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Plain bearings — Terms, definitions, classification and symbols —

Part 5:
Application of symbols

Paliers lisses — Termes, définitions, classification et symboles —

Partie 5: Application des symboles

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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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 4378-5 was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 6, *Terms and common items*.

This first edition cancels and replaces ISO 4378-4:1997 as well as ISO 7904-2:1995, which have been technically revised.

ISO 4378 consists of the following parts, under the general title *Plain bearings — Terms, definitions, classification and symbols*:

— *Part 1: Design, bearing materials and their properties*

— *Part 2: Friction and wear*

— *Part 3: Lubrication*

— *Part 4: Basic symbols*

— *Part 5: Application of symbols*

Introduction

As there is a large number of multiple designations in the domain of plain bearings, there is a considerable risk of error in the interpretation of standards and technical literature. This uncertainty leads to the continuous addition of supplementary designations, which only serves to increase the misunderstanding.

This part of ISO 4378 specifies pratical applications of the general symbols used in the field of plain bearings.

Plain bearings — Terms, definitions, classification and symbols —

Part 5:
Application of symbols

1 Scope

This part of ISO 4378 specifies practical applications of the general symbols defined in ISO 4378-4, with regard to the calculations, design and testing of plain bearings.

ISO 4378-4 distinguishes between basic characters and additional signs. Additional signs are subscripts and superscripts. The symbols necessary for plain bearing calculations, design, manufacture and testing are just basic characters or combinations of basic characters and additional signs.

This part of ISO 4378 lists symbols which have been found necessary for the calculations, design and testing of plain bearings. They have been defined in accordance with the recommendations given in ISO 4378-4.

Angles and directions of rotation are defined positively as rotating in a left-hand (anticlockwise) direction; the same applies to rotational frequencies, and circumferential and angular velocities.

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 4378-4, *Plain bearings — Terms, definitions, classification and symbols — Part 4: Basic symbols*

3 Symbols and terms

The following listings are not necessarily complete. They may be enlarged, if necessary.

NOTE Some letters of the Roman and Greek alphabet have not yet been used. Therefore, these letters are not listed below.

3.1 Symbols of the Roman alphabet

A	heat-emitting surface area (bearing housing), elongation at fracture
A^*	heat-emitting surface area parameter [thrust bearing, $A^* = A/(B \times L \times Z_{\mathrm{ax}})$]
A_{B}	area of segment or pad
A_{G}	area of groove cross-section
A_{i}	heat-emitting surface area (bearing housing) inside of the machine (flange bearing)

A_{lan} land area

A^*_{lan} relative land area ($A^*_{lan} = A_{lan}/(\pi \times D \times B)$ for hydrostatic journal bearings)

A_o heat-emitting surface area (bearing housing) outside of the machine (flange bearing)

A_P area of lubricant pocket

A_S area of cross-section

$\bar{A}_T$ specific area of tube

$A_{T,i}$ area of tube cross-section flowed through

a distance, acceleration, thermal diffusivity, inertia factor

a_F distance between leading edge and pivot position of pad (tilting-pad bearing)

a^*_F relative distance between leading edge and pivot position of pad (tilting-pad bearing)

a_{min} minimum distance between two circular thrust pads

a_T distance between temperature measuring point and bearing sliding surface

B width parallel to the sliding surface, normal to the direction of motion; bearing width, nominal bearing width, pad width, nominal pad width

B^* relative width, relative bearing width, relative pad width, width ratio ($B^* = B/D$)

B_{ax} width of thrust bearing or thrust pad [$B_{ax} = (D_o - D_i)/2$]

B_{eff} effective bearing width (without grooves, chamfers, etc.), effective pad width

