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ISO 7146

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Plain bearings — Terms, characteristics and causes of damage and changes in appearance

Paliers lisses — Termes, caractéristiques et causes de détérioration et de changement d'aspect

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Contents

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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.

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 7146 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*.

Introduction

In practice, damage to a bearing may often be the result of several mechanisms operating simultaneously. The damage may result from improper assembly or maintenance or from faulty manufacture of the bearing, its housing or the counterface against which it operates. In some instances, damage may be caused by a design compromise made in the interests of economy or from unforeseen operating conditions. It is the complex combination of design, manufacture, assembly, operation, maintenance and possible reconditioning which often causes difficulty in establishing the primary cause of damage.

In the event of extensive damage or destruction of the bearing, the evidence is likely to be lost, and it will then be impossible to identify how the damage came about.

In all cases, knowledge of the actual operating conditions of the assembly and the maintenance history is of the utmost importance.

The classification of bearing damage established in this International Standard is based primarily upon the features visible on the running surfaces and elsewhere, and consideration of each aspect is required for reliable determination of the cause of bearing damage.

Since more than one process may cause similar effects on the running surface, a description of appearance alone is occasionally inadequate in determining the reason for damage. In such cases, the operating conditions have to be considered. Thus sections 1 and 2 are subdivided according to the mechanism of damage and in incremental degrees of severity sometimes related to the operating conditions.

In the case of full oil film separation in hydrodynamically lubricated plain bearings, no direct contact between the sliding members occurs. Any change and possible damage thus result from thermal effects (overheating, see 2.3), fluctuation in oil film pressure (fatigue, see 2.4), pressure fluctuation on a micro scale (cavitation erosion, see 2.5), chemical interaction with the lubricant (corrosion and deposition, see 2.6 and 2.7, respectively), or some special circumstance (see 2.8).

The presence of hard extraneous particles dimensionally exceeding the minimum oil film thickness causes indirect local contact between the plain bearing and the journal (dirt contamination, see 2.1).

Under unfavourable operating conditions for hydrodynamic lubrication, direct contact between the journal and the bearing may prevail either over a wide area (starting and stopping, high loads, high temperatures) or more localized (alignment faults, see 2.9) resulting in contact wear (see 2.2).

Both direct contact and dirt contamination increase the severity of operating conditions thereby accentuating thermal and chemical effects (see 2.3 and 2.6, respectively).

Possible deviation from ideal configuration in a bearing assembly may be expected to occur predominantly in the region of closest approach between journal and bearing, the location of which is related to the loading direction. The incidence of an unusual pattern of damage may indicate that the geometry under load deviates from the ideal configuration or that an abnormal load is being encountered (see 2.9).

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Plain bearings — Terms, characteristics and causes of damage and changes in appearance

Section 1: General

1.1 Scope

This International Standard defines, describes and classifies the characteristics and causes of damage and changes in appearance occurring in service in hydrodynamically lubricated plain bearings and journals. It will assist in the understanding of the various forms of change and damage which may occur.

For the purposes of this International Standard, the term "damage to plain bearings" includes all damage and changes in appearance occurring in the bearing surface during operation, whether or not the change or damage adversely affect the performance of the bearing.

Consideration is restricted to characteristic forms of change and damage which have a well-defined appearance and which can be attributed to particular causes with a high degree of certainty. The features peculiar to the change and damage are described, the various forms are illustrated with photographs and diagrams, and the most frequent causes are given.

1.2 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 4378-1:1983, *Plain bearings — Terms, definitions and classification — Part 1: Design, bearing materials and their properties.*

ISO 4378-2:1983, *Plain bearings — Terms, definitions and classification — Part 2: Friction and wear.*

ISO 4378-3:1983, *Plain bearings — Terms, definitions and classification — Part 3: Lubrication.*

1.3 Definitions

For the purposes of this International Standard, the definitions given in ISO 4378-1 and ISO 4378-2 and ISO 4378-3 apply.

