Stability of Gas-Lubricated Externally Pressurized Two-Layered Porous Journal Bearings

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ABSTRACT

An externally pressurized gas bearing with a porous surface has many attractive features namely low noise during rotation and zero friction when the instruments are used as null devices. As gas is fed through the porous matrix, uniform distribution of gas in the clearance space is also ensured. Moreover, porous gas bearings have better damping characteristics Due to their low frictional losses, gas bearings are used for high speed machinery, e.g. electric motors, turbo machines and high precision instruments. The main disadvantage is their low stability, which often limits the range of operation.

Recent research in Japan and Germany suggested that a two-layered bearing using an inner layer of ultra fine powder of low permeability could be used for enhancing stability. The two-layered structure would allow the designer to optimize the geometry of the coarse layer to satisfy the structural requirements and simultaneously design the fine layer with low permeability to suit the flow restriction performance provided that the pressure drop is insignificant in the coarse layer.

This paper analyzed the stability of externally pressurized gas lubricated two-layered porous journal bearings considering three dimensional flow through the porous matrix. With the usual assumptions of porous gas bearings, the equation of continuity of flow through porous bushing and the modified Reynolds equation under dynamic condition are written. The Reynolds equation, a non-linear partial differential equation, in the bearing clearance is solved by Newton- Raphson Iterative method. The perturbed equations come out in linear form and are solved by finite difference method in successive over relaxation scheme. To match the condition at the interface between coarse and fine layer, flow continuity at the interface is equated. The film stiffness and damping coefficients are found from the dynamic pressures. These coefficients are then used in the equations of motion of a rigid rotor to determine the threshold mass parameter, which is a measure of stability. To validate the analysis, the results obtained for single layer from the present solution have been compared with the existing results and have been found to be in fair agreement. It has been observed that the use of a two-layered porous bearing enhances the stability considerably when compared with a single-layered one.