Design of Active Magnetic Bearing Controllers for Rotors Subjected to Gas Seal Forces

Proper design of feedback controllers is crucial for ensuring high performance of Active Magnetic Bearing (AMB) supported rotor dynamic systems. Annular seals in those systems can contribute with significant forces, which, in many cases, are hard to model in advance due to complex geometries of the seal and multiphase fluids. Hence, it can be challenging to design AMB controllers that will guarantee robust performance for these kinds of systems. This paper demonstrates the design, simulation and experimental results of model based controllers for AMB systems, subjected to dynamic seal forces. The controllers are found using H-infinity - and µ synthesis and are based on a global rotor dynamic model in-which the seal coefficients are identified in-situ. The controllers are implemented in a rotor-dynamic test facility with two radial AMBs and one annular seal with an adjustable inlet pressure. The seal is a smooth annular type, with large clearance (worn seal) and with high pre-swirl, which generates significant cross-coupled forces. The H-infinity controller is designed to compensate for the seal forces and the µ controller is furthermore designed to be robust against a range of pressures across the seal. Experimental and simulation results shows that significant performance can be achieved using the model based controllers compared to a reference decentralised Proportional Integral Derivative (PID) controller and robustness against large variations of pressure across the seal can be improved by use of robust synthesised controllers.

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