POWER LOSSES IN THE PIVOTED SHOE JOURNAL BEARING

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INTRODUCTION

The pivoted-shoe journal (PSJ) bearing is today's industry standard for rotordynamically sensitive rotating machinery and is widely used in a variety of high power-density machinery. Recently, attention has focused on the steady-state behaviour of the PSJ bearing, particularly in regard to reducing oil flowrate requirement and power loss, and increasing load carrying capacity. Ideally, these objectives should be reached without raising bearing operating temperatures.

This paper presents results from an experimental and theoretical study of the power losses in a 150 mm diameter PSJ bearing with an L/d ratio of 0.46. Offset and centre pivoted shoes were tested for both "on-pad" and "between-pads" loading conditions.

EXPERIMENTAL STUDY

The experimental study was performed on a new test facility that measures the static operating characteristics of radial type bearings, with particular reference to bearing power loss. Load from a pneumatic loading system is applied to the test bearing through two hydrostatic bearing systems. The upper spherical hydrostatic bearing ensures good alignment between test bearing and shaft, and also permits bearing torque reaction to be measured even under heavily loaded conditions. The second lower hydrostatic bearing provides lateral freedom for the test bearing. The test facility is driven by a 112 kW variable speed DC motor and has maximum load and speed capabilities of 25 kN and 15,500 rpm respectively.

THEORETICAL STUDY

A quasi 3D thermohydrodynamic model of the PSJ bearing was used to calculate the viscous shearing losses at the surface of each shoe (1). This model accounts for heat conduction across the oil film, heat convection in the circumferential direction, turbulence, oil mixing and pad deflection. Besides shearing losses, the model also calculates parasitic losses in the bearing. These include churning losses which result from oil exposed to the moving surfaces, and kinetic losses which are associated with the delivery of oil into the bearing housing.

RESULTS AND DISCUSSION

Measured and calculated bearing power losses for the offset pivot bearing with a load of 14 kN are shown in Figure 1 below.

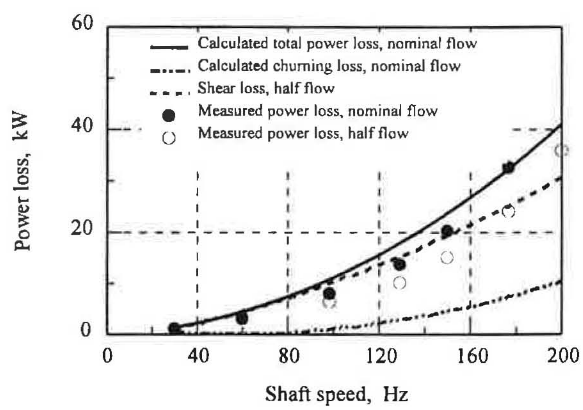

Fig. 1: Measured and calculated power losses

The experimental results confirm that reductions in oil flowrate will lead to reductions in bearing power losses. As Figure 1 shows, this seems to be the result of reducing the churning losses in the bearing cavity. This conclusion is reached on the basis that, for all shaft speeds, the calculated churning losses are similar to the difference between the measured power losses at nominal and half flowrate conditions (in this analysis, the half oil flowrate is similar to the calculated side flow of the bearing). Thus, it is justified to assume that, for the half flowrate condition, the bearing cavity contains only a limited amount of oil. Furthermore, because bearing metal temperatures rise only slightly with a 50% reduction in flowrate, it appears that bearing efficiency (power loss) can be improved significantly without compromising operational efficiency (bearing metal temperature).

REFERENCES

(1) W. Dmochowski et al, ASME Journal of Tribology, Vol. 115, 219-226 pp, 1993.