DISCUSSION

E. D. Jackson[3]

The analysis part of this paper is essentially identical to the previously published paper by Childs [A1]. Instead of solving the complicated Navier-Stokes equations, the authors applied the commonly used bulk-flow approach which is suitable and logical for seal leakage and seal rotordynamic coefficient calculations. This analytical contribution is significant in that the authors are able to provide the most complete high pressure annular seal model which includes the combined effects of fluid inlet swirl, turbulent flow, shaft rotation and non-straight (conical or tapered) seal geometry.

The authors are also to be commended for providing experimental results to compare with the analytical models. There has been a significant deficiency of good systematic data to provide confidence in the analytical models for calculating these seal rotordynamic forces. It was of interest to note that the analytical model shows reasonably good agreement with the experimental results for the tapered seal, but the model consistently underestimates the stiffness of straight seals. Obviously, our models require further development to be completely satisfactory. It might also be noted that the assumption of the present model that the eccentricity is small compared with the concentric clearance has been eliminated by a numerical approximation by Chen and Jackson [A2] to cover the dynamic coefficients and seal leakage at large eccentricity and/or misalignment. However, no test data exist to verify the latter model for the rotordynamic coefficients.

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Additional References

A1 Childs, D. W., "Convergent-Tapered Annular Seals: Analysis for Rotordynamic Coefficients," Fluid/Structure Interactions in Turbomachinery, ASME Publication, Winter Annual Meeting, Washington, D.C., Nov. 1981, pp. 35–44.

A2 Chen, W. C., and Jackson, E. D., "Eccentricity and Misalignment Effects on the Performance of High-Pressure Annular Seals," presented at the 39th Annual Meeting of ASLE in Chicago, Ill., May 7–10, 1984, ASLE Preprint No. 84-AM-5E-2.

G. L. von Pragenau[4]

This paper by Childs and Dressmen investigates the high stiffness option offered by convergent seal gaps. However, as the authors point out, the stiffness gain is rather limited while leakage is increased and seal damping is markedly reduced. The concern of whirl instability, voiced in their conclusion, speaks against tapered seals. The paper should caution against unintentional tapering due to pressure gradients. A performance index of stiffness versus leakage is discouraged, because increased leakage is an unacceptable trade for marginal stiffness gains.

Both of the papers by Professor Childs (84-Trib-31 and 84-Trib-33) treat the dynamic properties of annular seals and compare test data with analytical results. The subject is important for turbomachinery operating at supercritical speeds, because destructive whirl must be avoided. When the rotor speed exceeds a limit of twice the first critical speed, then the fluid circulation in seal and journal bearing gaps can excite unstable whirl. Speed limits are imposed at the cost of performance to avoid expensive shutdowns, unless, the speed limits increased by a stiffer rotor support or by retrofitting with damping seals.

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