PERFORMANCE CHARACTERISTICS OF AN LEG, NON-EQUALIZING, TILTING PAD, HYDRODYNAMIC THRUST BEARING

JOSEPH J. WILKES and MATT MARCHIONE
Kingsbury, Inc., 10385 Drummond Road, Philadelphia, PA, 19154 U.S.A.

ABSTRACT

Presented are data from tests of a newly designed hydrodynamic tilting pad thrust bearing. The accomplished goal of this thrust bearing is to perform at high speeds and high loads with reduced film temperatures, lower oil flow requirements and reduced frictional losses as compared to conventional flooded designs. The intention was to optimize the design for a single direction of rotation in order to achieve peak performance. This thrust bearing incorporates leading edge groove (LEG) lubrication technology and offset spherical pivots in a thin non-equalizing size frame.

The authors also compare, examine and analyze the different aspects of the new bearing, such as pivot location, shape of pivot, and method of lubricant supply. Comparisons are made against an 8 pad, flooded, line-contact, center pivot thrust bearing of approximately the same size. The new bearing is an 8 pad, 273 mm O.D. x 148 mm I.D., with 31,666 square mm of bearing area. The data in this paper are obtained from tests run on a test rig capable of speeds between 4,000 and 14,000 rpm and bearing specific loads between .7 MPa and 4.14 MPa. Data from over 100 sensors were recorded and analyzed. A range of operating conditions were tested including variations in load, speed, oil supply flow rate, and pad material.

The LEG design is a directed lube method, incorporating an oil feed groove at the leading edge of the pads which supplies cool oil directly into the hydrodynamic film. Since oil is effectively supplied directly to where it is needed, less oil flow is required. This serves two benefits: a smaller lubrication system and reduced frictional losses in the bearing. Although LEG technology has been utilized for 15 years in equalizing bearings, results have not been presented using it in the thin, non-equalizing style.

Designing a bearing for one direction of rotation greatly improves the bearing as compared to the one size fits all condition. Offset pivots are an example of this rational. It has been shown by many authors over the years that offset pivots significantly improve the thrust bearing's performance with respect to film temperatures and load carrying capacities. Also since most bearings today are instrumented with temperature sensors at the 75/75 position, bi-directional bearings are inevitably used primarily in one direction.

Another feature of this new bearing which has been found to improve performance is its spherical pivot which offers three advantages. First, it allows the pads to find the proper tilt for balanced forces within the oil film. Second, it allows for misalignment and can not be edge loaded. Third, it provides some elastic compliance at the pivot which helps equalizes the load between the pads.

Line contact pivots have been thought to prevent pad distortion due to the pad being in contact across the width on the pad. However, since most of the pad distortion in high speed applications is thermal, the line contact strip is ineffective against this type of crowning.

The following graphs compare the new LEG bearing to the flooded thrust bearings operating at 2.76 MPa.

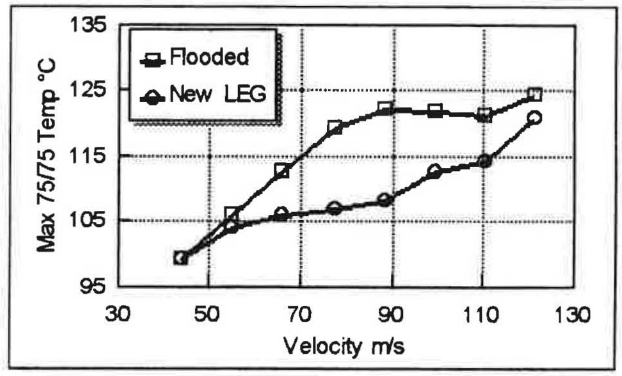

Fig. 1 Maximum measured 75/75 pad temperature versus speed at 2.76 MPa unit load.

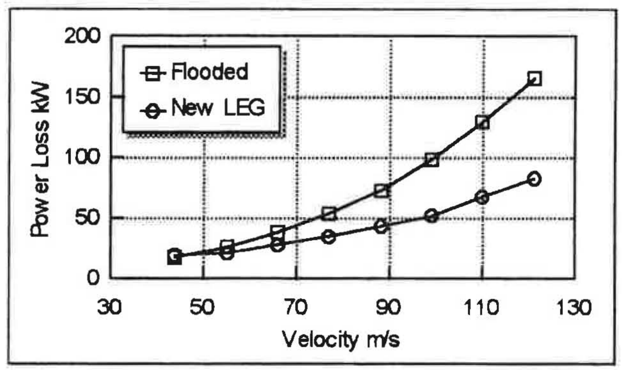

Fig. 2 Frictional power loss versus speed for double element bearings at 2.76 MPa unit load.

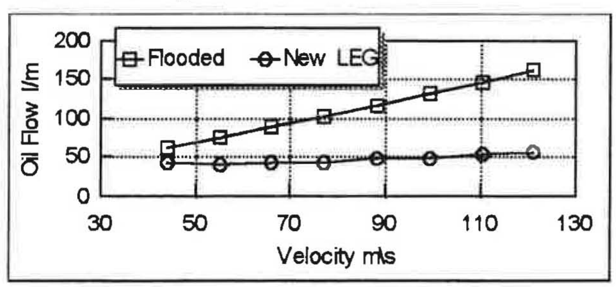

Fig. 3 Oil flow versus speed for loaded side bearing at 2.76 Mpa.