University of Belgrade
Faculty of Mechanical Engineering
Laboratory of Thermal Turbomachinery

ACFlow –Through-Flow Code for Axial Compressors

The **ACFlow** (**A**xial **C**ompressor **Flow**) is a 2-D axial compressor design tool for axisymmetric flow calculation based on streamline function method and finite elements solution procedure.

For given compressor geometry and operating data, the code calculates

- flow field (thermodynamic properties and velocity components) in every point of the meridional plane,
- overall performances (efficiency and pressure ratio),
- blade row and stage parameters and
- stability stall/surge limit

over a wide operating range, i.e. for different rotating speeds and inlet mass flow rates.

Feachers: supersonic compressors, real/ideal gas model, compressors with very large numbers of stages, IGV/vanes adjucements, bleeds.

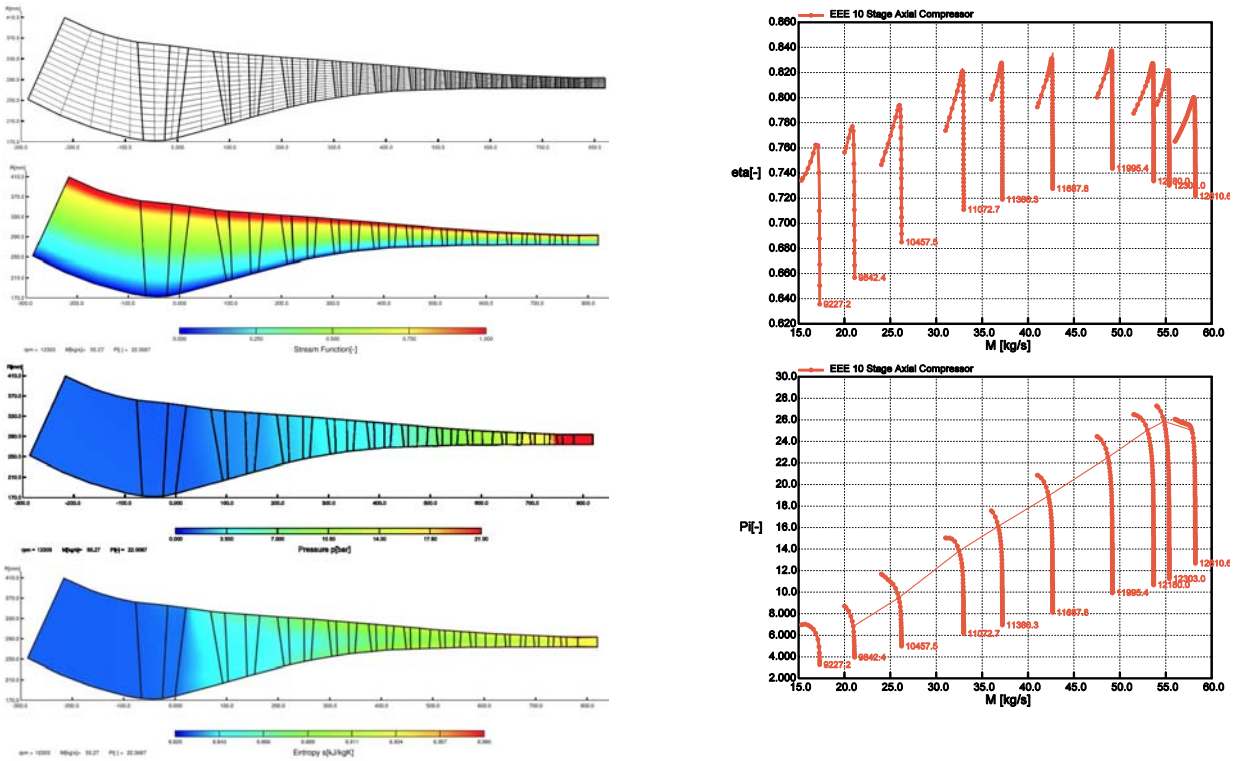
The system consist of

- preprocessor for a quick discretization of calculating domains and for a grid generation
- main code for flow calculation
- postprocessor for powerful presentation of results.

The system contants

- new loss and deviation model for IGV
- updated and calibrated models for profile losses and deviation
- new models for secondary and clearance losses
- new endwall boundary layer model
- new model for surge and stall prediction

The method was validated by calculation of flow of a large number of compressors employing different airfoil. The total-to-total stage pressure ratios varied from 1.04 to 1.7 and the overall compressor pressure ratio from 1.07 to over 20. The operating conditions varied widely, from the design point to stall and to fully choked operation. Cases where the compressors operated at 40% or 50% of their design aerodynamic speed were also analyzed. Particular attention was devoted to machines with a large number of blade rows, where even a small uncertainty in the models may have a large influence on the final results.



