44th Leeds-Lyon Symposium on Tribology - September 4-6, 2017, Lyon, France

THERMO-HYDRODYNAMIC FE-ANALYSIS OF JOURNAL BEARINGS: EFFICIENT COUPLING OF THE REYNOLDS AND NAVIER-STOKES EQUATIONS

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KEYWORDS
Journal bearing; thermo-hydrodynamic model; Reynolds equation; Navier-Stokes equations

ABSTRACT

This paper deals with the fluid flow characteristics and the thermal behavior of a hydrodynamic journal bearing with a single oil supply groove. For this purpose, a thermo-hydrodynamic model has been developed, which represents the physical properties and interactions of the lubricant, the journal and the bush.

The pressure distribution in the fluid film region between the journal and the bush is described by the generalized Reynolds equation according to Dowson [1]. The determination of the velocity field and the pressure distribution within the groove requires the numerical solution of the Navier-Stokes equations and the continuity equation. The formulation of appropriate energy equations serves to obtain the temperature distribution in all bearing domains. The rapture and reformation of the fluid film in the cavitation region is modelled by a mass-conserving cavitation approach.

The physical domains of the bearing model –journal, bush, lubricant- are connected by using appropriate coupling conditions. Assuming that the temperature gradient in the axial direction is negligible, the energy equations as well as the Navier-Stokes equations are solved within the bearing mid plane. This simplification provides a reduction of computational effort and improves the convergence. The mathematical description yields a system of coupled nonlinear integro-differential equations, which are discretized by finite elements.

The predicted temperature and pressure profiles agree fairly well with the experimental data presented in [2]. The velocity field in the upper part of the bearing groove, see Fig.1, is dominated by two vortices, which cause the temperature to homogenize in this region. In the lower part, i.e. in the vicinity of the journal, a velocity boundary layer and a significant change of the lubricant temperature profile in radial direction is observed. Within this groove region, it can also be seen that the radial temperature profile remains almost constant along the circumferential direction.

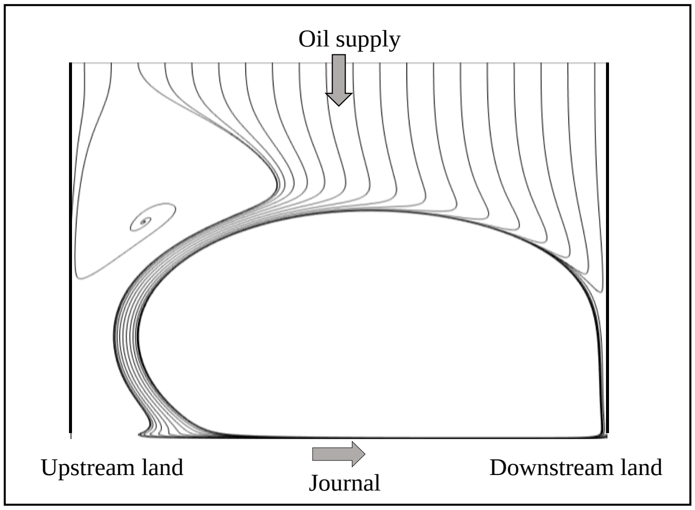

Fig.1 Streamlines of the velocity field in the upper part of the bearing groove

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