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Aerodynamic design of transsonic compressor airfoil family

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New family of transsonic compressor airfoils is being developed in the frame of KOBRA project. This project is focused on the development of new gas-cooled nuclear reactor and axial compressor is a part of the secondary system. Maximum Mach number based on intake velocity is assumed 0.8, which gives compromise between high stage pressure ratio and low loss coefficient. New airfoil family should have better performance that classical NACA 65 airfoils [2], but it should offer performance comparable with the Controlled Diffusion Airfoils (CDA) [1].

Airfoil shape is defined in an explicit way, i.e. like NACA 65 airfoils. This is the main difference in comparison with common CDA airfoils [5, 3, 4], where each airfoil have to be designed separately and optimised by means of CFD simulation. Explicit formulation of airfoil geometry brings several advantages, e.g., faster and easier blade design or less problems during blade assembly from separated airfoils.

Several chamber functions were tested during airfoil development (see Fig. 1):

1. combination of straight line and polynome, Fig. 1 (left),
2. mean line of NACA 6 airfoils for constant γ, Fig. 1 (middle),
3. mean line of NACA 6 airfoils for trapezoidal γ, Fig. 1 (right).

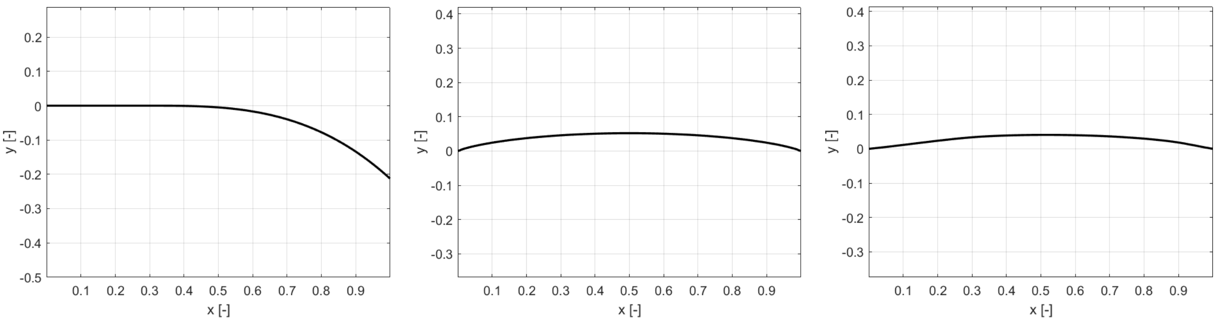

Fig. 1. Comparison of three mean curves used for the compressor airfoil development

Thickness function is based on the thickness function derived from the NASA supercritical airfoil SC(2)-1006. Thickness function is modified so that trailing edge thickness can be chosen according to the design requirements. Comparison of the original and modified thickness functions ca be seen in Figs. 2 and 3. Presented airfoils have third type of chamber function and intake angle 60° and Mach number 0.8. Airfoils characteristics will be analyzed by means of CFD in order to find design rules for cascade solidity, incidence and deviation angles.

The design procedure of the new airfoil family suitable for transsonic axial compressors is presented in this paper. These airfoils will be used for the compressor for nuclear reactor

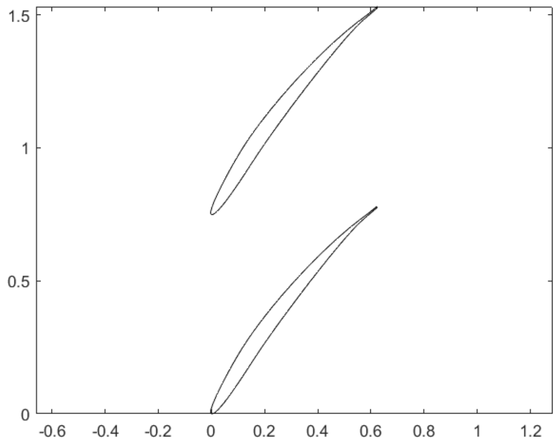

Fig. 2. Airfoil with unmodified thickness function for the intake angle 60° and Mach number 0.8

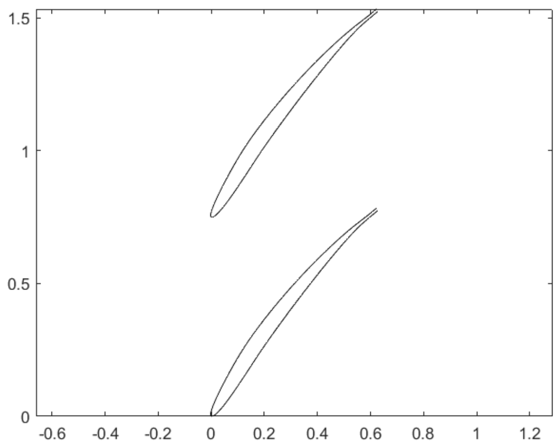

Fig. 3. Airfoil for the intake angle 60° and Mach number 0.8 with modified trailing edge, i.e. trailing edge thickness is 1% of the airfoil chord

cooling developed during the KOBRA project in the cooperation of Czech Technical University, Nuclear Research Institute and Czech Academy of Sciences. The aim is to develop airfoils which geometry is defined in explicit way and which have performance comparable with controlled diffusion airfoils (CDA), i.e. high stage pressure ratio and high polytropic efficiency is reached. Airfoil geometry is based on the mean curve and thickness distribution. Thickness distribution is modified so that prescribed trailing edge thickness is reached. Several mean curves are tested. Finally, the geometry of the airfoil family is presented.

Acknowledgement

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