EVALUATION OF MASS CONSERVATIVE MODELS FOR THE TRIBOLOGICAL ANALYSIS OF POROUS BEARINGS

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ABSTRACT

We investigate two theoretical mass-conservative models for the tribological evaluation of porous journal bearings. The first model supposes that the lubricating fluid film is fully contiguous in the range $\theta_1 < \theta < \theta_2$ (Figure 1), i.e. effects due to cavitation are excluded. The fluid pressure distribution is determined numerically by solving a modified Reynolds equation which governs the fluid film and accounts for the porous surface and Darcy's law that describes the flow through the porous matrix in the usual manner. These equations are supplemented with the integral angular momentum equation applied to the fluid film and the integral mass balance between the flow rates of the lubricant entering and leaking from the clearance, respectively [1]. Here the (quasi-stationary) results show that air penetrates into the porous matrix and that the lubricant leaks from the clearance, eventually leading to a mixed lubrication mode after a finite operation time.

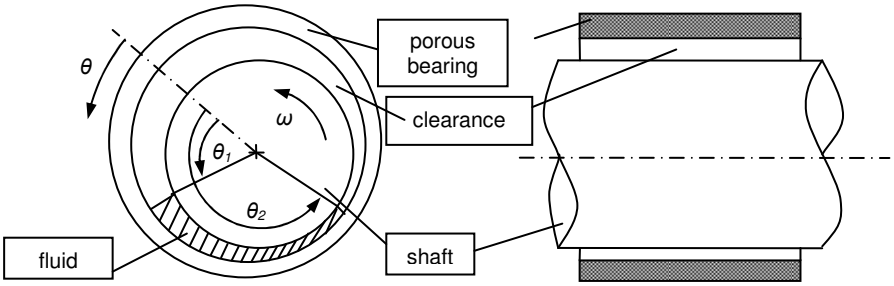

Figure 1

Considering the second theoretical model [2], we again solve Darcy's law that holds in the porous bearing seat but adopt a modification of the Elrod's model [3] in order to study the flow in the clearance. In striking contrast to the former model, here rings of lubricant are supposed to form at the ends of the bearing, serving as an external storage for the lubricant. As an important consequence, cavitation is observed, and the lubricant leaking from the clearance, namely the region of high pressure, instantaneously enters the porous matrix, i.e. the low-pressure zone. Comparisons of the results obtained from each of these models both among themselves and with experimental data are presented. It is the primary goal of this study to assess which of the two theoretical formulations is more feasible from the viewpoint of the basic physical mechanisms and eventually proves preferable for describing the operation of the bearing in a self-consistent manner.

[1] Kaneko, S., Takabatake, H., Ito, K., ***Numerical analysis of static characteristics at start of operation on porous journal bearings with sealed ends***, Journal of Tribology, Vol. 116 (1999), pp.62-68
[2] Meurisse, M. H., Giudicelli, B., ***A 3D conservative model for self-lubricated porous journal bearings in a hydrodynamic steady state***, Journal of Tribology, Vol.121 (1999), pp. 529-537
[3] Elrod, H. G., ***A cavitation algorithm***, ASME Journal Lubr. Technol., Vol. 103 (1981), pp. 350-354

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