AERODYNAMIC STUDY OF AIRFOIL WITH ROTARY SLAT

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Abstract. Aerodynamic study of an airfoil with rotary slat conducted in Samara State Aerospace University (Russia) is presented. "Rotary slat" is a term for the rotating cylinder installed at the nose of the airfoil. Two types of the airfoil were investigated, both sharing the same circular nose but with different aft parts: one was wedge-shaped, the outline of the other was made of two circular arcs. Both CFD modelling using Star-CD and ANSYS CFX, and experimental study in a low-speed subsonic wind-tunnel were conducted. Experimental study consisted of measurements for pressure distribution at the airfoil surface and flow visualization using smoking wire and laser sheet. Variable parameter were the angle of attack α and relative rotational velocity of the slat $\bar{U} = U/V_\infty$, where U – linear velocity of the cylinder surface; V_∞ – flow velocity. Angle of attack α varied from 0 to 10 degrees, and relative rotational velocity $\bar{U}$ - from 0 to 5. Different flow velocities were considered - 7 *m/s* and 31.5 *m/s* for the experiment and 10 *m/s* for CFD modelling. CFD models used in Star-CD simulation were 3D, and featured a stationary diaphragm bisecting the rotating cylinder in the spanwise direction (in the experiments it was used for pressure orifice location). RNG *k-ε* turbulence model was used together with non-equilibrium wall function accounting for streamwise pressure gradient. CFD models used in ANSYS CFX were 2D. Two different turbulence modelswere compared: standart *k-ε* and *k-ω* SST. CFD simulations and experiments resulted in the estimation of key aerodynamic properties (lift and drag coefficients, lift-to-drag ratio) as functions of kinematic parameters α and $\bar{U}$. It was found that rotary slat can increase lift-to-drag ratio comparing to $\bar{U} = 0$ case. Flow visualization have shown that it can prevent airfoil stall for the angle of attack up to $\alpha \sim 90$ degrees.

Keywords. Airfoil, rotary slat, experiment, Star-CD, ANSYS CFX, lift coefficient, drag coefficient, lift-to-drag ratio, pressure distribution, visualization.