SLOVENSKI STANDARD
SIST ISO 6281:2008

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Nadomeģ a:
SIST ISO/TR 6281:2002

Drsni leģaji - Preskuģanje leģajev na preskuģevaliģ u pri hidrodinamiļ nem mazanju in meģanem trenju - Smernice

Plain bearings - Testing under conditions of hydrodynamic and mixed lubrication in test rigs

Gleitlager - Prüfung bei Vollschmierung und Mischreibung - Richtlinien

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INTERNATIONAL STANDARD

ISO 6281

First edition
2007-06-15

Plain bearings — Testing under conditions of hydrodynamic and mixed lubrication in test rigs

Paliers lisses — Essai des paliers lisses dans les conditions de lubrification hydrodynamique et mixte dans des machines d'essai pour paliers

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 6281 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 first edition of ISO 6281 cancels and replaces ISO/TR 6281:1990, of which it constitutes a technical revision.

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Plain bearings — Testing under conditions of hydrodynamic and mixed lubrication in test rigs

1 Scope

This International Standard establishes guidelines for the testing of lubricated plain journal bearings in test rigs, running under conditions of hydrodynamic or mixed lubrication, during bearing and/or material development. It deals with both static and dynamic loading in solid and multi-layer journal bearings. It is not applicable to the testing of dynamic characteristics of lubricant film in journal bearings applied in calculation of vibration and stability of turbo-rotors. Further details of test procedures will need to be established when carrying out testing based on these guidelines.

2 Symbols

See Table 1.

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Table 1 — Symbols

Symbol	Description	Unit
a	Length of period	s
B	Bearing width	mm
F	Bearing load	N
F^*	Bearing load per unit bearing width	N/mm
f	Coefficient of friction of journal bearing	—
t	Time	s
U	Sliding velocity	m/s
β	Direction of bearing load	°
ω	Angular velocity	rad/s
η	Dynamic viscosity of lubricant	$N{\cdot}s/m^2$

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3 Test objectives for bearing properties

The test objectives for plain journal bearing test rigs operating under conditions of hydrodynamic or mixed lubrication are to obtain information, among others, on the following bearing properties, which can serve as critical variables when designing and applying the bearing (see ISO 4378):

a) running-in ability;

b) wear resistance;

c) compatibility between bearing and journal materials (resistance to adhesion);

d) embeddability (foreign particles absorption);

e) resistance to journal scoring and abrasion;

f) conformability;

g) deformability (compressive strength);

h) resistance to erosion (cavitation erosion, fluid erosion, particle erosion);

i) static load carrying capacity;

j) dynamic load carrying capacity (fatigue strength);

k) friction characteristics;

l) lubricant flow rate characteristics;

m) temperature increase characteristics.

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Of these bearing properties, the first group, a) to h), depends primarily on the mechanical and tribological properties of sliding materials under specified conditions. The second group, i) to m), depends primarily on hydrodynamic variables, and therefore also on

— viscosity as a function of temperature, pressure and shear rate,

— energy dissipation in the lubricant film (shear heating and heat dissipation), and

— elastic and thermal deformation of the bearing and journal, and hence change of lubricant film thickness (thermo-elastohydrodynamic lubrication).

The determination of these bearing properties, or test objectives, requires lubrication conditions that can involve boundary, mixed or hydrodynamic lubrication — the three modes of lubrication regime. In certain cases, a repeated, time-dependent change between mixed and hydrodynamic lubrication can be required.

NOTE Specific test methods may not yet exist for all of the above-mentioned bearing properties.

Figure 1 depicts the typical relation between the dimensionless number, $\eta U/F^*$, and the coefficient, f, of friction of the journal bearing, where η, U and F^* denote dynamic viscosity of the lubricant, sliding velocity and bearing load per unit bearing width ($F^* = F/B$), respectively. It shows the three regimes of boundary, mixed and hydrodynamic lubrication and qualitatively indicates the dependence between these important parameters.

