Multiphysical Effects on High Speed Micro Rotordynamics

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Introduction

There have been recent developments on the high speed micro rotating machinery. However scarce results exists for examining the **multiphysical effects**, such as the interaction with the surrounding air and thermal effects on the **rotordynamic behavior** of these machines. In this study a new modeling approach is developed to incorporate flow induced forces and thermal effects into the structural model which includes the flexibility of the rotor.

Method

The rotor is modeled by finite element method based on **Timoshenko beams** and flow induced forces are implemented to the rotor's **finite element model** as a spring-damper and added mass at each node.

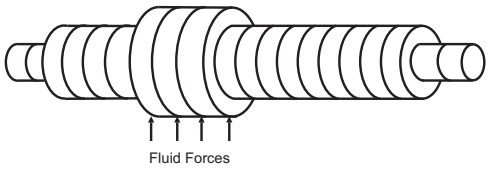

Figure 1 : Flow forces applied to structure model

Finally a thermal model has been established in order to calculate the heat dissipation and the temperature increase in the air. The new air gap temperature is used to calculate the flow induced forces with **updated** air properties. In this way **thermal and fluid effects** in medium gap confinements are coupled with the **rotordynamic models** and their effects on critical speeds and vibration response can be properly investigated.

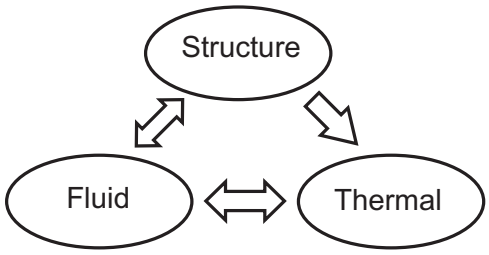

Figure 2 : Interaction between physical domains

Results

An **experimental setup** has been built in order to study the support flexibility and multiphysical effects on the dynamics of mini rotors and to validate the theoretical model. Modal analysis of individual components and the complete setup have been performed to identify the dynamic characteristics.

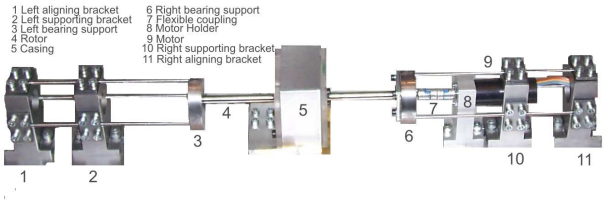

Figure 3 : Experimental setup

Spectrum maps are plotted in order to determine the **onset of instability**. Fair agreement between theoretical and experimental results has been observed.

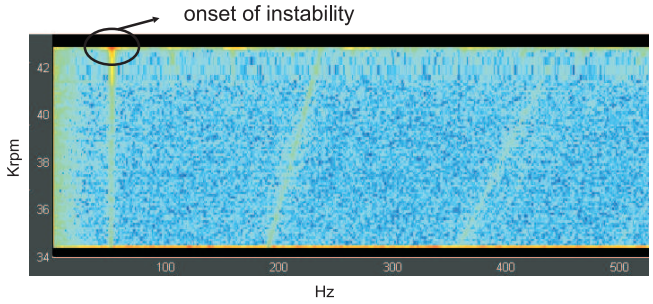

Figure 4 : Spectrum map

Conclusions and future work

The developed modeling approached is observed to be capable of determining the **dynamic behavior** of mini rotors under **multiphysical effects**. As a future work viscoelastic materials are intended to be used in order to prevent instability resulting from surrounding air.

Acknowledgments

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