38th Annual Meeting
Turbomachinery Research Consortium
May 15- 17, 2018

Half page Synopsis of Reports for website

Morton Effect Prediction and Large Steady State Journal Motion Simulation

Mr. Dongil Shin and Dr. Alan Palazzolo a-palazzolo@tamu.edu

Synchronous rotor instability phenomenon, known as the Morton Effect (ME), is caused by the temperature differential across the journal in fluid film bearings. The temperature difference will bend the rotor and cause increased vibrations, which will continue to grow and drive the system unstable in certain conditions. The deliverable of this project includes providing users with high-fidelity software for Morton effect prediction and designing experiment for software calibration.

The ME is quite sensitive to operational parameters including oil temperature, bearing clearance, overhung mass, etc. Accurate prediction of the ME instability onset speed requires precise modelling of the rotor dynamics, heat conduction and elastic deformation of the rotor and bearing. The objective is to offer users the capability for transient ME analysis and steady ME analysis. The former predicts the rotor vibration, bearing orbit, rotor & bearing temperature with respect to time, while the latter demonstrates the above information with respect to rotating speeds and evaluates the ME instability onset speed. Moreover, the thermos-elasto-hydro-dynamic analysis can also be applied to accurately predict the dynamic coefficients of various tilting/fixed pad and gas bearing types by taking the flexible pad & pivot, non-uniform oil viscosity, asymmetric bearing clearance due to pad & rotor deformation, etc. into account.

The current software packages provides three basic modules for users: the high-fidelity and simplified ME prediction modules and bearing dynamic coefficient evaluation module. The software adopts the parallel computing and mixing programming with C for computational acceleration. The 3D finite element method is utilized to predict the rotor dynamics with Euler/Timoshenko beam theory and the 3D temperature distribution in both the rotor and bearing. Moreover, the hydrodynamic pressure and 3D temperature of the oil film is obtained by solving the Reynolds equation and energy equation, respectively. Both the ME prediction module and the dynamic coefficient evaluation module have been fully calibrated by published data to ensure accuracy. The simplified ME software is also developed for much faster calculation and its accuracy has been verified by comparing with test data.

A testing rig is designed to measure the journal circumferential temperature inside a five-pad tilting pad bearing. 20 temperature sensors are equally spaced across 360^o and give the most detailed journal circumferential temperature up to date. The journal is whirling synchronously inside the bearing with speed up to 5500 rpm, and operating conditions including various journal static eccentricities and supply oil temperature are tested. Measurements in terms of temperature difference, maximum temperature, hot spot location are used to benchmark the software, and satisfying agreement is found.