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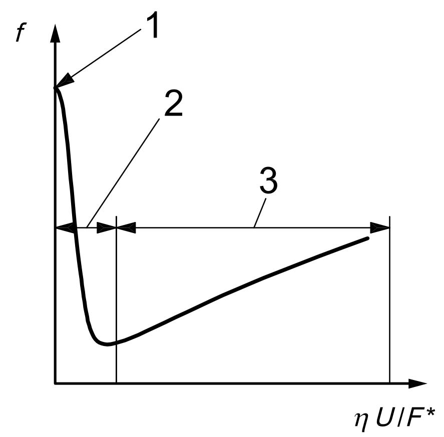

Key

1 boundary lubrication

2 mixed lubrication

3 hydrodynamic lubrication

Figure 1 — Three modes of lubrication regime

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4 Test rigs

4.1 General recommendations

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It is often more practical and efficient to investigate the bearing in a test rig than in an actual application. The design of the bearing test rig should be such as to simulate as far as possible all the relevant characteristic parameters (geometric, dynamic, hydrodynamic, thermal, thermodynamic, etc.) of the actual application.

In addition, the following is recommended for the test rig.

a) Simple mechanical construction.

b) Simple dismantling and assembly procedures for the test objects; with well-defined positioning of the bearing and housing; preferably it should be possible to inspect the test bearing *in situ*. In addition, the test rig should be equipped with an emergency stop mechanism, both for safety reasons and to allow the inspection of the sliding surface before the onset of catastrophic damage.

c) Well-defined dimensions for the test bearing.

d) High dimensional stability with little shaft deflection. The test rig should be as rigid as possible, with a high natural frequency. In special cases, however, it may be necessary to vary the dimensional stability or the shaft deflection in order to simulate the operating condition of the actual application.

e) Appropriate lubricant supply condition. When the lubricant flow within the bearing clearance has to be simulated exactly, the circumferential and axial position of the lubricant supply in the test rig should be the same as in the actual application.

f) Well-defined and experimentally verifiable lubrication conditions.

g) The regime of laminar or turbulent flow should be the same in the test rig and in the actual application.

h) The rig should replicate as far as possible the temperature and stress range that can occur in practice.

i) Appropriate measuring techniques or equipment should be employed.

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4.2 Generic types of test rig

Generic types of test rig for plain journal bearings are shown in Figures 2 and 3. Figure 2 a) and b) depict the rotational motion of the journal, where a combination of both is also possible. In practice, many more patterns of journal motion other than rotation may occur, such as inclination, bending, axial, conical and their combinations. In addition, the bearing itself can rotate or oscillate or even move in space instead of, or together with, the journal, as with a crank-pin bearing. In any case, the relative motion of the journal to the bearing has to be known (measurable) exactly. However, constant rotational speed of journal and the parallel movement of journal to bearing are the simplest and most preferable for testing.

Figure 3 shows patterns of the bearing load. In the case of statically loaded journal bearing [Figure 3 a)], the magnitude, F, and the direction, β, of the bearing load are constant. In a special case of dynamically loaded bearing, F is constant, but β increases or decreases with time [Figure 3 b)]. In the general case of dynamically loaded bearing [Figure 3 c)], both or at least one of F and β change periodically, while the remaining variable can be constant. The periodic form of F (also β) is then arbitrary, such as sinusoidal with or without constant offset, curving steeply up and downwards, as, for example, in engine bearing loading.

With regard to the loading of the test bearing, it is often more practical to load the test bearing directly supported by the journal [Figure 4 a)], than to load the test bearing indirectly through the journal [Figure 4 b)]. For static loading, a dead weight system, with or without lever, or hydraulic or pneumatic actuation can be used. For dynamic loading, a rotating or vibrating mass system, with or without lever, an electromagnetic exciter, hydraulic actuation, etc., can be applied. Dynamic loading by means of a mass fixed to the journal seems to be simple, but the amplitude of the bearing load is then determined primarily by the rotational speed of the journal. Therefore, it is not easy to change the load amplitude independently of the rotational speed. Furthermore, the magnitude and direction of the bearing load have to be precisely measured, and it is important to let the journal move freely inside the bearing clearance without hindrance from the loading mechanism.

