journal bearing can be a versatile design tool to help solve the problems associated with

(*a*) frictional drag
(*b*) positioning
(*c*) stick-slip
(*d*) high relative surface speeds
(*e*) high temperatures.

However, these advantages cannot be widely realized unless we have available means of calculating the performance of a bearing system. Further, since it appears from our work that high optimized stiffness values are indicative of a successful bearing design, we feel that it is imperative to be able to perform such an optimization analytically.

Finally, we conclude that:

(1) Within the mentioned limitations of the analysis, the bearing stiffness can be optimized simply by matching the incoming resistance with the outgoing resistance such that the recessed pool pressures are approximately 70 per cent of the supply pressure at zero eccentricity.

(2) Predicted pressure, flow, and load, versus eccentricity, compare reasonably with experimental measurements if the L/D is 1.0 to 1.4, and if $P_i(0)/P_1$ is 0.4 to 0.9.

Acknowledgments

The author wishes to express his sincere appreciation to Dr. Ziebur of Ohio State University for the help and advice given him while working on this research and to thank the members of the Physical Research Department of The Cincinnati Milling Machine Company for their support and guidance in this work; to their Mr. J. Hitch for his perfecting the experimental equipment and for obtaining accurate experimental results; Mr. M. Ling and Mr. J. Gavin for valuable suggestions.

The author is also indebted to The Ohio State University for the use of their computer facilities.

References

1 J. H. Laub, "Hydrostatic Gas Bearings," Trans. ASME, Series D, Journal of Basic Engineering, vol. 82, 1960, pp. 276–286.
2 H. H. Richards, "Behavior of Compensated Hydrostatic Gas Bearings," Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge, Mass.
3 J. R. Lemon, "Analytical and Experimental Study of Externally Pressurized Air Lubricated Journal Bearings," MS thesis, The Ohio State University, 1959.

DISCUSSION

I. C. Tang[2] and W. A. Gross[3]

Mr. Lemon has presented a clearly written paper which gives a valuable method for determining the operating characteristics of externally pressurized gas lubricated journal bearings. The method is particularly useful, as the author implies, when there are only three or four supply sources. His technique for approximating the effects of circumferential flow by assuming an interior pressure profile, then considering only longitudinal flow, appears to make further refinement in analyzing bearings of this specific type unnecessary.

To illustrate, we have compared the experimental and calculated results given here with those obtained by using the simpler assumption that the bearing with zero eccentricity can be approximated by a line source through the bearing mid-plane with constant pressure equal to the recess pressure. The restricting orifice area is assumed to be that of the actual bearing, and the active lubricating film is assumed to occur only over the land regions at each end of the bearing where flow is purely longitudinal. The entire central land region, which includes recesses and which has an axial extent equal to that of the recesses, is assumed to be at constant pressure.

By using the design charts in the paper "Analysis and Design of Externally Pressurized Gas Bearings," ASLE paper 61 LC-20, also given at this Conference, and using the same bearing diameter (2.25 in.) as in Lemon's tests, we obtain the results in Table 1.

It is evident that, since circumferential flow is ignored in this approximation, the error in stiffness is large. As expected, the interior pressure shows much better agreement. Clearly, simpler methods such as described in ASLE paper 61 LC-20 require considerable caution in their application.

Table 1

Supply pressure, 9 atm; ambient pressure, 15 psi

Stiffness

Radial clearance (in.)	Bearing parameter	Stiffness (lb/in.)
Line source approximation, longitudinal flow		
$h_0 = 0.0010$	$B = 6.84$	$k = 116 \times 10^4$
$h_0 = 0.0004$	$B = 85$	$k = 520 \times 10^4$
Lemon's measurement (Fig. 11a)		
$h_0 = 0.0010$		$k = 33 \times 10^4$
$h_0 = 0.0004$		$k = 70 \times 10^4$

Intermediate (recess) pressure

$h_0 = 0.0010$ in.

Line source approximation, longitudinal flow: $B = 12$		
$P_1/P_e = 7$	$P_1(0)/P_e = 4.5$	$P_1(0)/P_1 = 0.64$
$P_1/P_e = 9$	$P_1(0)/P_e = 5.2$	$P_1(0)/P_1 = 0.58$
Lemon's measurement and calculation (Fig. 9)		
$P_1/P_e = 7$		$P_1(0)/P_1 = 0.65$
$P_1/P_e = 9$		$P_1(0)/P_1 = 0.58$

[2] IBM ASDD Laboratory, San Jose, Calif.
[3] IBM Research Laboratory, San Jose, Calif. Mem. ASME