B_H outer width of bearing housing in axial direction

B_{tot} total bearing width

b width parallel to the sliding surface, normal to the direction of motion or flow

b_c width of circumferential discharge (hydrostatic bearing, $b_c = B - b_{lan}$)

b_G width of lubricant groove, width of lubricant supply groove, width of bleed groove

b_{lan} land width parallel to the sliding surface, normal to the direction of flow

b_P width of lubricant pocket, width of lubricant supply pocket

b^*_P relative width of lubricant pocket, relative width of lubricant supply pocket

C bearing clearance, nominal bearing clearance, chamfer, concentration

C_{ax} axial bearing clearance (thrust bearing)

$C_{ax,m}$ mean value of C_{ax} [$C_{ax,m} = (C_{ax,min} + C_{ax,max})/2$]

$C_{ax,max}$ maximum value of C_{ax}

$C_{ax,min}$ minimum value of C_{ax}

C_D bearing clearance, bearing diametral clearance (difference between bearing bore and journal diameter of a journal bearing, $C_D = D - D_J$)

$C_{D,m}$ mean value of C_D [$C_{D,m} = (C_{D,min} + C_{D,max})/2$]

$C_{D,eff}$ effective bearing diametral clearance

$C_{D,max}$ maximum value of C_D

$C_{D,min}$ minimum value of C_D

C_G circumference of groove cross-section

C_R bearing radial clearance (difference between bearing bore and journal radius of a journal bearing, $C_R = R - R_J$)

$\Delta C_{R,el}$ elastic change of C_R

$C_{R,eff}$ effective bearing radial clearance

$C_{R,m}$ mean value of C_R [$C_{R,m} = (C_{R,min} + C_{R,max})/2$]

$C_{R,max}$ maximum value of C_R

$C_{R,min}$ minimum value of C_R

$\Delta C_{R,th}$ thermal change of C_R

$\Delta C_{R,tot}$ total change of C_R ($\Delta C_{R,tot} = \Delta C_{R,el} + \Delta C_{R,th}$)

c specific heat capacity, lubricant specific heat capacity, stiffness

c_{ax} axial bearing stiffness

$c_{ax,i}$ axial stiffness of the bearing when load is directed into the machine (flange bearing)

$c_{ax,o}$ axial stiffness of the bearing when load is directed out of the machine (flange bearing)

c_{dw} vertical stiffness of the bearing loaded downwards

c_F stiffness of pad pivot support in direction of load (tilting-pad bearing)

c_h horizontal bearing stiffness

c_{ik} lubricant film stiffness coefficient of journal bearing (i, k = 1, 2)

c_{ik}^* non-dimensional lubricant film stiffness coefficient of journal bearing

$$c_{ik}^* = \frac{\psi^3}{2 \times B \times \eta \times \omega} \times c_{ik} \; (i, k) = (1, 2)$$

$c_{ik,i}$ inner lubricant film stiffness coefficient of journal bearing (i, k = 1, 2)

$c_{ik,o}$ outer lubricant film stiffness coefficient of journal bearing (i, k = 1, 2)

c_{JR} flexural stiffness of the Jeffcott Rotor

c_p specific heat capacity of the lubricant (at constant pressure)

$c_{p,cl}$ specific heat capacity of the coolant (at constant pressure)

c_{sh} flexural stiffness of shaft

c_{sup} stiffness of isotropic bearing or bearing shell support

$c_{sup,ik}$ stiffness coefficient of anisotropic bearing or bearing shell support (i, k = 1, 2)

c_{up} vertical stiffness of the bearing loaded upwards

c_{v} vertical bearing stiffness

c_{ϑ} angular stiffness of pad pivot support (tilting-pad bearing)

D bearing diameter (inside diameter of journal bearing), nominal bearing diameter

D_{B} twice the lobe or pad bore radius of a multi-lobed or tilting-pad journal bearing

$D_{\mathrm{B,m}}$ mean value of D_{B} [$D_{\mathrm{B,m}} = (D_{\mathrm{B,min}} + D_{\mathrm{B,max}})/2$]