Section 2: Damage to the bearing lining

2.1 Dirt contamination

The effect of contaminating hard particles upon a surface strongly depends on the relative motion of the particles. A stationary position with respect to the bearing (see 2.1.1) implies the risk of scoring the journal (extreme effect in 2.8.3) and *vice versa* (see 2.1.2). Motion with respect to both surfaces is usually rather irregular (see 2.1.3).

NOTE 1 Scoring can also occur in direct journal-to-bearing contact (see 2.2).

2.1.1 Embedded particles (see figures 1 to 3)

2.1.1.1 Characteristics

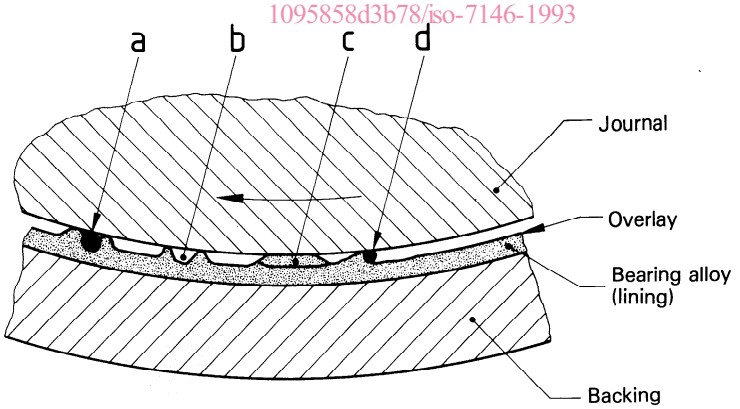
Pitted surface with some particles of dirt embedded in the bearing surface, surrounded by raised bearing metal displaced as the dirt particle is embedded. The raised bearing metal is often subject to rubbing by the counterface, and in this case appears as a highly reflective halo around the embedded particle.

The formation of wire wool can be caused by embedded dirt (see 2.8.3).

2.1.1.2 Causes

Contamination of the oil by residues from manufacturing or commissioning (metal turnings, casting sand), poor maintenance of or damage to the filters (carbon in the oil, particles produced by the wear of other components) or bearing damage (fatigue, cavitation wear).

Introduction of foreign bodies during installation.



Key

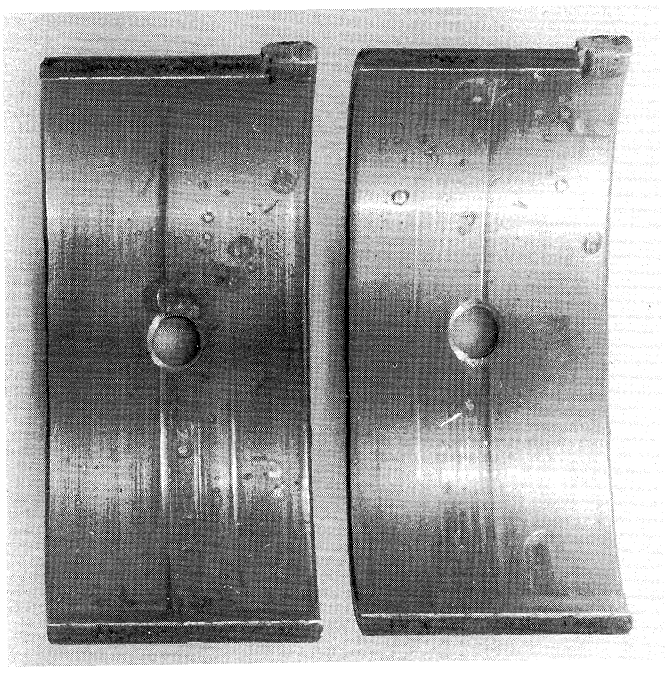
a — embedded foreign particle usually with a highly reflective raised ring (halo) of bearing material around it (see also figure 2)

b — crater left by a displaced foreign particle (see also figure 3)

c — particle of bearing metal from a damage site elsewhere in the bearing smeared onto the bearing surface

d — foreign particle with entry track

Figure 1 — Schematic diagram of possible forms of embedding



Material: steel/AlSn
Magnification: × 1 (actual size)

Figure 2 — Embedding of foreign particles (typical of cause **a** illustrated in figure 1)

Material: steel/lead bronze/electroplated overlay
Magnification: × 50

Figure 3 — Crater left by displaced foreign particle surrounded by reflective ring (halo) (typical of cause **b** illustrated in figure 1)

2.1.2 Scoring (see figures 4 and 5)

2.1.2.1 Characteristics

Scratches in the direction of motion. Deep scores or grooves may show displaced bearing metal alongside. Scores and grooves are burnished by wear (see figure 4).

