Key Words : journal bearings, hydrodynamic journal bearings, porous bearings, externally pressurized bearings, hybrid bearings, turbulent regime, steady state performance, dynamic characteristics, stability, conical whirl instability.

ABSTRACT

Normally, a high velocity combined with low kinematic viscosity (an unconventional lubricant) leads to high Reynolds numbers resulting in either super laminar flow or turbulence. The conventional laminar lubrication theory can not predict the behaviour of the system accurately, when the bearing is operating in turbulent regime. Therefore turbulent lubrication theory is required to establish basic understanding of lubrication in turbulent zone of operation. Three of the most commonly used models of turbulence applied to lubrication problems are : (i) mixing length theory developed by Constantinescu (ii) the eddy viscosity theory developed by Elrod, Ng and Pan and (iii) the bulk flow theory adopted by Hirs.

A comparision between these theories are made first, for plain journal bearings with that of experimental data.

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Constantinescu's load capacity curve is found in excellent agreement with the Smith and Fuller's experimental data. Therefore this theory has been choosen for further detailed analysis of the bearings.

The aim of the present work is to investigate and predict theoretically the steady state and dynamic characteristics of hydrodynamic plain metal journal bearings, self acting porous journal bearings and hybrid porous journal bearings. Conical whirl instability of self acting porous journal bearing has also been investigated.

For porous bearings, the flow through the porous matrix is assumed to be viscous, laminar and governing equation of flow is obtained by Darcy's law. The lubricant flow in the clearance space of the bearing is turbulent.

With these assumptions, the generalized differential equation for porous bearing alongwith turbulent Reynolds equation (satisfying appropriate boundary conditions) in finite difference form, have been solved simultan ously by Gauss-Siedel iteration with successive overrelaxation scheme and steady state pressures have been obtained. For dynamic pressure, first order perturbations of eccentricity ratio and attitude angle are used. A knowledge of steady state and the perturbed pressures enable one to obtain steady state characteristics viz. dimensionless load capacity, friction

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parameter and end flow; and the dynamic characteristics in terms of stiffness and damping coefficients. From these dynamic coefficients critical mass parameter for threshold of instability has been obtained for a system consisting of balanced rigid rotor supported by two equal bearings symmetrically.

If two bearings are closely spaced and transverse moment of inertia is high, then conical whirl onset speed can occur before the cylindrical whirl onset. Therefore conical whirl instability of bearing has become an important parameter in the design of single rigidly mounted bearing supporting a rigid rotor. Conical whirl instability has been studied only for self acting turbulent porous journal bearings. In the analysis, it is assumed that the journal is unloaded and the mean steady state position of the journal is concentric.

In general, a parametric study has been made for the bearing characteristics by varying the design parameters and the results are presented in the form of graphs and tables.

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