BS ISO 14287:2012

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Plain bearings — Pad materials for tilting pad bearings

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National foreword

This British Standard is the UK implementation of ISO 14287:2012.

The UK participation in its preparation was entrusted to Technical Committee MCE/12, Plain bearings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Plain bearings — Pad materials for tilting pad bearings

Paliers lisses — Matériaux des patins pour paliers à patins oscillants

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Contents

Page

Foreword

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ISO 14287 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 7, *Special types of plain bearings*.

Introduction

Tilting pad bearings support loads equally with their pads, which are pivoted at the supporting points on their back surfaces. This configuration allows the pads to tilt freely; it serves to keep the shape of the oil film on the sliding surface in optimum condition and improve load-carrying capabilities.

Such bearings are normally used as thrust and journal bearings for rotating machineries; they operate under static load conditions with lubricating oil applied. They have been used for many years and have a long history. As a result of developments in high-speed, high-performance rotating machineries, many various types of pad materials have been put into practical use.

Plain bearings — Pad materials for tilting pad bearings

1 Scope

This International Standard specifies requirements for materials based on metals, polymers, back metals and pivots for the manufacture of tilting pad bearings.

2 Normative references

The following referenced documents are indispensable for the application 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 4381, *Plain bearings — Tin casting alloys for multilayer plain bearings*

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

3 Requirements

3.1 General

The sliding surface of a pad may be composed of a metal bearing material or a polymer material, which is typically bonded to the back metal, depending on the conditions for operation of the bearing. Alloys are in accordance with ISO 4381; materials are in accordance with ISO 4383. Guidance for the selection of pad surface layer materials is given in Annex A.

3.2 Metallic materials

3.2.1 Typical materials

The chemical composition of some typical materials based on metal are given in Table 1.

3.2.2 Tin-based whitemetals

Tin-based whitemetals are used as general-purpose metallic materials. They are provided with linings by casting, in general.

Whitemetals are characterized by good castability. However, attention should be paid to quality problems, such as bonding strength with the back metal, segregation and blow holes.

To ensure appropriate strength/softness of a whitemetal alloy, the combination of Sb and Cu described in Table 1 is used in many applications.

Lead-based whitemetals are rarely used because of their effects on the environment.

3.2.3 Aluminium bearing alloys

Aluminium-based bearing alloys are used for high-speed operation under high-load and high-temperature conditions. Al-Sn alloys, i.e. alloys which are made by adding tin to aluminium, are the most commonly used aluminium bearing alloys. To improve sliding characteristics at high speed, 40 % Sn-Al alloy is typically used.

The pad of a bearing manufactured from such an alloy is formed from a bimetal strip consisting of an aluminium alloy, which is roll-bonded to carbon steel. The pad of a journal bearing made from such an alloy can have uneven alloy thickness along the slide direction because it is formed by bending; it is possible to correct the thickness to make it even.

3.2.4 Lead-bronze bearing alloys

Lead-bronze bearing alloys are used under operating conditions equivalent to those for aluminium-bearing alloys or under higher load and higher temperature conditions. However, lead-bronze bearing alloys have limited uses. Lead-bronze bearing alloys are high in hardness; they normally require surface hardening (quench hardening, etc.) on the sliding surfaces of mating parts.

The pad of a bearing manufactured from such an alloy, as in the case of an aluminium bearing alloy, is typically formed from a bimetal strip. Although it is a rare case, it can take the form of a copper alloy (solid or cast) with a steel backing.

Table 1 — Chemical composition of metal materials

Chemical element	Chemical composition mass fraction, %		
	Tin-based whitemetals	**Aluminium bearing alloys**	**Lead-bronze bearing alloys**
Sn	Remainder	35 to 42	8 to 12
Al	0,01	Remainder	—
Cu	3 to 5	0,7 to 1,3	Remainder
Sb	8 to 10	—	0,5
Pb	0,5	—	7 to 13
Zn	0,01	—	0,75
Ni	—	0,15	0,5
Si	—	0,3	—
Fe	0,08	0,7	0,35
Bi	0,08	—	—
As	0,01	—	—

3.3 Polymer materials

Bearings with pads having polymer layers on their sliding surfaces, which are characterized by polymer-specific tribological characteristics, are in use.

