HEAT TRANSFER AND FLOW MEASUREMENTS IN A SMOOTH STATOR ROTOR CAVITY WITH PURGE FLOW AND VARIABLE AXIAL GAP

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ABSTRACT

This paper presents advances in the data-analysis and experimental measurement techniques used in local heat transfer coefficient and flow measurements in a rotor-stator disk cavity system. The rotating disk surface temperatures are acquired from thermochromic liquid crystals (TLCs) on both sides of the disk, and the flow structures are studied using high frequency pressure transducers and dual-film hot-wire probes at several locations near the rotating disk surface. The stator temperatures are also measured with TLCs. The paper also describes advances in image processing techniques that improves the usefulness of the temperature data acquired from the TLCs. Also, a new method on triggering a temperature transient required for semi-infinite heat transfer experiments based on inductive heating is explained and discussed. The ultimate aim of this work is to study the relationship between the cavity flow structures and the heat transfer on the disk surface with a special focus on the laminar to turbulent flow transition region.

INTRODUCTION

Daily and Nece (1960), studied the different flow regimes in an enclosed rotor-stator wheelspace, and determined that there are four distinct flow regimes, depending on the axial gap between the stator and the rotor, and the rotational Reynolds number on the disk surface. Since then, many experiments have been carried out, and notably to this research, Schouveiler, Gal and Chauve (2001), identified that the cavity has various different flow structures, both stationary and non-stationary, that take the shape of circular rolls near the center of the disk, and the shape of spiral rolls towards the outer radius of the disk. Wave turbulence and turbulent spots were also identified.

The test rig used in this research can be set-up to generate similar flow conditions, with a variable axial gap ratio approximately from 0.01 up to 0.08, and the rotational Reynolds numbers up to 300 000. Additionally, purge flow can be introduced axially at the center of the rotating disk, which changes the flow structures present in the cavity. The purge flow amount, axial gap, disk rotational speed can be adjusted to generate a range of different experimental conditions. An image of the test rig is shown below, in figure 1.

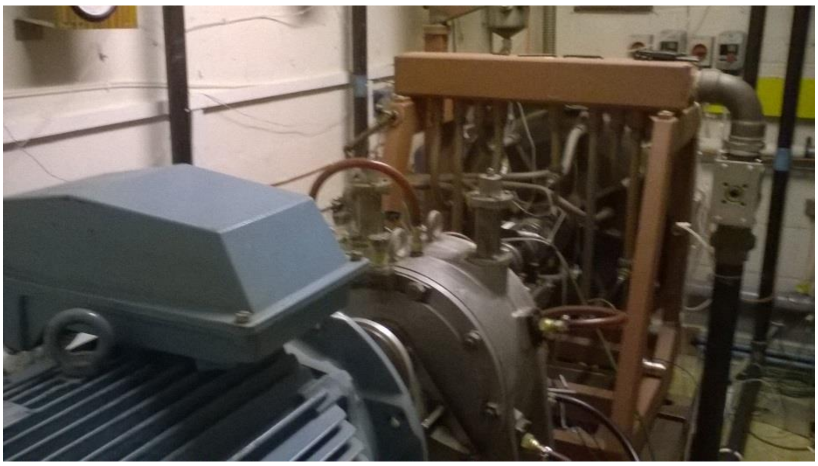

Figure 1. Rotor-Stator Cavity Flow Test Rig

RESULTS AND DISCUSSION

The experiments are currently under way. The data demonstrates the existence of different types of flow structures changing based on the test rig running conditions, and also that the inductive heating technique is capable of heating the disk sufficiently for transient heat transfer experiments. The image processing techniques studied also show that the accuracy of the TLC response can be increased.

REFERENCES

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