This results in a highly reflective line on both sides of the groove, usually occurring in the most highly loaded region of the bearing, but occasionally around the entire circumference.

2.1.2.2 Causes

Contamination of the oil by large hard particles introduced during manufacture or commissioning (turnings), particles resulting from damage to other components due to poor maintenance, filter damage or bearing damage (fatigue, cavitation wear) to the same bearing or the bearing immediately preceding it in the oil supply system.

NOTE 2 Fine but widespread scoring is also possible as a result of mixed lubrication (see 2.2).

Material: steel/lead bronze/electroplated overlay
Magnification: x 1 (actual size)

NOTE — Score has been burnished by wear on this thin-walled bearing.

Figure 4 — Deep circumferential score with displaced bearing metal alongside

Magnification: × 1 (actual size)

Figure 5 — Scoring by particles entrained in the oil on a thick-walled bearing

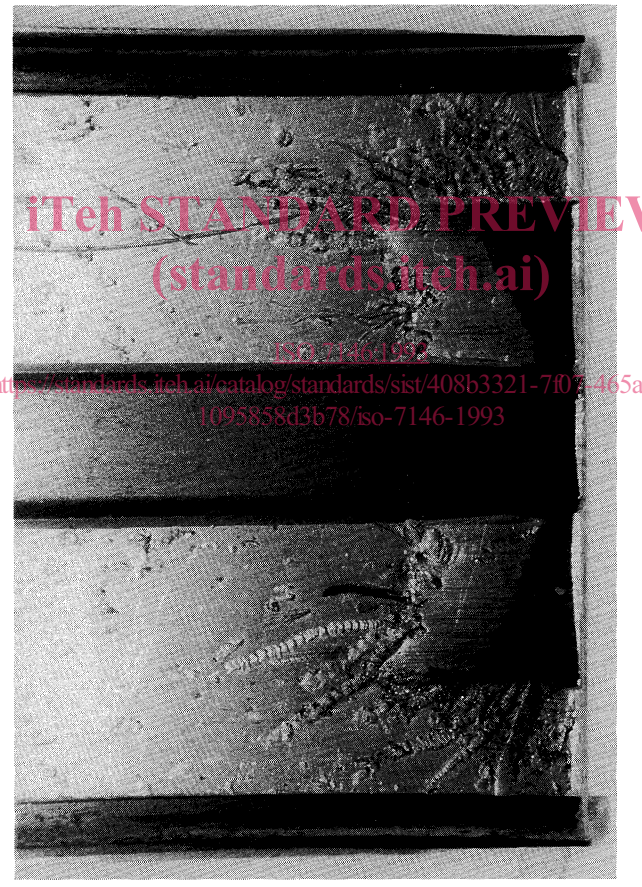
2.1.3 Dirt migration tracks (see figure 6)

2.1.3.1 Characteristics

Multiple indentations by a hard particle in a line generally inclined to the outer edge of the bearing often originating from grooves, pockets or oil inlets.

2.1.3.2 Causes

Contamination of the oil by very large hard particles introduced during manufacture or commissioning, particles resulting from damage to other components due to poor maintenance or filter damage.



← Direction of shaft rotation

Material: steel/AlSn
Magnification: × 2

Figure 6 — Dirt migration tracks from a pocket in a thin-walled bearing

2.1.4 Influence of dust (see figure 7)

2.1.4.1 Characteristics

Matt, often slightly roughened and finely scored surface.

2.1.4.2 Causes

Increased accumulation of dust or mud which reaches the lubricant despite air filtration and sealing.

Material: steel/lead bronze/electroplated overlay
Magnification: x 3

Figure 7 — Change of appearance of lining due to influence of dust on a thin-walled bearing, with matt and roughened surface and isolated fine scores

2.2 Wear through partial lubrication

Wear is confined to changes in microgeometry and to the loss of material as a result of interaction between journal and bearing.

