Multiphysical effects on High Speed Micro Rotordynamics

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Introduction

Recently, there has been great effort on the design and development of high speed rotating micro devices. Advanced rotordynamic modeling of these devices is necessary in order to reach high speeds.

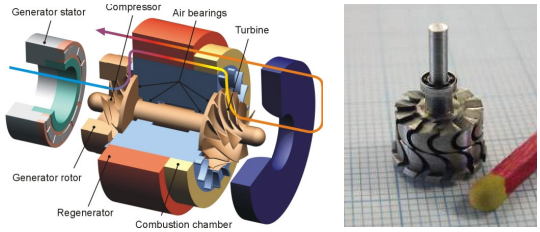

Figure 1: High Speed Microturbine [1]

Objective

The objective of this study:

- Develop modeling techniques for multiphysical effects
- Couple the models with rotordynamics

Method

In this study, thermal and flow induced effects in moderate flow confinement are modeled and coupled with rotordynamic model.

Fluid Forces
(Spring, mass, damper)

Temperature increase
(Thermal network)

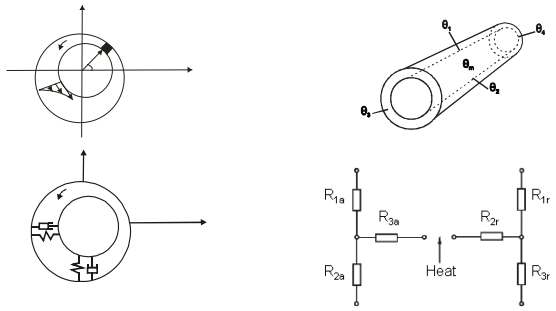

Figure 2: Thermal and Fluid Models

Flow induced forces are implemented to the rotor finite element model as spring-damper and added mass at each node.

Air gap temperature is calculated and used to update the flow induced forces with new properties.

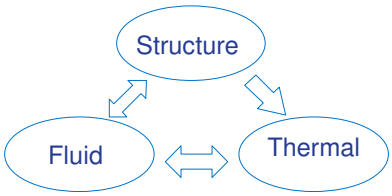

Figure 3: Interaction between physical domains

Results

Natural Frequencies (rad/s)			
	Without Fluid	δ=0.25 mm	δ=0.5 mm
Rigid Body	***677***	***532 (21.42 %)***	***597 (11.82 %)***
Flexible	***10 562***	***10 560***	***10 560***

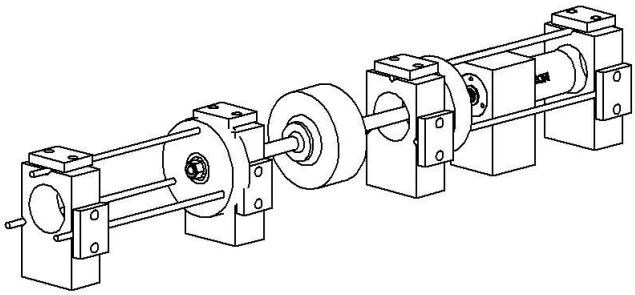

Figure 4: Natural frequencies & Experimental Setup

Discussion

The surrounding air has almost no effect on the ***flexural*** natural frequency but it affects the ***rigid*** body frequency. The influence becomes more pronounced when the ***stiffness*** of the supports and the air gap decrease.

References

[1] Peirs J, "Micro Power Generation Based on Micro Gas Turbines: a Challenge", MST news, 4, 2005 , pp. 37-39.