Automated Optimization of the Non-axisymmetric Casing Endwall of a Fan Rotor

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Abstract

In this study the endwall casing of a fan rotor is modified in an automated optimization process in order to achieve a higher efficiency and to gain surge margin. The casing endwall is allowed to take non-axisymmetric shapes by means of different parameters describing the contour. The parameters have only the possibility to move upwards or downwards in the radial direction. Given these non-axisymmetric shapes and since the simulations are conducted in the steady state, the casing has to move along with the rotor which makes this study a theoritical case non-feasible in reality and having as main aim the understanding of the influence of endwallshaping on the tip flow.

For CFD calculations the DLR in-house TRACE-code is used. The optimization tool is AutoOpti, a DLR developed tool, which is based on a genetic algorithm speeded up by surrogate models. During the optimization two operating points are considered : One is calculated at a fixed backpressure (OP1) representing the operating point at maximum stage efficiency for the smooth casing and the other one (OP2) is an operating point near the surge limit calculated at a fixed outlet mass flow regulated by a PID controller.

Acting on the secondary flow at the tip as well as on the tip leakage vortex is believed to be one of the main reasons for the detected aerodynamic improvements. These improvements can be seen in the reduced losses in the tip area of the OP1 as well as in the surge margin. The study mainly focuses on the aerodynamic explanation of these improvements analyzed in different members.