Polyether-etherketone (PEEK) and polytetrafluoro-ethylene (PTFE) polymer materials are available. Bearings composed of such materials are provided with special measures to allow for bonding to the back metal. A porous metal layer is used as the bonding interface layer and its voids are impregnated with a polymer layer material to form a sliding surface layer. Thus, the metal interface layer is joined with the back metal. PEEK polymer materials contain some PTFE in order to improve sliding characteristics.

The chemical composition of some typical polymer materials are given in Table 2.

Two types of electrical conductivities are provided: conductive and non-conductive, which are determined depending on the elements added. Non-conductive polymer materials have the advantage of preventing electro-erosion without an additional insulator.

Table 2 — Chemical composition of polymer materials

Chemical element	Chemical composition mass fraction, %		
	PEEK material		PTFE material
PEEK	Remainder	Remainder	—
PTFE	1 to 3	8 to 12	Remainder
CF	27 to 33	—	10 to 20
MoS_2	—	—	4 to 6

CF carbon fibre

MoS_2 molybdenum disulfide

3.4 Back metal materials

Low-carbon steels containing approximately 0,10 % C to 0,35 % C are often used as back metal materials. The carbon content of a back metal material is typically determined using a combination of a surface layer bearing material and a bonding process.

In the case of bearings operating under high-speed and high-temperature conditions, a copper alloy may be used as a back metal, although it is a rare case. Back metals of the copper alloy are usually Cu-Cr (copper chromium) alloy, which are expected to decrease pad temperature by approximately 10 °C to 20 °C because of their excellent thermal conductivity.

3.5 Pivot materials

Pivots are subjected to concentrated loads and may be separated from the pads. Pivot materials are very hard and are fixed to pads. A typical example of a pivot is a flat, cylindrical one. It is press-fitted on to the back surface of a pad and is then secured by caulking. High-carbon chromium bearing steels containing approximately 0,95 % C to 1,10 % C are commonly used pivot material and thermally treated, in general.

The shape of a pivot is designed to have different curvatures with respect to the circumferential and axial directions to allow the pad to tilt freely in the circumferential and axial directions.

Pivots may be installed on the bearing casing side on their designs.

Annex A
(informative)

Guidance on properties and selection of materials

A.1 Additional information on metallic materials

Whitemetals are excellent in castability as well as in conformability, seizure resistance, embeddability and so on. Therefore, they are often used as versatile materials in thrust and journal bearings.

Gravity casting and centrifugal casting are used to produce thrust pads and journal pads, respectively. Centrifugal casting produces fine structures with high bonding property.

Whitemetals are limited in strength and high-temperature characteristics; the maximum permissible sliding surface temperature of whitemetals is approximately 120 °C to 130 °C.

Bearings are subjected to high temperatures due to the development of high-speed and high-performance rotating machinery. Some of them employ aluminium alloy. Aluminium bearings can be used at about 25 °C to 30 °C higher temperatures than the whitemetal bearings.

Aluminium bearings are formed from bimetal strip materials by machining them. The size of a bearing depends on the size of the bimetal strip and the capability of the machine which processes the bearing. In general, small or medium size bearings are produced.

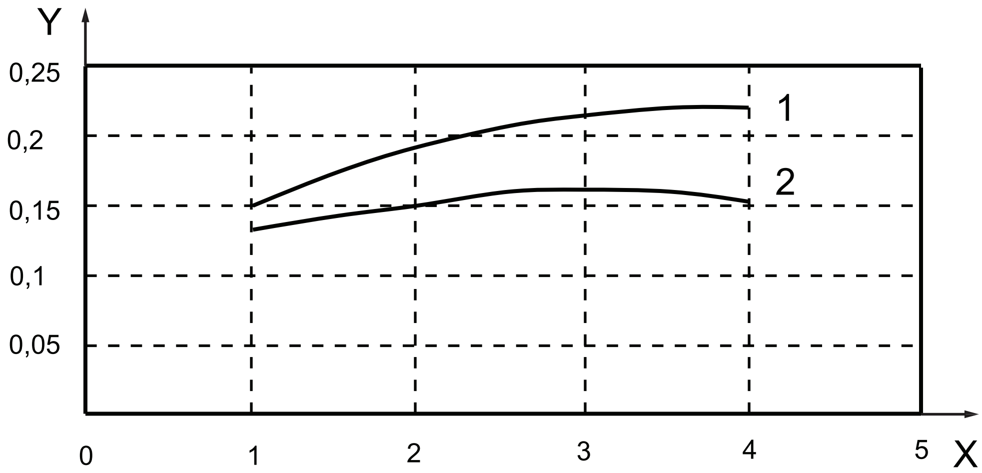
Lead bronze bearings can be used at about 30 °C to 40 °C higher temperatures than the whitemetal bearings. However, they are high in hardness and sensitive to seizure. Their uses are thought to be limited to special applications utilizing the high-temperature characteristics of copper materials.

