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USING MULTICRITERION OPTIMIZATION METHODS TO OPTIMIZE THE 3D SHAPE OF AXIAL COMPRESSOR BLADES

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Abstract: Multicriterion optimization methods are widely use in many types of design process. This is because the using of optimization tools allows in an automated mode to find such a combination of design parameters of the investigated unit, in the implementation of which all the requirements are best met. One of the applications of such methods in turbomachinery is to optimize the 3D shape of the compressor blades. The article presents developed optimization methods for improving the working process of an axial compressor of gas turbine engine. Developed method allows performing the search for the best 3D geometry of compressor blades automatically by using optimization software IOSO and CFD software NUMECA Fine/Turbo. The algorithm of developed method is described below. The optimization software IOSO generates vector of input parameters describing the geometry of compressor blades in parametric form. Then “in-house” software Profiler generates files containing information about the new geometry of blades. Generated files are loaded into a numerical model of the compressor which is using to calculate the parameters of the working process in CFD software NUMECA Fine/Turbo using 3D Navier-Stokes solver. A vector of output parameters and restrictions is formed after the end of the calculation and is returned to IOSO to select the best variant of blade geometry and to form a new set of input parameters. This cycle is repeated until the desired result is achieved. Optimization was performed by changing the form of the camber line in three sections of each blade and by shifting three sections of the guide vanes in the circumferential and axial directions. The calculation of the compressor parameters was performed for work and stall points of its performance map at each optimization step. The study was carried out for seven-stage high-pressure compressor and two three-stage low-pressure compressors. Optimization problems was solved in a two-criteria formulation. To ensure that the position of the operating point on the characteristics of the compresses did not change, limitations were set on the amount of flow of the working fluid and the ration of total pressure in the process of optimization. As the result of optimization, improvement of efficiency was achieved for all investigated compressors. For HPC was found variant of blades that provides an increase in the efficiency by 1.2% and for LPC was found variant of blades that provides an increase in the efficiency by 1.3%.