
The energy sector’s recent drive towards subsea oil and gas production brings about a requirement to locate process equipment in deep-water installations for which performing liquid and gas separation on the well stream is limited. Consequently, the subsea installed pumps and compressors are now required to handle multiphase fluids. The difference between fundamental properties of single phase and multiphase flows entails that multiphase flow impact on the rotordynamics of rotating machines requires special treatment. Furthermore, turbomachinery seals are pivotal for the performance of pumps and compressors for which reason the ability to predict the complex interaction between fluid dynamics and rotordynamics within these seals is a key aspect in the design of rotating equipment. Numerical tools offering predictive capabilities for seals subjected to multiphase flow conditions are currently being developed and refined, however a pronounced lack of experimental data renders benchmarking and validation impossible.

This thesis focusses on documenting the design and commissioning of a test facility enabling the much needed experimental identification of rotordynamic properties for turbomachinery seals in both single phase and multiphase flow. The commissioning phase of the test facility solely employs single phase air flow for performance assessment of the test facility and no experimental multiphase results are included in the thesis. The test facility consists of four modules of which an industrial scale rotordynamic test bench consisting of two radial active magnetic bearings with an embedded Hall sensor system, a rigid rotor, and a drive unit acts as the hub. In addition, the test facility includes a module facilitating calibration of the state of the art system of Hall sensors which provides important contact free force measurement capabilities. The third module houses the smooth annular test seals and the fourth module adds a single phase air flow supply to the test facility infrastructure. For experimental identification purposes the ability to acquire precise information of the forces exerted onto the rotor by the seal flow is of paramount importance. Consequently, this subject receives substantial attention throughout the thesis with a strong focus on the calibration necessary for the Hall sensor system to be of any practical use. The presented calibration results and subsequent performance validation campaign documents that the test facility is capable of quantifying forces with high precision. With the addition of rotor displacement measurements the rotordynamic properties of the test seals can be determined. This is demonstrated for a limited range of seal flow perturbation frequencies using a time domain identification scheme. Additionally, the use of commercial computational fluid dynamics software for estimating rotordynamic properties of seals in a range of multiphase flow conditions is exemplified in the thesis. The thesis documents a first step towards establishing validated numerical models for multiphase seal analysis and forms a fundamental basis for future studies within the research field.

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