ASIATRIB 2002International Conference
JEJU ISLAND, KOREA

EFFECT OF LOAD ANGLE ON THE OPERATION OF TILTING 12-PADS JOURNAL BEARING

S. STRZELECKI [1] and T. SOMEYA [2]

[1] *Lodz University of Technology, Institute of Machine Design, Poland*
Stefanowskiego 1/15, 90-924 Lodz, POLAND
[2] *MUSASHI INSTITUTE OF TECHNOLOGY, Tokyo, JAPAN*

Radial, tilting 12-pad journal bearings are applied as the radial bearings of vertical rotors of water turbines. The mean loads are stable at the peripheral speeds of journal reaching 50 m/s.
The operation of tilting 12-pads journal bearing has been introduced at the assumption of adiabatic oil film. The oil film pressure, temperature and viscosity distributions have been obtained by iterative solution of the Reynolds', energy and viscosity equations. The resulting oil film force, minimum oil film thickness, power loss, oil flow, maximum oil film pressure, maximum temperature have been computed for different load angle of bearing.

Keywords: Static characteristics, Tilting-pad journal bearings

1. INTRODUCTION

The radial, tilting 12 pads journal bearings are applied in the rotating machines operating at stable small and mean loads and the peripheral speeds of journal reaching 150 m/s. These bearings are hydrodynamically stable at high speed, less sensitive to the load direction and shaft misalignment compared to the multilobe bearing, They allow for minimising of oil flow and for using the standard components; spares consist of pads only. One of the advantages of tilting-pads bearings is the progressive increase of the assembly stiffness with geometric preload [1]. If this is correct, the fractional frequency whirl can be completely suppressed. Some disadvantages of these type of bearings include a higher power loss and lower load capacity than other types of bearings, such as the elliptical and multilobe (stationary segment) journal bearings [2].
The number of tilting-pads can be basically 3 to 5 depending on the required operating parameters of rotating machine [1,2] but in special application the number of 12 pads can considered. The operating surfaces of tilting-pads are the cylindrical ones with the pivot centered on the pad arc or displaced in the direction of journal rotation from the pad centre [1,2]. The relative length of bearing is assumed from 0.5 to 1.0 but smaller values as e.g. 0.2 can be applied.
The paper introduces the operation of tilting 12-pads journal bearing at the assumption of adiabatic model of oil film. Solution of the basic equations of thermo-hydrodynamic theory of lubrication gives the necessary data on the pressure, temperature distributions, the maximum value of pressure and temperature of oil film [1,2], the minimum oil film thickness, oil flow and friction forces, that means the static characteristics determining the input variables for the design of bearing. Numerical calculation have been performed at the conditions of static equilibrium position of the journal which allows the application of the results for the determining of spring and damping coefficients and stability of bearing and bearing system.

2. OPERATION OF THE BEARING

The lay-out of tilting 12-pads journal bearing is introduced in **Fig. 1** (φ - angular co-ordinate). In static equilibrium position each pad of tilting-pad bearing is aligned such, that the resultant forces act through the support point of the pad.

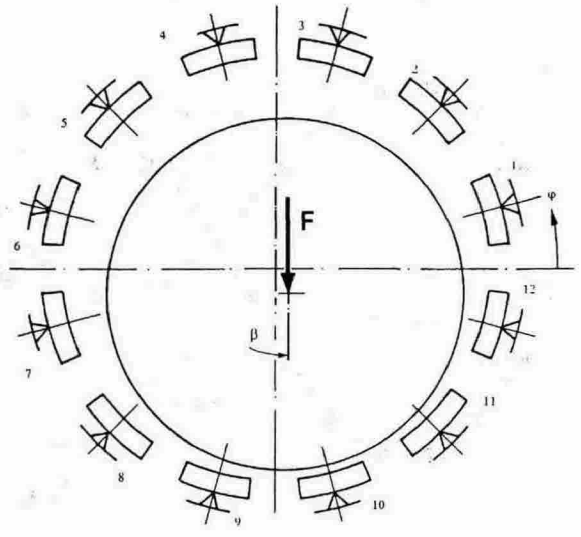

Fig.1 Lay-out of tilting 12-pad journal bearing (vertical direction of load; load between pad 9 and 10)

The geometric sum of resultant forces on a single pad gives the reaction corresponding the external load. Oil film pressure,

temperature and viscosity distributions of the oil film were determined on the basis of Reynolds, energy and viscosity equations [1,2].

3. RESULTS OF CALCULATION

The results of calculation of oil film pressure and temperature distributions are introduced in **Fig. 2** (at the pad relative clearance ψ_S=3, and the relative eccentricity ε =0.2). Minimum oil film thickness H_{min} and the friction loss $\overline{P}_{loss}$ for the pads of bearing are introduced in **Fig. 3 and Fig. 4. Table 1** gives the values of load capacity, So, power loss P_{loss} and maximum oil film temperature T_{max} for two relative eccentricities of bearing and different heat numbers K_T.

