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WIND TUNNEL TESTS AND CFD-SIMULATION FOR AIR-BREATHING PROPULSION SYSTEMS AERODYNAMICS

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The standard wind tunnel test conditions of aircraft wind tunnel models and their propulsion systems are considered. Some wind tunnels and models to be tested in these wind tunnels are presented. The methodology specific features of experimental aerodynamics and acoustics simulation in wind tunnels are given. These features require to be supported by the CFD –simulation in terms of improving the test results information capability and quality.

The experience of CFD methods implementation in TsAGI experimental activities is shown. The description of the method to calculate the flow around aircraft model in wind tunnel is presented. Special boundary conditions are formulated, which permit achieving the necessary flow parameters in control sections and simulating some peculiarities of wind tunnel walls, for example, the perforation and support systems. Examples of the proposed methodology application are presented. A mathematical model of TsAGI's T-104 large low speed wind tunnel with open test section is presented. It is shown that, in conditions of the subsonic wind tunnel, one can simulate the construction elements influence on a model, when these elements are not represented in this wind tunnel (for example, the take-off runway). On the other hand the impact of the test rig for model installation in the wind tunnel on tested model aerodynamic characteristics is shown. Two examples of the test rigs influence are demonstrated: 1) the test of an aircraft turbofan model under thrust reverser regime and 2) the test of a contra-rotating propeller (open rotor) in TsAGI's T-104 wind tunnel. A mathematical model of TsAGI's T-131 high speed wind tunnel for combustors test is presented. The physics of hydro-carbon fuel combustion in a combustor model is under investigation taking into account the test rig influence. Technology for fast computation of non-stationary viscid flows is applied to supersonic flow in a model combustor with combustion of kerosene fuel in pseudoshock. High-frequency oscillations of flame front in the duct are found and explained. Their influence on the flame stabilization in the duct is shown. Correlation between useful force and heat release is demonstrated.

It is summarized that the wind tunnel mathematical model is an indispensable part of the experimental investigation method.