EngOpt2018 - 6th International Conference on Engineering Optimization
Instituto Superior Técnico, Lisbon Portugal • 17-19 September, 2018
Editors: H.C. Rodrigues, J. Herskovits, C.M. Mota Soares, et al.

Abstract ID 1155

EXPERIMENTAL COMPRESSOR MULTIDISCIPLINARY OPTIMIZATION USING DIFFERENT PARAMETERIZATION SCHEMES

Tatiana Buyukli[(1)], Igor Egorov[(2)], Grigorii Popov[(3)], Evgenii Goriachkin[(3)], Anton Salnikov[(1)]

[(1)]Central Institute of Aviation Motors, Russian Federation
buyukly@mail.ru, salnikov_anton_vlad@mail.ru

[(2)]Lyulka Design Bureau, Russian Federation
egorov300657@yandex.ru

[(3)]Samara National Research University, Russian Federation
grishatty@gmail.com, goriachkin.e.s@gmail.com

Keywords: Compressor,optimization,blades,shape

Abstract: The present-day compressors development is a labor-intensive problem, because compressor structure should meet different requirements to the design characteristics (aerodynamic, strength, weight, design constraints, processing limits etc.). In order to make this task easier, it's reasonable to find optimal combination of compressor design parameters using the mathematical optimization resources. The optimization problem formulation is very important in optimization. The optimization problem formulation includes development of parameterized grid-model, parameterization scheme and designers' decision about which parameters and what number of parameters they should vary. In this paper the multi-criteria and multidisciplinary optimization of the rotor and stator blades of the experimental compressor stage NASA Rotor 37 is carried out. For the optimization the unified parameterized multidisciplinary 3D model was used. This model includes the air-gas channel of the compressor stage and the finite element model of the rotor blade. This approach allows the consideration of different requirements for the aerodynamic, strength, and mass characteristics within one coupled optimization problem in unified computational space. The goal of this work is the analysis of different blade parameterization schemes and determination of optimum number of variable parameters for compressor stage aerodynamic characteristics improvement with respect to rotor blade static and dynamic strength. As an optimization criterions compressor stage efficiency and the blade mass minimization were used. Aerodynamic limits are: flow rate and pressure ratio values should not exceed base values more than ±0.5%. A static and dynamic strength limits are: maximum stress level should not exceed base level (the original design stress level) and the relative distance between the four natural frequencies and the nearest harmonics should not be less than 20%. In order to research an effect of the number of variables to the optimization results, the four parameterized models were created. The optimization of the NASA Rotor 37 was carried out using all created parametric models. The models are characterized by number of variables, which describe the blade pressure and suction sides. As a result of optimization the NASA Rotor 37 version was found, which provide the efficiency increasing by approximately 2% and the blade centrifugal load decreasing by approximately 9%, while all aerodynamic and strength requirements are satisfied. It was also found, that increasing of the blade profile number of variables more than 7 is not rational.