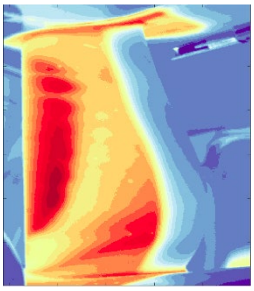
Numerical and Experimental Study of Novel Heat Flux Measurement Method in Turbomachinery



1-2 Person
Supervisor: Isak Jonsson isakj@chalmers.se
Examiner: Valery Chernoray
Contact: Isak Jonsson
MSc Thesis or Project Course: 15hp

Short Introduction

In the joint endeavour of Chalmers and GKN Aerospace in the project AT3E a new experimental method has been developed in Chalmers turbine test facility which radically improved the measurement accuracy of force convection heat flux (Jonsson I, 2020).

The method and results are of high value for both the industry and academia, but before full implementation is possible, the method needs verification in a controlled environment.

We are now locking for 1-2 students to evaluate this method both numerically and in Chalmers L2 wind tunnel. This is a relatively challenging project but since a clear pathway of project execution and experimental infrastructure exist it is reasonable to achieve the expected results within set time.

Background

The method was developed to evaluate steady state heat transfer on a turbine stator vanes in our newly built world unique facility (Rojo, 2017) at Chalmers. Industry interest is represented via GKN which is a world leading manufacturer of the turbine stators and a close collaborator in this and many other projects within the division of fluid dynamics. Two projects are now running in the turbine facility: and the method will also be implemented in the compressor facility currently under construction in another project.

Key enablers for the realization of the new method have been recent development in accuracy of stereolithography manufacturing, infrared thermographic methods to estimate background radiations (Povey, 2017) and mapping of low thermal conductive material properties.

Msc Thesis expectations

The key target of the thesis is to evaluate the current heat transfer method together with researchers at the laboratory of Fluids and Thermal Sciences. Student's tasks include, but not limited to:

- A literature study onconvective heat transfer measurement methods (Will, Kruyt, & Verner, 2017).
- The students are to optimise existing test geometry and test conditions for maximum measurement accuracy. The evaluation is to be done by using in-house developed uncertainty evaluation tools and potentially numerical simulations using commercially available CFD tool, preferrably Fluent or STAR-CCM+.
- Propose a measurement/simulation plan with test matrix, both for experimental and numerical work. This includes a specified dataset needed to bridge experimental and numerical results with high confidence.
- Experimentally measure the heat transfer and flow field on a verification case in the fluid dynamics lab. Full support from researchers in the lab will be available for development,

implementation and instrumentations. However, the student is expected to perform the measurements with only minor supervision.

- Analyse experimental and numerical uncertainties with an extended discussion on estimated quantities.

The examination consists of a written report and a 20-min presentation with 10 min for questions.

After the completion it is expected that the student will be familiar with state-of-the-art experimental heat flux measurements applicable to lab conditions that we have in Chalmers wind tunnel lab.

Jonsson I, C. V. (2020). Heat Transfer on Outlet Guide Vanes in a Turbine Rear Structure. *International Journal of Turbomachinery, Propulsion and Power*, 5-23.

Povey, B. K. (2017). *High-accuracy infra-red thermography method using reflective marker arrays.* Measurement Science and Technology.

Rojo, B. (2017). *Aerothermal Experimental Investigation of LPT-OGVs .* Chalmers, Applied Mechanics, Fluid Dynamics .

Will, J., Kruyt, N. P., & Verner, C. (2017). An experimental study of forced convective heat transfer from smooth, solid spheres. *International Journal of Heat and Mass Transfer*, 1059-1067.