large piston engines and rolling mill bearings.	

1) In multilayer plain bearings, the difference between the hardness of the bearing material and the shaft material should be such that welding under working conditions is safely avoided. The working conditions, in particular the lubrication conditions, have considerable influence on the selection of the shaft material. For this reason, the recommended hardness value for the shaft material is a minimum value. In general, unquenched and untempered shaft materials are used in the case of bearing materials based on lead and tin.