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Numerical modelling of dynamics and aerodynamics processes of Darrieus and Savonius rotors

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The procedure offered in the present work is founded on the joint solution of the equation of wind turbine rotation and the equations describing a non-stationary incident airflow of a wind. Simultaneously with the problem of streamlining of wind turbines blades the equation of rotation of a rotor concerning fixed axis under the action of the incident airflow and the affixed loading for definition of the current angular rate of wind turbine rotation was decided. For calculation of aerodynamic characteristics algorithms are used on the basis of Reynolds average Navier-Stokes equations (RANS). The one-equation model of turbulence Spalart-Allmaras, SARC and SALSA are used. The algorithm of a numerical solution of initial equations based on schemes TVD of the third and Roe of the fifth orders for convective terms and the second order central-difference for viscous terms.

In the capacity of the test problems streamline of the fixed and rotating circular cylinder; fixed, oscillating and rotating airfoil NACA 0015 are considered.

The procedure is applied to calculation of aerodynamic characteristics of vertical-axis wind turbines. The results of Darrieus and Savonius rotors calculations with different quantity and geometrical performances of blades are submitted. Singularities of aerodynamics (boundary layer breakaway, interaction of blades, flow in a track and near to a wind turbine nacelle) are analyzed at the rotation of the windwheel. The developed procedures, algorithms and computational programs allow to calculate dynamics of rotation wind turbine, to analyse aerodynamic characteristics of wind turbine blades, to select rational configurations (quantity of blades, angles of incidence, airfoil configurations) taking into account their motion under action of unsteady wind loads.