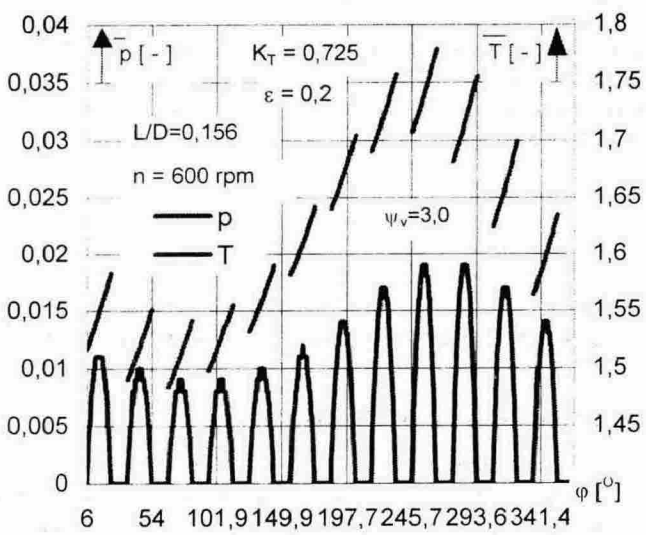

Fig. 2 Oil film pressure and temperature distributions of tilting 12-pad journal bearing

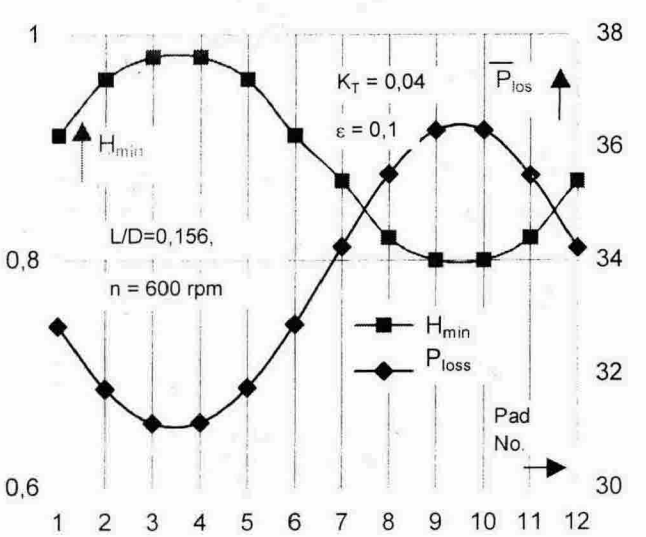

Fig. 3 Minimum oil film thickness and power loss of pads in the tilting 12-pad journal bearing

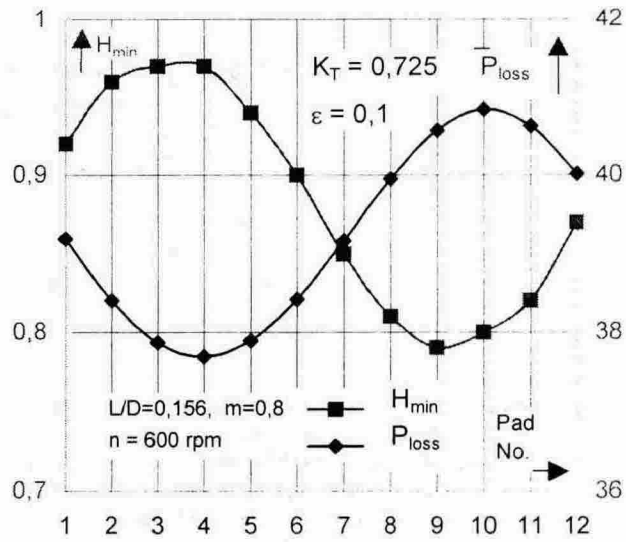

Fig. 4 Minimum oil film thickness and power loss of pads in the tilting 12-pad journal bearing

Table 1

β	ε = 0.1			ε = 0.6		
[°]	So	P_{loss}	T_{max}	So	P_{loss}	T_{max}
230	0.00434	320.36	1.392	0.05324	27.14	2.154
240	0.00434	320.30	1.392	0.05325	27.13	2.185
250	0.00437	317.58	1.391	0.05308	27.21	2.152
260	0.00435	319.22	1.392	0.05323	27.14	2.152
270	0.00435	319.39	1.392	0.05317	27.17	2.185
280	0.00439	315.88	1.391	0.05311	27.20	2.151
290	0.00444	313.09	1.392	0.05315	27.18	2.154
300	0.00435	318.89	1.392	0.05316	27.18	2.185
310	0.00437	317.58	1.391	0.05305	27.23	2.152

4. CONCLUSIONS

Developed program of calculation allows the investigation of load angle effect on the operation of tilting 12-pad journal bearing.

5. REFERENCES

[1] Lund, J.W., "Spring and Damping Coefficients for the Tilting Pad Journal Bearing", Trans. ASLE, 7, pp.342-352, 1964.

[2] Strzelecki S., "An Effect of Pad Support Position on the Dynamic Characteristics of Tilted 4-Pads Journal Bearing". ISCORMA-1. Proceedings of the 1st International Symposium on Stability Control of Rotating Machinery, 20-24th August 2001, South Lake Tahoe, California, USA. Paper 3008, 2001.

[3] Strzelecki S., "Load capacity of 5-lobe tilted-pad journal bearing". Proc. of 2000 AIMETA International Tribology Conference., L'Aquilla, Italy, pp. 520-527, 2000.