NOTE 3 Scoring can also result from dirt contamination (see 2.1.2).

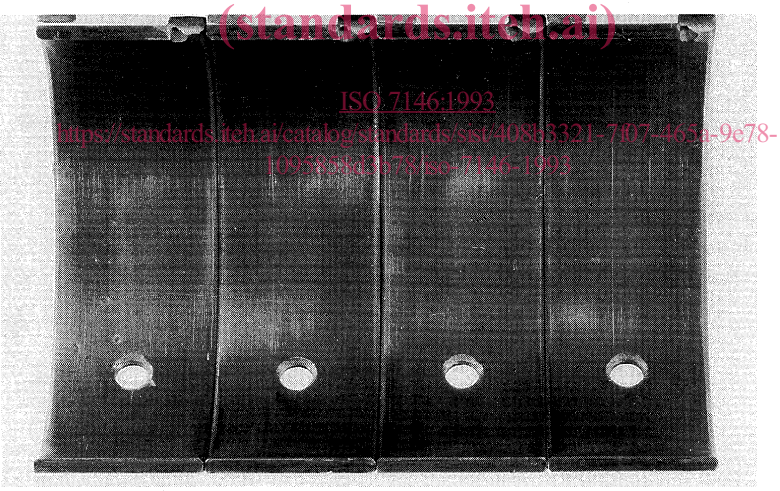
2.2.1 Running-in polishing (see figure 8)

2.2.1.1 Characteristics

Very light reflective marks in the most highly loaded region of the bearing; marks which appear across the whole width of the bearing or in local areas of high pressure. The transition from unmarked to marked areas is quite gradual. This polishing does not give rise to a detectable reduction in wall thickness. Such running-in marks are normal after a short period of operation.

2.2.1.2 Causes

Polishing of the asperities on the bearing surface in the most highly loaded region and on local areas of high pressure.



Material: steel/AlSn
Magnification: × 1 (actual size)

Figure 8 — Running-in polishing and burnishing in the main loaded area of a thin-walled bearing

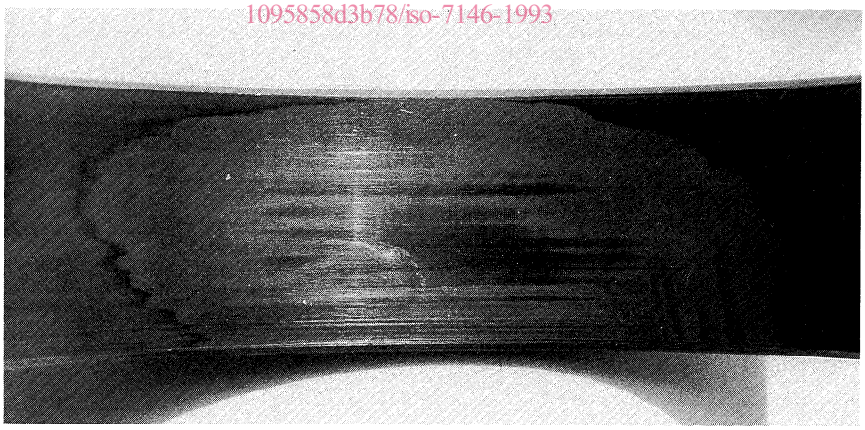
2.2.2 Bedding-in or adaptive wear (see figure 9)

2.2.2.1 Characteristics

Smooth reflective wear marks in the most highly loaded region of the bearing; marks which appear across the whole width of the bearing or in local areas of high pressure. The transition from unmarked to marked areas is quite gradual. The reduction in wall thickness is barely perceptible. Such running-in or adaptive wear is normal after an appropriate interval of operation.

2.2.2.2 Causes

Smoothing of the asperities and the bearing surface profile in the most highly loaded region and on local areas of high pressure.



Material: steel/lead bronze/electroplated overlay
Magnification: × 1 (actual size)

Figure 9 — Bedding-in wear of the overlay in the main loaded area on a thin-walled bearing