Thermal Features of Compliant Foil Bearings—Theory and Experiments

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The paper presents an analytical and experimental investigation aimed at eliciting the thermal characteristics of air lubricated compliant foil bearings. A Couette Approximation to the energy equation is used in conjunction with the compressible Reynolds equation to obtain a theoretical temperature distribution in the air used as a lubricant. The effect of temperature on the thermal properties of the working fluid is included. In parallel, an experimental program was run on a 100 mm diameter foil bearing operating at speeds up to 30,000 rpm employing cooling air across the bearing. The temperature rise of the cooling air provided an indication of the amount of heat energy conducted across the top foil of the bearing from the hydrodynamic film. The temperatures resulted from some tests are compared with the temperatures predicted by the analysis, and maximum over-prediction of about 19 percent was obtained. This simplified approach provides us with reasonably predicted temperatures. By comparing the theoretical heat dissipation obtained from the analytical predicted temperatures with the amount of heat carried away by the cooling air it was possible to arrive at the relative quantities of heat transferred from the bearing by convection via side leakage and by conduction via the top foil. From these comparisons it was deduced that about an average of 80 percent of the heat energy is carried away by conduction. The transient temperatures of the foil bearing in conducted tests for various speeds and loads are also presented. [DOI: 10.1115/1.1308038]

