Semester/MSc project proposal

Heat loss investigation in a high-T compressor-turbine-unit with steam injection

General Information:

Laboratory: Laboratory for Applied Mechanical Design (LAMD)

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Background

A new small-scale high-speed compressor-turbine-unit (CTU) suitable for high temperatures is currently under development. This system is running on gas bearings, which are very sensitive regarding their clearances – if the clearances are too large, the gas bearings will run sub-optimally; if they are too small, it will lead to a crash. Gas bearing windage losses will lead to a build-up of excess heat in the system. This and a thermal gradient within the system will lead to the material undergoing thermal expansion, which can change the clearances.

One way to evacuate excess heat in the system is to inject steam through the housing, which helps to even out temperature and thus thermal expansion differences. This solution is therefore to be investigated.

Objective

The goal of this project is to investigate a CTU housing concept with external steam injection. For this, a 2D heat model of the new CTU is to be developed using an LAMD in-house code. To check whether the developed concept would actually work, FE analysis of the design will be needed. Goal is to use this 2D heat model to calculate the heat losses for different steam injection locations, operating temperatures and used materials.

In case of a master's project, it is further possible to investigate the combined implementation of steam injection and heat fins by adjusting an existing model.

Tasks

1. Literature review. State of the art concepts of high-T turbomachinery housings and heat models (1D to 3D). Fundamentals of heat transfer phenomena in turbomachinery and gas bearings.
2. Develop and adjust 2D heat model of CTU geometry using in-house code
3. FE analysis of 3D design regarding thermal behavior
4. Comparison and validation of results from 2D heat model with results from FEA
5. (If master's project) Integration of 2D heat model with existing 2D model of heat fins
6. Written report, presentation of results

Prerequisites

Fundamentals in heat transfer phenomena, programming experience with Matlab/Simulink and FE analysis. Motivation, structured working and reliability very important.

Note: Adjustments may be required according to progress, results and project duration.