Some results of flow calculation in the EEE 10-stage compressor

Contact: Prof. Dr. Milan Petrovic, Fac of Mech Eng, Kraljice Marije 16, 11120 Belgrade, +381 11 3370353, mpetrovic@mas.bg.ac.rs

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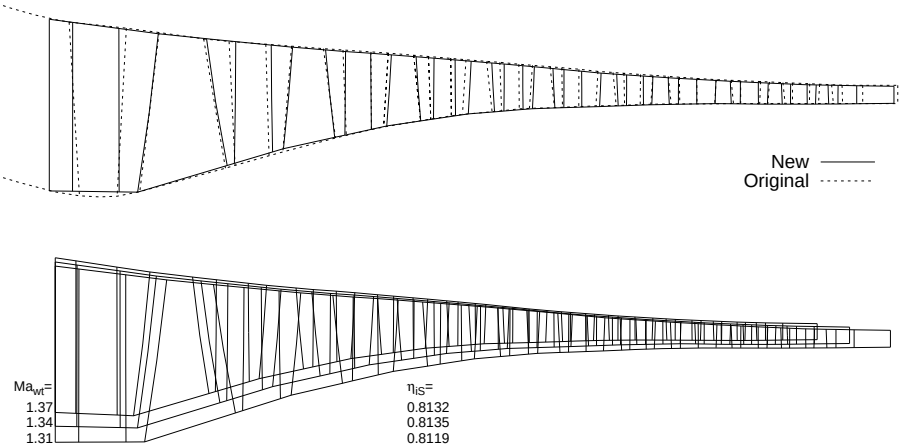
ACDesign – A Code for Multistage Axial Compressor Design

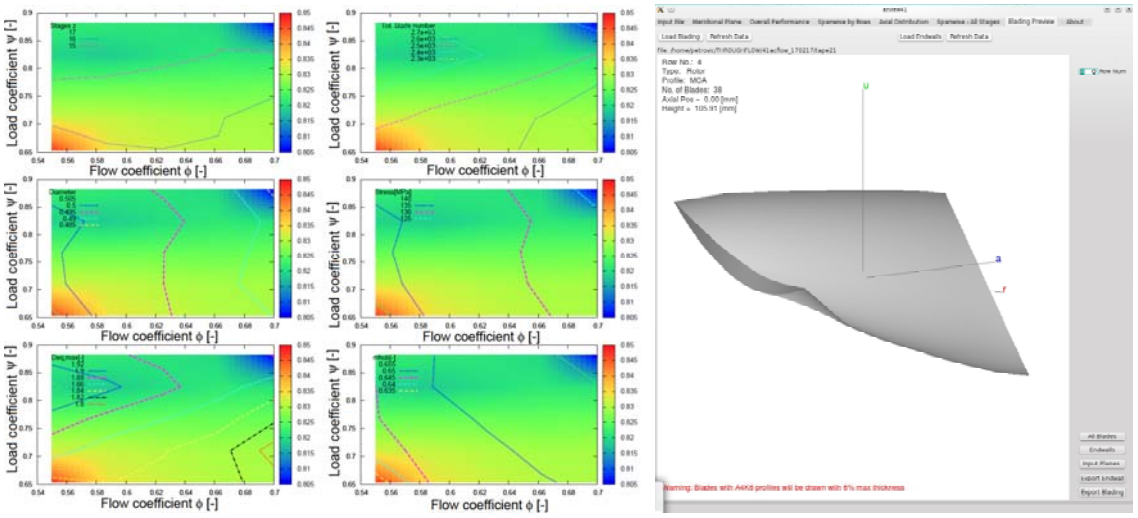
ACDesign is a code for aerodynamic 1D/2D design of axial compressor. The loss and deviation models developed and validated for flow analysis system (ACFlow) were applied in scope of a computer program for the meanline design of multistage axial compressors. A variation of input parameters and a redistribution of stage parameters can be done in order to achieve high values of efficiency and desired stability indicators over the given operating range. The applied stage vortex type additionally determines blading geometry at hub and tip sections which creates a flow path geometry and initial meanline and (quasi)two dimensional solution.

Using the previosly obtaned meanline solution and the selected vortex type, a two-dimensional design is obtained by applying streamline curvature throughflow equations and spanwise distribution of losses. The iterative calculation procedure slightly reshapes initial flowpath to retain desired input parameters while some of the other stage parameters are changed in order to keep the input value of overall pressure ratio. Further, a spanwise distribution of stage parameters can be adjusted to achieve desired flow field variation in radial direction. Also, basic one-dimensional input data can be easily changed in any moment to obtain new one-dimensional concept and and associated two-dimensional solution.

New geometry is created instantly and can be further used for CFD analysis, throughflow or blade to blade flow calculations, or, for mechanical analysis.

Developed program is considered to be a flexible and stable tool to be used for manual or automated optimization process using an external optimization program.





Some results of redesign and optimization of EEE 10-stage axial compressor

Contact: Prof. Dr. Milan Petrovic, Fac of Mech Eng, Kraljice Marije 16, 11120 Belgrade, +381 11 3370353, mpetrovic@mas.bg.ac.rs