NUMERICAL INVESTIGATION OF A SINGLE STAGE AXIAL COMPRESSOR

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To achieve more environmentally friendly aero-engines, several breakthrough solutions are being investigated. One of these is the contra-rotating fan architecture, which offers the possibility of reducing engine noise by lower fan speed. It causes higher blade loading of the LP compressor stages to keep the engine weight at reasonable levels. Keeping sufficient stability margin in those highly loaded stages is becoming more and more important. Casing treatments are therefore being considered to extend compressor operation while keeping the pressure ratio and efficiency.

The present work focuses on the numerical investigation of the single stage compressor which is being tested in the VKI R4 test facility. The aerodynamic design of this ½ scale test compressor has been performed at VKI according to the specifications given by the industrial partner. The full scale design is representative of a highly loaded LP compressor stage appropriate to the operating conditions of a contra-rotating fan engine architecture.

The objective of the project is first to investigate in detail the performance of this highly loaded design, with an unconventional triangulation. The longer term objective is to study the possibility of using casing treatments to extend the stability margin of such a stage.

The recent part of the study is therefore focused on the steady behavior of the compressor in different circumstances like at different rotational speeds and different throttle settings, i.e. its performance map at different Reynolds numbers. However, numerically, a number of important parameters must be taken into account. Many efforts were invested in obtaining a very high quality mesh, since phenomena like tip leakage vortex, secondary flows, boundary layer separation play an important role in the onset of stall for compressors. Several turbulence models and different computational domains were investigated for the same reason, and the study includes also detailed investigation of numerical stall.

The calculations were compared with previously achieved results with the TRAF code which was used for the aero design. The choice of using the FINE code for all calculations performed in the present work is justified by the long term goal of investigating casing treatments, which the TRAF code is unable to handle.

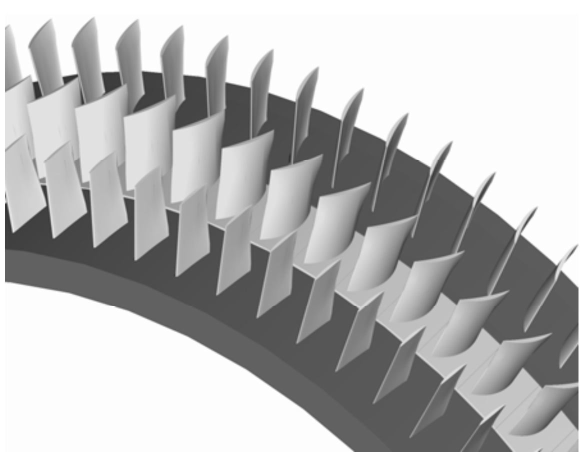

Figure 1: 3D view of the blade-rows of the compressor-stage