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Besides such bearing test rigs operating under hydrodynamic or mixed lubrication, as described above, many other kinds of test apparatus and test methods may be used to investigate the tribological or mechanical properties of bearing materials, including coefficient of friction, mechanical strength, hardness, elasticity, plasticity and bond strength. The study of the tribological properties of boundary films has also led to the development of other test apparatus and methods; these are, however, outside the scope of this International Standard (see ISO 4384-1, ISO 4384-2, ISO 4385, ISO 7148-1, ISO 7148-2, ISO 7905-2, ISO 7905-3 and ISO 7905-4).

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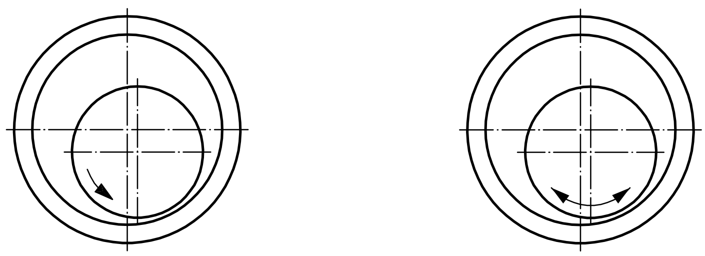
NOTE The testing of the resistance to corrosion of bearing materials by the lubricant is the subject of ISO 10129.



a) Rotation b) Oscillation

Figure 2 — Rotational motion of journal

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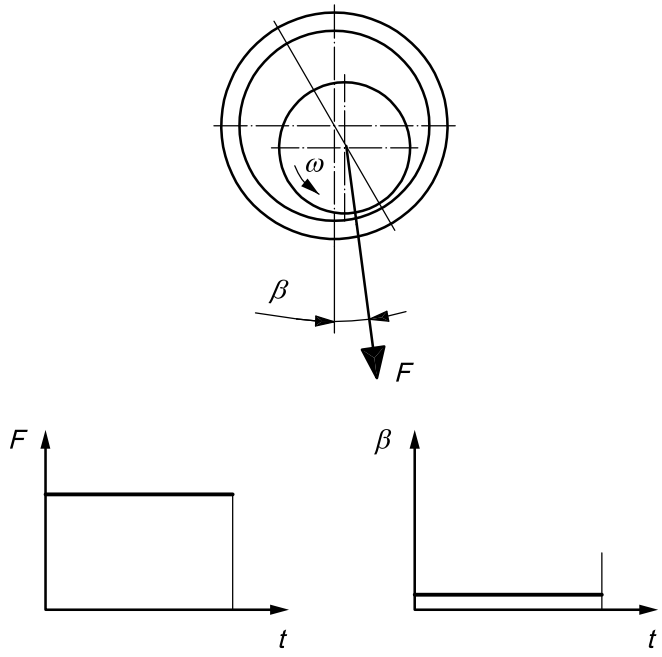

a) Static load

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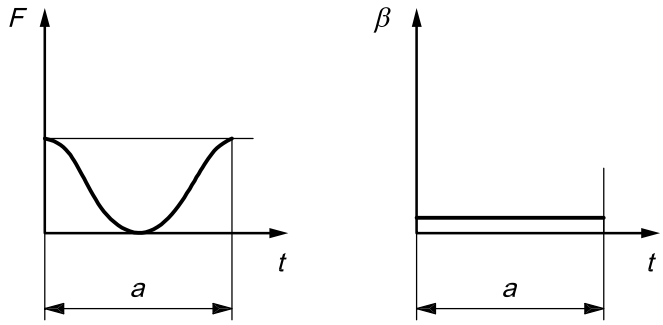
b) Dynamic load (rotating load)



c) Dynamic load (arbitrary pattern)

Key

a length of period
F bearing load
β direction of bearing load
t time
ω angular velocity

Figure 3 — Examples of bearing load patterns

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