TECHNICAL REPORT

ISO/TR 21784

First edition
2018-09

Plain bearings — Spray nozzle type directed lubrication for tilting pad bearings

Titre manque

Reference number
ISO/TR 21784:2018(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

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

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.

Introduction

These days, rotating machines such as turbines, generators, compressors, pumps, etc. tend to be increasing in speed and reducing in size. Bearings used in such machines can cause large power losses, which not only degrades machine performance but also results in the associated cooling system being larger in size. Directed lubrication type bearings can reduce the power loss significantly. They are energy-saving bearings that can simplify facilities and improve plant efficiency.

Plain bearings — Spray nozzle type directed lubrication for tilting pad bearings

1 Scope

Directed lubrication is an advanced technology that is capable of reducing the power loss and improving the performance of tilting pad type bearings. Unlike flooded lubrication, where the bearing components remain permanently submerged in an oil filled housing, with directed lubrication the components are not submerged and the oil is delivered from an external source directly to the working surfaces of the tilting pads after which it falls freely away to be drained from the bottom of the housing. There are several alternative methods of realising the benefits of directed lubrication in tilting pad bearing designs. As an example, this document specifies a spray nozzle type directed lubrication system where lubricant is supplied to each pad through nozzles mounted between the pads in tilting pad thrust and journal bearings. The design concept of this type of lubrication is described.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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 Symbols and abbreviated terms

For the purposes of this document, the following symbols apply.

Table 1 — Symbols and units

Symbol	Explanation	Unit
B_{tc}	Thrust collar width	m
c_p	Specific heat capacity of lubricant	J/(kg·K)
D_d	Diameter of discharge oil hole	m
d_h	Hole diameter of nozzle	m
K_Q	Coefficient of oil flow rate	1
n_h	Number of holes per nozzle	1
n_n	Number of nozzles per bearing	1
P	Power loss	W
p_{en}	Oil supply pressure	Pa
Q	Total oil flow rate	m^3/s
Q_n	Oil flow rate per nozzle	m^3/s
ΔT	Oil temperature rise	K
ρ	Density of lubricant	kg/m^3

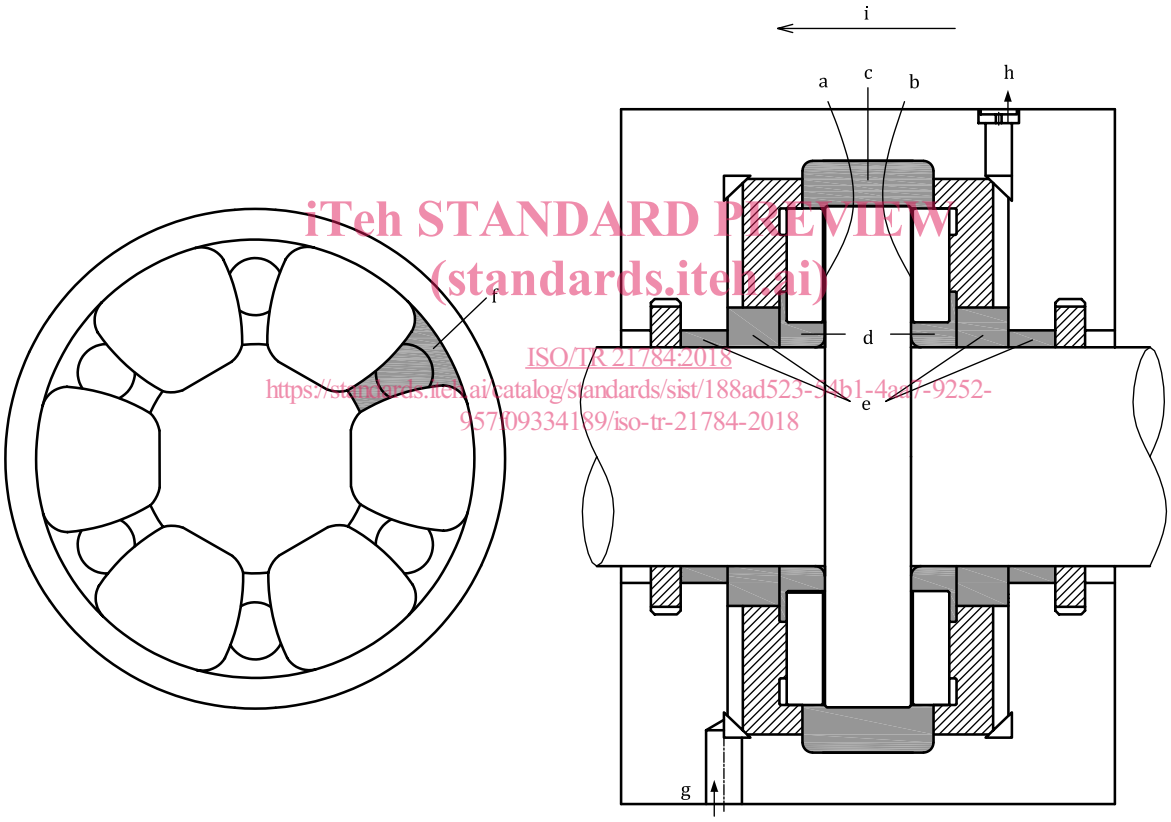
5 Reduction effect of power loss by spray nozzle type directed lubrication systems

