Thermohydrodynamic lubrication problems and journal–bearings stability

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ABSTRACT

Thermal effects in hydrodynamic lubrication are very important because the technical advance requires more and more trustworthy and effective industrial devices. Precisely in those situations, in which a journal–bearing device operates under high rotation and considerable imposed loads, the dissipated energy by viscous effects is significant and causes a temperature increase that results in a decrease of the oil viscosity. The thermohydrodynamic coupling is given by the viscosity influence in the hydrodynamic equation, and the velocity field obtained from pressure gradients that it is introduced in the energy equation. Additionally, the bush and shaft thermal exchange with the external environment must be included in the model.

For the numerical solution a finite element method for the hydrodynamic Reynolds equation with a cavitation model of Elrod-Adams is applied. Next, the energy equation in the lubricating film is solved by a cell–vertex finite volume method. The advantage of this method lies in the possibility of retrieving second order convergence in some examples with regular meshes [1]. The bushing temperature distribution is computed by using a P1 collocation boundary element method, and a simplified thermal model is considered for the shaft, due to the fact that it is highly rotating.

The extension of this model to describe evolution problems is quite straightforward [2]. Nevertheless, the adaption of the boundary element scheme used for the thermal model in the bush is not so easy. A combination of boundary elements and dual reciprocity methods can be used to obtain time–stepping algorithms. Additionally, a model describing the mouvement of the shaft must be provided. This model will consist of an ODE system relating aceleration of the center of gravity and the pressure loads. The numerical experiments try to clarify both the position of the neutral stability curve and the kind of instabilities by analysing the dynamical response of a journal–bearing system based on the Elrod–Adams equation (that do not impose the location of the cavitated region).

References

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