Thermal Effects on Dynamic Characteristics of Tilting 5-Pad Journal Bearing

Stanislaw Strzelecki*)
Zygmunt Towarek**)
*) Institute of Machine Design
**) Group of Mechanics
Lodz University of Technology
Stefanowskiego 1/15, 90-924 LODZ, Poland
Phone: +48 42 6312239
Fax: +48 42 6367489
E-mail: strzelec@pkm1.p.lodz.pl

ABSTRACT

Radial, tilting-pad journal bearings are applied in high speed rotating machines operating at small and mean stationary loads and the peripheral speeds of journal reaching 150 m/s. These bearings have good stability at high speeds, are less sensitive to the load direction and shaft misalignment compared to the multilobe bearings. 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, and either the matching or elimination of cross-coupled stiffness.

The multilobe journal bearings in high speeds applications are closed on their peripheral and the increase of relative clearance causes the partial or full transition from laminar to turbulent flow in the lubricating gap. The tilting-pad bearings are the bearings, which have separate pads and the space between single tilting-pads effects the bearing operation. The number of tilting-pads can be basically 3 to 5 depending on the required operating parameters of rotating machine. The operating surfaces of tilting-pads are the cylindrical ones with the pivot centred on the pad arc or displaced in the direction of journal rotation from the pad centre.

Tilting 5-pad journal bearings have found wide application in high-speed turbomachinery but there is still insufficient information on the thermal conditions of bearing operation.

Solution of the basic equations of thermo-hydrodynamic theory of lubrication gives the necessary data on the oil film pressure, temperature distributions, the maximum value of pressure and temperature of oil film, the minimum oil film thickness, oil flow and friction forces, that means the static characteristics determining the input variables for the design of bearing. The static characteristics are also required for determination of dynamic characteristics expressed by four stiffness and four damping coefficients applied in the vibration analysis and calculation of the stability of the rotor-bearing system.

The paper introduces the results of calculation of dynamic characteristics of the tilting 5-pad journal bearing characterized by asymmetric support of pads at different temperature of supplied oil as well as at different thermal conditions between the pads. The Reynolds, energy, geometry and viscosity equations were solved numerically assuming incompressible laminar and adiabatic flow of oil in the bearing gap of finite length bearing. Aligned orientation of bush and journal axis without deflections of pads and journal was assumed. Calculations have been performed at the condition of static equilibrium position of the journal.