The effect of power loss reduction by the spray nozzle type directed lubrication system is shown with regard to tilting pad thrust bearings. The power loss of tilting pad thrust bearings arranged for flooded lubrication consists of shearing losses at the thrust pad surfaces and churning losses from oil in contact with the parts other than the pad surfaces (refer to Figure 1[2][3]).

As the bearing housing of a flooded lubrication type bearing is entirely filled with oil, churning losses cannot be avoided. Particularly at high speed, the churning losses increase rapidly and dominate a majority of the total losses in the bearing (refer to Figure 2[2][3]).

Spray nozzle type directed lubrication bearings supply oil directly to the pad surfaces and are designed to allow all unnecessary oil in the bearing housing to freely flow out. As a result, the churning losses associated with oil coming into contact with parts other than the pad surfaces can be minimized (H3, H4, H5, H6).

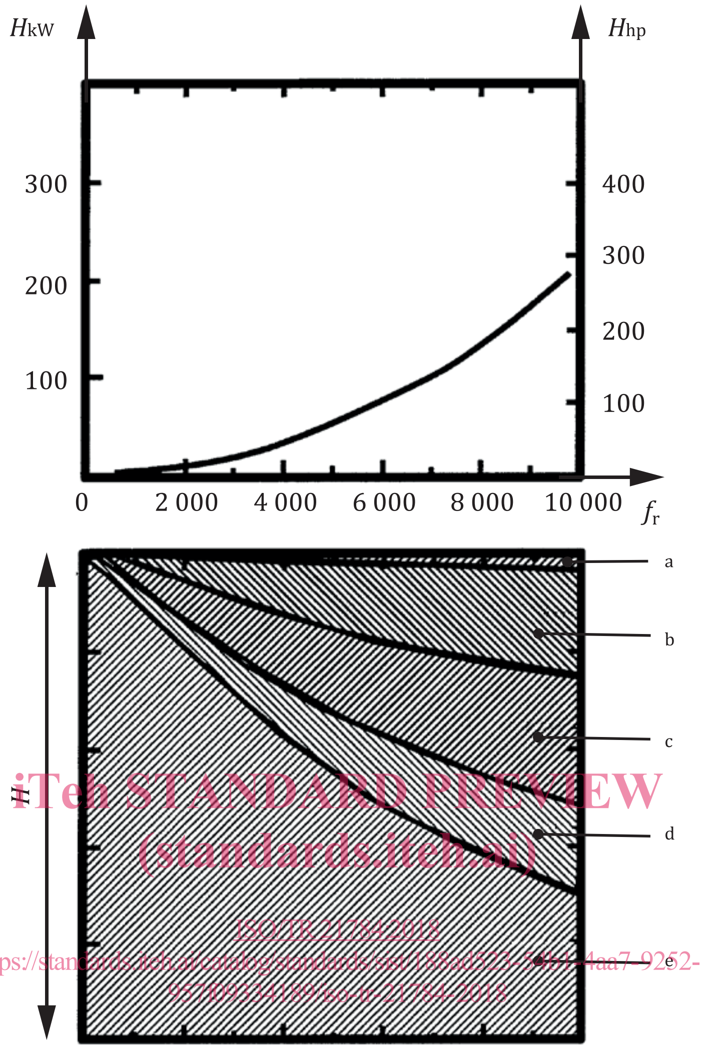
Spray nozzle type directed lubrication produces a significant reduction in power loss in the entire bearing.