$D_{\mathrm{B,max}}$ maximum value of D_{B}

$D_{\mathrm{B,min}}$ minimum value of D_{B}

$D_{\mathrm{B,o}}$ outside diameter of bearing shell or pad of a fixed-pad or tilting-pad journal bearing

D_{fi} (outside) diameter of lubricating ring fixed to the shaft

$D_{\mathrm{H,i}}$ inside diameter of bearing housing

$D_{\mathrm{H,o}}$ outside diameter of bearing housing

D_{i} inside diameter of thrust bearing sliding surface

D_{J} journal diameter (diameter of the shaft section located inside of a journal bearing)

$D_{\mathrm{J,m}}$ mean value of D_{J} [$D_{\mathrm{J,m}} = (D_{\mathrm{J,min}} + D_{\mathrm{J,max}})/2$]

$D_{\mathrm{J,max}}$ maximum value of D_{J}

$D_{\mathrm{J,min}}$ minimum value of D_{J}

D_{lo} (outside) diameter of loose lubricating ring

D_{m} mean diameter of thrust bearing sliding surface [$D_{\mathrm{m}} = (D_{\mathrm{i}} + D_{\mathrm{o}})/2$]

D_{max} maximum value of D

D_{min} minimum value of D

D_{o} outside diameter of thrust bearing sliding surface

$D_{\mathrm{T,i}}$ inside diameter of tube

$D_{\mathrm{T,o}}$ outside diameter of tube

d diameter, distance, depth, damping

d_{B} diameter of circular thrust pad

d_{cp} diameter of capillary

d_{e} damping of eigenfrequency, system damping

d_{F} damping of pad pivot support in direction of load (tilting-pad bearing)

d_{G} diameter of groove

$d_{\mathrm{G,m}}$ mean diameter of groove

d_{ik} lubricant film damping coefficient of journal bearing (i, k = 1, 2)

d_{ik}^* non-dimensional lubricant film damping coefficient of journal bearing

$$\left[d_{ik}^* = \frac{\psi^3}{2 \times B \times \eta \times \omega} \times \omega \times d_{ik} \; (i, k = 1, 2) \right]$$

d_L lubrication hole diameter

$d_{orf,i}$ inside diameter of orifice

$d_{orf,o}$ outside diameter of orifice

d_P diameter of lubricating pocket

d_{sup} damping of isotropic bearing or bearing shell support

$d_{sup,ik}$ damping coefficient of anisotropic bearing or bearing shell support (i, $k = 1, 2$)

d_ϑ angular damping of pad pivot support (tilting-pad bearing)

E Young's modulus (modulus of elasticity)

E_B Young's modulus of bearing material

E_J Young's modulus of journal material

E_{res} resultant Young's modulus

E_{sh} Young's modulus of shaft material

e eccentricity (distance between journal and bearing axis)

e_B eccentricity of bearing sliding surfaces (segments or pads) of a multi-lobed or tilting-pad journal bearing

$e_{B,h}$ eccentricity of bearing sliding surfaces (segments) of a multi-lobed journal bearing in the horizontal direction

$e_{B,v}$ eccentricity of bearing sliding surfaces (segments) of a multi-lobed journal bearing in the vertical direction

e_{CG} eccentricity of centre of gravity (distance between centre of gravity and shaft axis)

e_x component of eccentricity normal to direction of load

e_y component of eccentricity in direction of load

F bearing force, bearing load, nominal bearing load, load-carrying capacity

F^* bearing force parameter

ΔF additional dynamic force

ΔF^* additional dynamic force parameter ($\Delta F^* = \dfrac{\Delta F \times \psi^2}{B \times D \times \eta \times \omega}$ for journal bearings)

F_{ax} axial bearing force, axial bearing load, thrust bearing load (nominal load)

$F_{ax,lim}$ maximum admissible thrust bearing load

$F_{ax,lim,i}$ maximum admissible thrust bearing load directed into the machine (flange bearing)

$F_{ax,lim,o}$ maximum admissible thrust bearing load directed out of the machine (flange bearing)