A.2 Additional information on polymer materials

In general, PEEK and PTFE polymer materials are superior to metal materials in terms of tribological characteristics. They are excellent in low-friction coefficient and seizure resistance. In recent years, PEEK and PTFE polymer materials utilizing those characteristics have been developed. Such materials are used to produce pads for both thrust and journal bearings.

Although a thermal conductivity of polymer materials is small, this is beneficial to reduce a thermal distortion of the bearing surface. PEEK materials have excellent load-carrying capabilities and little wear/creep deformation under high surface pressure conditions. In addition, they can be used at approximately 75 °C higher temperatures than the whitemetal materials. Owing to the excellent load durability and low friction, the size of bearings can be reduced and the overall size of equipment can accordingly be reduced.

The results of start-up friction coefficient experiment under vertical static load conditions are shown in Figure A.1. In some cases, the use of jacking oil for large-size vertical thrust bearings can be eliminated by applying the PEEK thrust pads. The size of PEEK sheet materials which can be produced vary according to the capability of the equipment used. Sheet materials that measure approximately 1 000 mm × 600 mm are available.



Key

X specific bearing load (MPa)

Y friction coefficient at start-up

1 whitemetal

2 PEEK

Test bearing size: tilting pad thrust bearing with eight pads under test; pad outside diameter of 457 mm and pad inside diameter of 246 mm.

Figure A.1 — Example of start-up coefficient of friction on the vertical static load test machine

A.3 Operation range

A general chart, giving the operation range for metallic materials and polymer materials, is shown in Figure A.2.

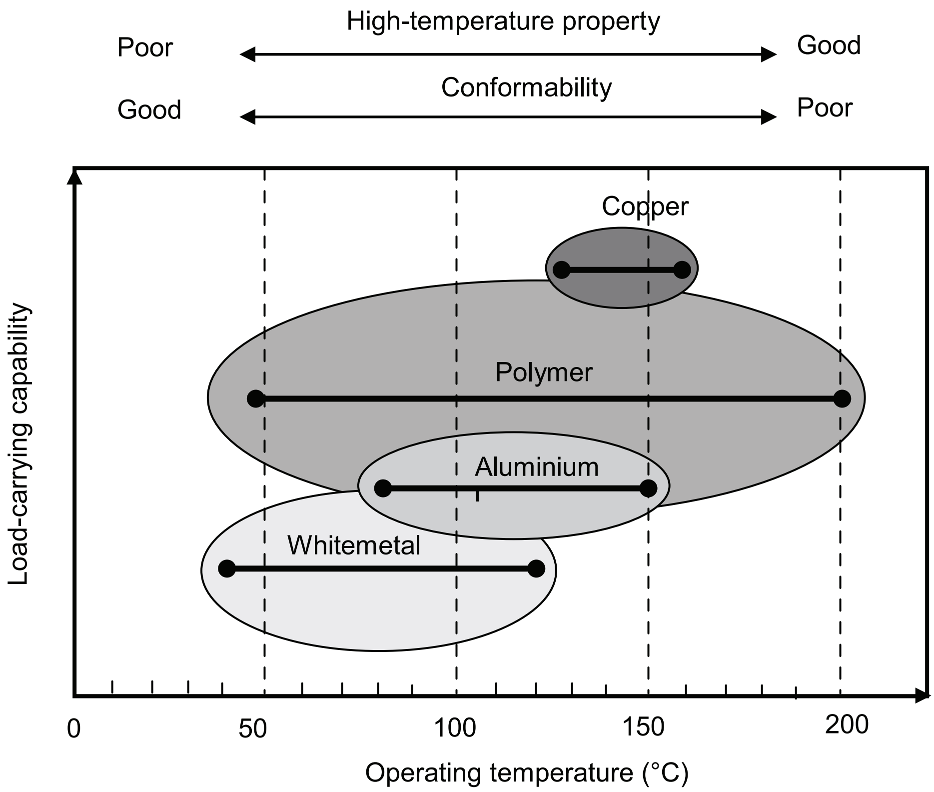


Figure A.2 — General chart concerning the operation range for metallic materials and polymer materials

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