Abstract

Owing to high speed of present day machinery and increasing trend of using low viscosity lubricants, there may be certain situations when fluid inertia forces are of the same order that of the viscous forces. In such a situation classical approach of negligible fluid inertia may not be applicable. On the other hand stability, especially for lightly loaded bearings, is a cause of concern for the designers. In this context a fresh look to lubrication problems is perhaps a necessity.

In this work the influence of fluid inertia on the steady-state, dynamic characteristics and stability of hydrodynamic journal bearings under isothermal condition has been studied. Effect of fluid inertia on stability and dynamic characteristics of flexibly supported bearings are also investigated.

The governing equations are derived starting from Navier–Stokes equations by using two different approaches. In the first approach momentum equations are linearized using perturbation technique. However, in the second approach governing equations are derived considering that velocity profiles across the film remain parabolic even when fluid inertia is not negligible. Second approach seems to be better out of the two since momentum equations are not linearized and therefore, can be applied for any value of inertia parameter (modified Reynolds number).

Both liner and non–linear analyses are carried out to study the stability of a rigid

rotor supported on hydrodynamic journal bearings when fluid inertia is not negligible.

The non-linear transient analysis has been performed to study the sub-synchronous stability of these bearings under a unidirectional constant load. Journal centre trajectories have been obtained to find the status (stable or unstable) of the system. In addition to the stiffness and damping coefficients, acceleration coefficients are also evaluated from the linearized perturbation technique without neglecting the mass of the oil. Using these coefficients threshold of stability is determined for different operating conditions.

Stability of flexibly supported bearings are in general much stable compared to usual rigidly supported ones. An attempt is also made to study the stability characteristics of these type of rotor-bearing systems without neglecting fluid inertia. Both non-linear as well as linear analyses are carried out

Another important area which drew attention of many researchers is that cavitation boundary move with time. Therefore, in addition to usual boundary conditions, a model has been used here in the non-linear transient analysis to incorporate the film prehistory which takes care of the boundary movement with time.

This study appears to provide a better understanding of the performance of hydrodynamic bearings when flow is laminar but fluid inertia forces are not negligible.