DISCUSSION

H. J. Sneck[1]

I have reviewed the above paper and find it difficult to ask any interesting questions about it. Those that I would like to ask I am afraid the author would be unable to answer.

Naturally I would like to know how well the analysis compares with actual performance. (No experimental results are cited.) I would also be curious about how the poro-slip parameter β is determined. Is it an open parameter which will be used to bring theory and experiment into agreement?

Of course I am very interested in the stability of this bearing. On one hand the added porosity will tend to make the shaft operate at larger eccentricities where it should be more stable, statically. On the other hand, the add volume of gas in the bearing's porous bushing could have a destabilizing effect. Which trend wins out I suppose will have to await further analysis and test.

Having tried to patent a bearing like this several years ago (and been turned down), maybe I will finally find out whether it was a good idea or not. That is provided the authors continue their investigation, analytical and hopefully experimental.

Author's Closure

Professor Sneck raised three questions: (1) How can the poro-slip parameter $\beta\left(\beta = \frac{\alpha c}{\sqrt{k}}\right)$ be determined? (2) Is β going to bring analysis and experiment into agreement? (3) Is a porous bearing more stable than a solid-wall bearing? Except the first question, the author is afraid that without further investigations there are no good answers to the other two questions.

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The parameter β includes two parameters, α and k. α is the slip coefficient which is dependent on the structure of the porous material, and k is the permeability, a physical property of the porous medium. The values of α and k can be determined by experiments which have been illustrated by Beavers and Joseph [1] and by Beavers, Sparrow and Magnuson [2]. The experimental setup mainly consists of a porous block and an impermeable bounding plate; the gap between the block and the plate is adjustable. α is determined by matching the measured flow rates through the channel and the block to that predicted by the Beavers and Joseph's slip flow model. On the other hand, k is essentially involved in the Darcy flow. Its value is determined by measuring the flow rate through the porous block when the gap of the channel is closed.

If β is well determined and the film thickness is moderately thin, the theory, which is based on the macroscopic slip flow model and the Darcy flow, will not be too far away from the experiment. However, if the film is very thin, then the microscopic structure of the porous medium may have to be considered, namely, both porosity and roughness have to be included in the analysis.

Regarding the so-called fractional frequency whirl, the instability threshold speed is a function of eccentricity ratio and is also a function of Sommerfeld number. For a specified load, a porous bearing tends to operate at a higher eccentricity than a solid-wall bearing does; this implies that a porous bearing is more stable than a solid-wall bearing. However, in terms of Sommerfeld number, the presence of the porous bushing causes a drop of load capacity and in turn results in a decrease of instability threshold speed. Therefore, stability analysis is needed; stability parameters should be compared under specified conditions to determine which kind of bearing is more stable. Furthermore, in order to understand the stability characteristics of a rotor-bearing system the dynamic coefficients, stiffness and damping, of a porous bearing should be determined through a suitable dynamic analysis.

Additional References

10 Beavers, G. S., and Joseph, D. D., "Boundary Conditions at a Naturally Permeable Wall," *Journal of Fluid Mech.*, Vol. 30, 1967.

11 Beavers, G. S., Sparrow, E. M., and Magnuson, R. A., "Experiments on Coupled Parallel Flows in a Channel and a Bounding Porous Medium," ASME Journal of Basic Engineer, Vol. 92, No. 4, Dec. 1970, pp. 843–848.

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