Adjustable hybrid gas bearing – Influence of piezoelectrically adjusted injection on damping factors and natural frequencies of a flexible rotor operating under critical speeds

Damping factors and natural frequencies of a flexible rotor supported by a gas bearing with piezoelectrically adjusted flow, are theoretically determined using a rotor finite element model coupled with the modified Reynolds equation. An extra term is added to the standard formulation of Reynolds equation aiming at incorporating the effect of the adjustable external pressurized inlet flow. Two different configurations are theoretically as well as experimentally studied: (a) the air is injected from a single orifice positioned at the bottom of the bearing and (b) the air is injected through four radial injectors equally pressurized. For the two configurations, the theoretical results are experimentally validated as a function of the piezoactuators input voltage and the journal angular velocity. Results show a good agreement for natural frequencies and damping factors. Theoretical and experimental results show qualitatively as well as quantitatively that the injectors position and the injection flow (dependent on the piezoactuator input voltage) have an important influence on the dynamic characteristics of the rotor-bearing system. By using one single injector positioned at the bearing bottom, the damping factor associated with the first mode shape can be increased by 10 times when compared to four injectors equally pressurized.