Investigation of shock patterns in a linear blade cascade.

Supervisors: TUD: A.J. Head

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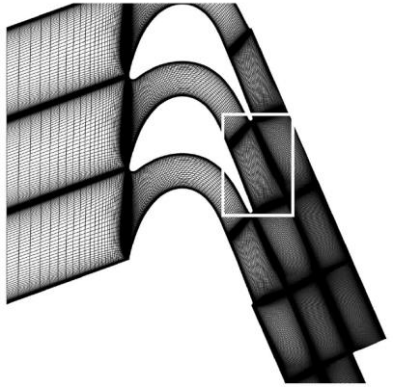
Starting date: ASAP

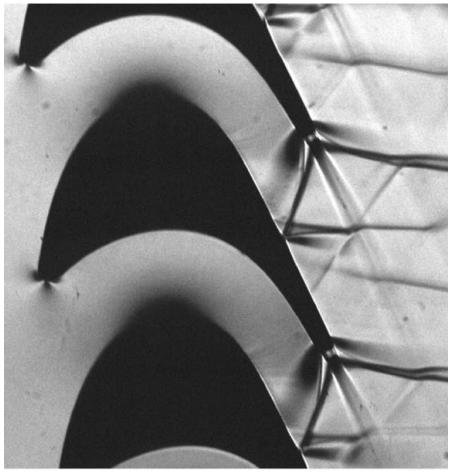
Location: Faculty of Aerospace, TU Delft

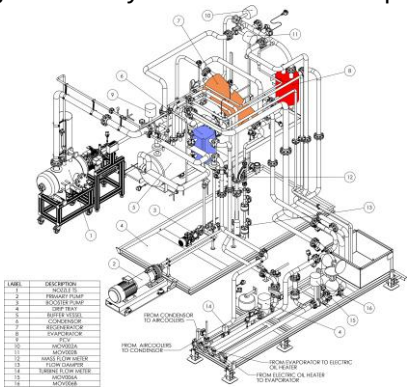
Project Overview

Nowadays Organic Rankine Cycle (ORC) Power Systems are of paramount importance to exploit waste heat and renewable energy sources. The design of the turbine of ORC systems is the most challenging task. Standard design rules and empirical models are mostly available for steam/gas machines but are not directly suitable for ORC turbine design. This is mainly due to the thermodynamic behavior of the working fluids, which expand in the so-called dense vapor region.

There is an uncertainty attributed with the thermodynamic properties (critical point and transport values) which lead to uncertain shock angles, differences in strength and boundary layer thickness. A new vapor tunnel facility called the ORCHID, see below, has recently been commissioned and is being used to generate the data required for validation of an open-source CFD code which will then be used for turbine design. The physics in a turbine can be represented by a simple linear blade cascade, one of the future test sections of the ORCHID, see right. The experiments needed to validate the thermodynamic model of the CFD code consist of generating and characterizing complex flow patterns between the blade profile. The student will focus on numerical and experimental investigations of shock flow patterns through an ORC linear blade cascade. The student will assist with experimental campaigns whereby the schlieren technique will be used to study the flow patterns of a dense vapor expansion.







TU Delft

FPP Master Thesis Assignment

SU2 The Open-Source CFD Code

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Other Details

Several small modifications are needed to the nozzle test section, see right, such that the ORCHID can incorporate a series of linear blades.

Deliverables

1. Literature study on the various types of measurement techniques which could be adopted to study phenomena in a cascade vapor tunnel. Review of relavent compressible flow phenomena, the use of CFD solvers and associated techniques. Review of 1D euler based real gas compressible solvers and uncertainty analysis techniques. (2-3 months).
2. Assesment of the influence of the uncertainty of thermodynamic properties on calculated flow dynamic quantities. (1 month)
3. Validation assessment of SU2, e.g., UQ + Steady-state CFD flow simulations of the dense gas expansion through the cascade. (1-2 months)
4. Development of a tool to automatically post process and extract lines and angles from schlieren images (1 month)
5. Thesis write-up (1 month)