

Influence of Structural Parameters and Flow Conditions on the Dynamic Behaviour of Flexible Labyrinth Seals

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The paper presents measurement data obtained from a static test rig for flexible labyrinth seals. The structures have a simple geometry provided with a look through labyrinth with two teeth on rotor. Measured vibrations are self excited by the interaction of compressed air with the structures. The direction of fluid flow can be inverted to investigate identical configurations at high pressure support or low pressure support. Stiffness of the structures and pressure conditions (inflow pressure and pressure ratio over the labyrinth) can be varied as measurement parameters. Instrumentation consists of three eddy current transducers to measure structural vibration and six pressure transducers. One pressure transducer is in the labyrinth chamber and one on either side. Three pressure transducers are at different positions of the cavity between the structures, adjacent to the labyrinth.

Measurements and evaluation of data show the influence of aeroacoustic effects in the cavity outside the labyrinth on the dynamic behaviour of the coupled system. Pressure amplitudes and phase angles between different transducer positions allow identification of acoustic modes in the cavity. Acoustic modes occur as pressure fields with amplitudes up to 30 kPa and a spatial shape similar to the displacement-fields of the corresponding structural modes.

Mode order and shape of acoustic modes with high pressure supported structures is widely influenced by pressure conditions and stiffness of the structures, though, in most experiments the frequency of the coupled system varies only in a small range of 5 %. Typical for hps-configurations are increasing pressure amplitudes in the cavity at positions with increasing distance to the labyrinth.

Low pressure support of the same structures and test configurations causes a significant decrease of frequency of about 40 %. In many tests other mode orders become dominant compared to high pressure support. Typical for lps-configurations are decreasing pressure amplitudes in the cavity at positions with increasing distance to the labyrinth.

These results lead to the assumption that –not in general, but concerning the conditions and geometry of the test rig- flow conditions and pressure gradients in the labyrinth cause varying excitations and boundary conditions for acoustic modes. Especially for hps- and lps-configuration flow conditions are significantly different and result in vital variations of the system's dynamic behaviour.