
**Plain bearings — Hydrodynamic plain
journal bearings under steady-state
conditions —**

**Part 3:
Functions for calculation of tilting pad
journal bearings**

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ISO/TS 31657-3:2020

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 123, *Plain bearings*, Subcommittee SC 8, *Calculation methods for plain bearings and their applications*.

A list of all parts in the ISO/TS 31657 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Plain bearings — Hydrodynamic plain journal bearings under steady-state conditions —

Part 3: Functions for calculation of tilting pad journal bearings

1 Scope

This document specifies the characteristic values for selected tilting-pad journal bearings with four or five centrally or eccentrically supported tilting pads and with angular spans of pad sliding surfaces of $\Omega = 80^\circ, 60^\circ$ and 45° .

The functions plotted and listed in table form below are required for the operationally safe design of hydrodynamic tilting-pad journal bearings according to ISO/TS 31657-1. They are based on the presumptions and boundary conditions indicated there and only apply to stationary operating states. The symbols used are explained in ISO/TS 31657-1; calculation examples are also included there.

The calculation method described in ISO/TS 31657-1 can also be used for other tilting-pad journal bearing designs, if the numerical solutions of the basic equations are available in the same manner for these designs.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

ISO/TS 31657-3:2020

<https://standards.iteh.ai/catalog/standards/iso/3973e24a-3de7-4a3f-83fd-8a36f8e4b95c/iso-ts-31657-3-2020>

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Functions for calculation of multi-lobed journal bearings

4.1 General

The characteristic values for symmetrically loaded tilting-pad journal bearings with four and five centrally (relative angular distance between leading edge and pivot position of pad $\Omega_F^* = 0,5$) or eccentrically ($\Omega_F^* = 0,6$) supported tilting pads are indicated below in table form.

The characteristic values were calculated for the geometrical parameters summarised in [Figure 1](#) (angular spans of pad sliding surface Ω , angular coordinates of pivot position of pad $\phi_{F,1}$, profile factors

K_p , bearing width ratios B^*) in the operating range $0,02 \leq h_{\min}^* \leq 1$. The following (dimensionless) characteristic values are individually listed in table form:

a) Static characteristic values

Sommerfeld number:

$$So = \frac{F \cdot \psi_{\text{eff}}^2}{B \cdot D \cdot \eta_{\text{eff}} \cdot \omega}$$

Relative eccentricity:

$$\varepsilon = \frac{e}{C_{R,\text{eff}}}$$

Attitude angle β in $^\circ$.

Product of maximum lubricant film pressure parameter and Sommerfeld number:

$$p_{\max}^* \cdot So = \frac{p_{\max} \cdot \psi_{\text{eff}}^2}{\eta_{\text{eff}} \cdot \omega}$$

Minimum relative lubricant film thickness:

$$h_{\min}^* = \frac{h_{\min}}{C_{R,\text{eff}}}$$

Friction force parameter:

$$F_f^* = \frac{f}{\psi_{\text{eff}}} \cdot So$$

Lubricant flow rate parameter due to hydrodynamic pressure build-up:

$$Q_3^* = \frac{Q_3}{Q_0}$$

Lubricant flow rate parameter due to supply pressure:

$$Q_p^* = \frac{Q_p}{P_{\text{en}}^* \cdot Q_0}$$

Lubricant flow rate parameter at the exit of the lubricant gap:

$$Q_2^* = \frac{Q_2}{Q_0}$$

Non-dimensional difference between maximum temperature of lubricant film and lubricant temperature in the lubricant pocket:

$$\Delta T_{\max}^* = \frac{\rho \cdot c_p \cdot \psi_{\text{eff}}}{\bar{p} \cdot f} \cdot \Delta T_{\max}$$

b) Dynamic characteristic values

Non-dimensional lubricant film stiffness coefficients:

$$c_{i,k}^* = \frac{\psi_{\text{eff}}^3}{2 \cdot B \cdot \eta_{\text{eff}} \cdot \omega} \cdot c_{i,k} \quad (i, k = 1, 2)$$

Non-dimensional lubricant film damping coefficients:

$$d_{i,k}^* = \frac{\psi_{\text{eff}}^3}{2 \cdot B \cdot \eta_{\text{eff}} \cdot \omega} \cdot \omega \cdot d_{i,k} \quad (i, k = 1, 2)$$

For some selected tilting-pad journal bearings ($\Omega_F^* = 0,6$, $\Omega = 45^\circ$, $\varphi_{F,1} = 36^\circ$), these characteristic values are shown graphically as a function of the Sommerfeld number So and the profile factor K_p in [Annex A, Figures A.1 to A.11](#).

Z	$\Omega [^\circ]$	$\varphi_{F,1} [^\circ]$	K_p	B^*	Load case
4	80	45	2, 3, 5	0,5, 0,75, 1	
		0	3	0,75	
	60	45	2, 3, 5	0,5, 0,75	
		0	3	0,5	
5	60	36	2, 3, 5	0,5, 0,75	
		0	3	0,5	
	45	36	2, 3, 5	0,5	
		0	3	0,5	

Figure 1 — Geometrical parameters of selected tilting-pad journal bearings
 ($\Omega_F^* = 0,5$ and $\Omega_F^* = 0,6$)