7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Theoretical investigations of a fluid film thrust bearing operational parameters under different oil supply modes

Michał Wodtke[1)*], Jean Bouyer[2)] and Michel Fillon[2)]

[1)]Gdańsk University of Technology, Faculty of Mechanical Engineering, Gdańsk, Poland
[2)]Prime Institute, CNRS - University of Poitiers - ISAE ENSMA, Poitiers, France
*Corresponding author: michal.wodtke@pg.edu.pl

Performance of the parallel land thrust bearing with pockets manufactured on its sliding surface was theoretically investigated. Three modes of the bearing lubrication were analyzed: hydrostatic (HS), hybrid (HS+HD) and hydrodynamic (HD). TEHD bearing model using Fluid Solid Interaction (FSI) approach was developed and verified experimentally. In the case of hybrid and hydrostatic lubrication modes very small differences in predicted bearing parameters were noticed. It was shown that under HD lubrication, parallel land thrust bearing could operate under with relatively small margin of safety due to thermal deformations and that presence of the pockets reduces effectiveness of the hydrodynamic effect.

Keywords: fixed-pad thrust bearing, hydrostatic, hydrodynamic, TEHD modeling

1. Introduction

According the theory of hydrodynamic lubrication, nominally parallel oil film - as formed in fixed-pad thrust bearings - cannot carry external load. Experiments proved that such bearing design can operate in conditions of limited loads. One of the solutions of improving performance of fixed-pad thrust bearings is hybrid or hydrostatic lubrication. Those modes require recesses to be manufactured on the bearing sliding surface, which additionally deteriorates hydrodynamic effect.
The goal of the research was to investigate theoretically operational performance of a parallel fixed-pad thrust bearing under three modes of lubrication: hydrostatic (HS), hybrid (HS+HD) and hydrodynamic (HD).

2. Methods

Parallel land thrust bearing with main geometrical parameters collected in Table 1 was selected as an object of the research. Prior to simulations, bearing was tested experimentally using dedicated test stand [1].

Table 1: Investigated bearing geometrical data.

Bearing outer diameter [10^{-3} m]	90
Bearing inner diameter [10^{-3} m]	50
Number of pads [-]	8
Pocket diameter [10^{-3} m]	6
Pocket depth [10^{-3} m]	0.4
Relative position of the pockets (circumferential/radial) **[-]**	70/50

TEHD model comprising one pad and 1/8th of the collar (with periodic BC) was developed using FSI approach [2]. Implemented modes of lubrication differs with oil supply inlet location: HS+HD (inlet through pocket and at inner bearing space), HS (inlet through pocket) and HD (inlet at inner bearing space). Appropriate BC were applied to imitate bearing conditions under tests (load, speed, oil flow rate). Satisfactory agreement of calculated and measured parameters was obtained.

2.1. Results

Sample of the calculated and measured results for different modes of bearing lubrication are presented in Figure 1. HD+HS and HD cases were obtained for 4000 rpm and 2000 N, while for HD much lower load was assumed (500 N).

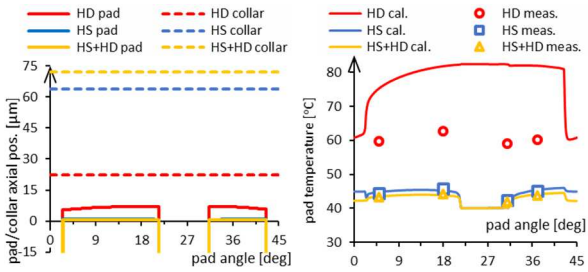

Figure 1: Comparison of calculated and measured bearing parameters at the bearing mid radius: a) position of the pad and collar (film thickness), b) temperature.

3. Discussion

Very small differences of the temperature for HD+HS and HS cases were obtained. Slightly lower temperature and thicker film was calculated for HD+HS case due to larger oil flow through the bearing (two oil inlets summed). In the case of HD lubrication positive pressure was generated close to the pad leading edge before pocket (due to pad sliding surface thermal convexity) and between grooves (axial oil flow from inlet to bearing outlet). In such a case the thrust bearing was operated also under relatively high level of temperature and very thin film thickness.

4. References

[1] Henry, Y. et al. "An experimental hydrodynamic thrust bearing device and its application to the study of a tapered-land thrust bearing," ASME Journal of Tribology 2014, vol. 136, no. 2, p. 021703.
[2] Wodtke, M. et al. "Application of the fluid-structure interaction technique for the analysis of hydrodynamic lubrication problems," Proc Inst Mech Eng Part J J Eng Tribol 2013;227.