

# **Modeling the Oil Flow Beneath the Flexible Sleeve of an Active Oil Bearing**

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## **ABSTRACT**

This paper presents results of the recent research towards the development of an oil bearing for active and passive control of vibrations of rotating machinery. There are numerous examples of active bearings in the literature. Here the concept is used of an external oil-filled chamber behind a flexible sleeve. The bearing is furnished with a cantilever sleeve wrapped around the journal whose deformation can be controlled by the pressure inside a thin film chamber located underneath the sleeve. The gaps, or clearance between the moving sides of the sleeve and the journal housing allow some flow of oil between the external chamber and the bearing. An external inlet port to the external chamber sets the chamber pressure and controls deformation of the sleeve. This paper considers isolated flow in the thin film chamber removed from the bearing.

Reynolds equation was adopted for modeling the pressure distribution below the sleeve. The cavitation pressure was set as the vapour pressure of the oil. The pressure distribution due to a stationary sleeve is first calculated. Calculations show the influence of inlet port location and gap thickness on the static pressure distribution. Sinusoidal oscillations of the sleeve in its first natural mode are next considered and the pressure distribution within the chamber computed. Dynamically the chamber oil acts as a non-linear hydrodynamic damper. As the flexible sleeve moves away from the chamber suction is induced in the chamber and as the sleeve moves towards the chamber compression is induced depending on the velocity of the sleeve. The induced pressure is a maximum as the sleeve moves through its equilibrium position where the velocity is highest.

An indicator of the effectiveness of the chamber design is the energy dissipated per cycle. In coupled performance of the chamber and bearing, this energy is being partly removed from the rotor and hence should indicate the effectiveness in damping rotor vibrations. Calculations were performed for different shapes and positions of the chamber inlet port and different widths of the gap between the chamber sleeve and the chamber housing. The influence of film thickness and sleeve thickness was also considered. This was done with a view to optimizing the chamber design prior to incorporating it into a rotor system. Results of the computations show that with optimized parameter values it is possible to create the pressure necessary for balancing the weight of the rotor and to ensure that a large amount of energy is dissipated in hydrodynamic damping action. It is shown that by reducing the film thickness or reducing the inlet port size or by positioning the inlet port near the fixed end of the sleeve energy dissipation is improved.