Key

a H1 shearing loss.
b H2 shearing loss at reverse face.
c H3 churning loss at rim of collar.
d H4 churning loss at inside of pads.
e H5 churning loss along shaft.
f H6 churning loss between pads.
g Oil inlet.
h Oil outlet.
i Thrust load.

Figure 1 — Components of power loss for flooded lubrication bearings[2][3]



Key

H_{kW} total power loss H, expressed in kW

H_{hp} total power loss H, expressed in hp

f_r rotational frequency, expressed in min^{-1}

a (H4 + H5)/H

b H3/H

c H6/H

d H2/H

e H1/H

NOTE These results are based on a study carried out under the following conditions.

— Type: Double thrust assembly (2 rings of 8 pads each)

— Pad size: 60 mm

— Oil: 25 cSt at 60 °C

— Specific load: 3 MPa

— Housing inlet temperature: 50 °C

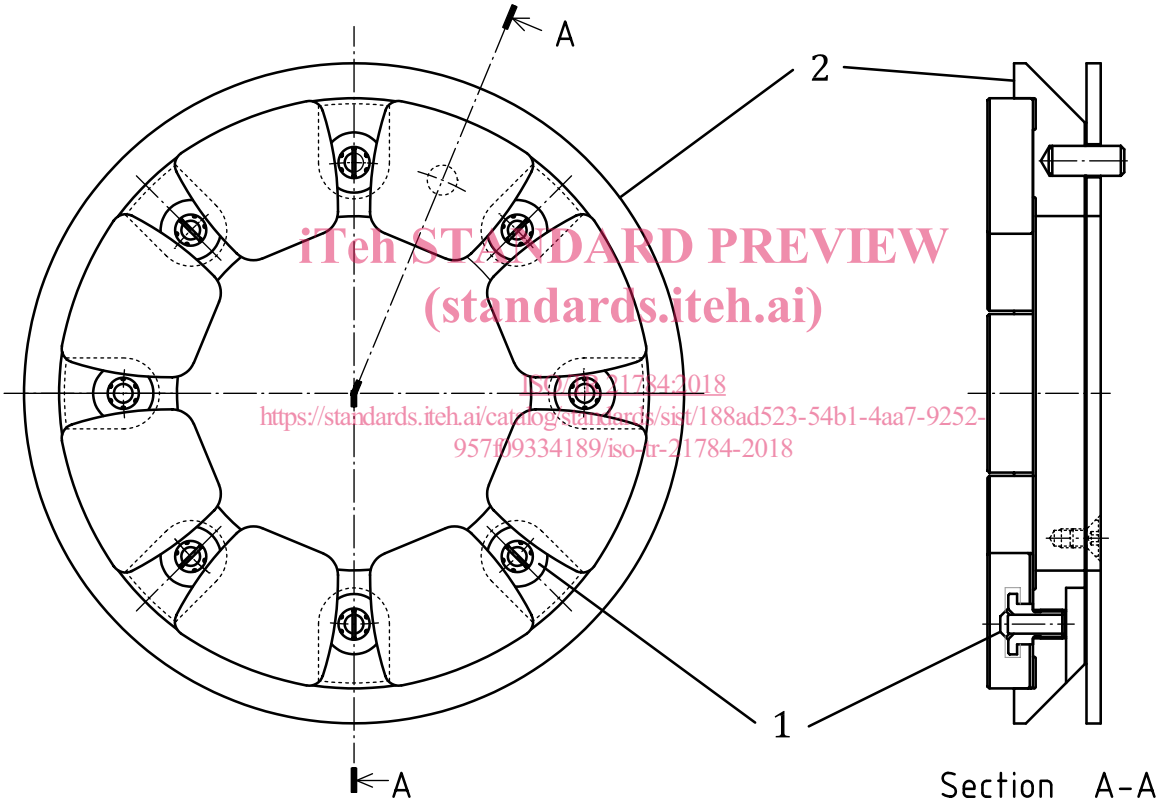
— Housing outlet temperature: 67 °C

Figure 2 — Components of power loss and their variation with speed[2][3]

6 Lubrication system

6.1 Tilting pad thrust bearing

There are two kinds of lubrication systems for tilting pad thrust bearings: a flooded lubrication system and a directed lubrication system. In the flooded lubrication system, lubricant continually fills the inside of the bearing housing. In the spray nozzle type directed lubrication system, lubricant is sprayed from mounted nozzles between the pads to the pad surfaces (refer to Figures 3 and 4). Lubricant is supplied through the oil groove on the back surface of the bearing, led to the nozzles, and then sprayed directly to the thrust collar from the oil supply holes of the nozzles (refer to Figure 4). The nozzles can also act as pad stops, preventing circumferential movement due to rotation of the collar and retaining the pads during assembly and disassembly. The oil sprayed from the oil supply holes ensures ample fresh cooled oil is supplied to the leading edge of each pad and reduces the amount of hot oil carry over from the trailing edge of each preceding pad. The spray nozzle type directed lubrication system delivers the oil required for oil film formation directly to the thrust collar surface and eliminates the need to maintain unnecessary oil in the bearing housing.

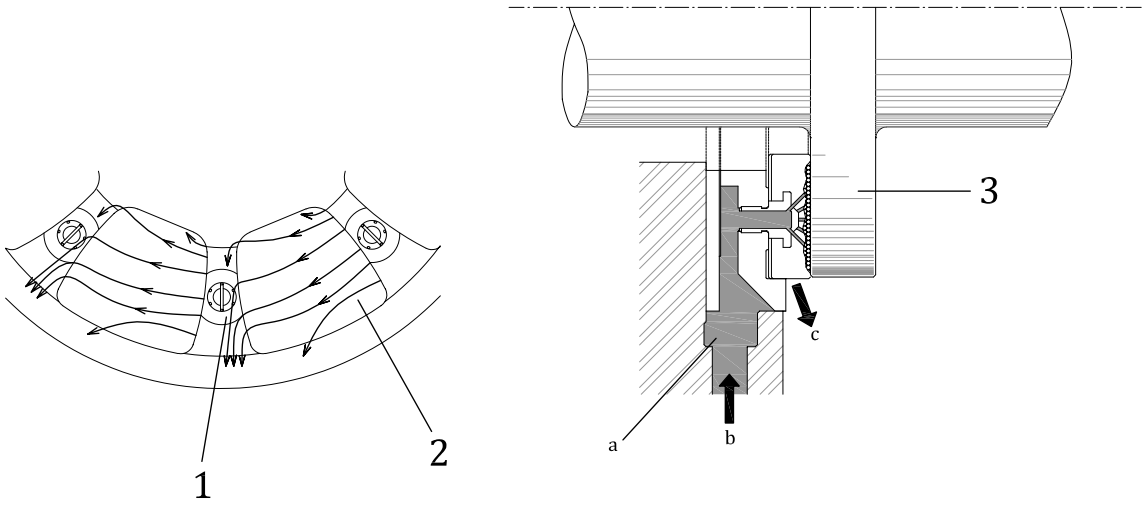


Key

1 nozzle (pad stop)

2 carrier ring

Figure 3 — Spray nozzle type directed lubrication system for a tilting pad thrust bearing



Key

1 nozzle (pad stop)
2 pad
3 collar
a Oil inlet.
b Oil supply.
c Oil discharge.

Figure 4 — Oil sprayed from the oil supply hole of the nozzle

6.2 Tilting pad journal bearing

Like tilting pad thrust bearings, tilting pad journal bearings can also be of the flooded or directed lubrication type. In the flooded lubrication system, oil fills the bearing housing and the working components are kept submerged by attaching seal rings at both axial ends of the bearing. In the spray nozzle type directed lubrication system, oil is supplied directly to the shaft surface from nozzles mounted between the pads and the seal rings attached at both ends of the bearing are removed to allow the oil to discharge freely in the axial direction. Figures 5 a) and 5 b) are examples of arrangements.

In some applications using nozzle type directed lubrication, seal rings are included, but they have a larger clearance with the shaft than in the case of those used for flooded lubrication. In this case, some oil remains to some extent in the bearing housing. Figure 5 c) shows this type of arrangement.