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Sergey V Alekseyenko, J Appl Mech Eng 2017, 6:5(Suppl)
DOI: 10.4172/2168-9873-C1-011

2nd International Conference on

Fluid Dynamics & Aerodynamics

October 19-20, 2017 | Rome, Italy

Numerical simulation of the airfoils icing processes

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In-flight icing of aircrafts is recognized as a world-wide serious hazard. The resulting ice layer changes the airfoils geometry, flow structure, increases drag, reduces lift and stall angle, has an adverse effect on the controllability of the aircraft as a whole. Development of modern computers has created opportunities for the application of numerical simulation methods together with the icing wind tunnel and aircraft flight tests. As a result, it allows to reduce the time and the cost of the development of anti-icing systems and to expand the investigation parameters range. In "classical" icing codes the potential equation for flow field and integral solutions for boundary layer are used. On one hand, these instruments are simple and productive, very good validated and accepted by authorities in the processes of aircraft certification. But on the other hand, the integral solutions have limitations because they are one-dimensional, assume local properties and neglect most of flow history effects. The present work aimed at creating a numerical simulation method considering the viscosity and compressibility of the air-droplet flow, the micro roughness on the icing surface and thus, allowing to estimate their influence on the aircraft aerodynamic performances. The numerical differential Reynolds-Averaged Navier-Stokes equations for calculation of airflow are used. For the description of turbulence, the modified Spallart-Almaras model is used. The motion of the supercooled drops is described using a model of interpenetrating media. When implementing the methodology, a method of control volumes based on the experimental investigations of the processes of interaction between supercooled large droplets and the icing airfoil surface as well as physical phenomena occurring during the icing process, a splitting method and an implicit difference scheme are used. Based on the developed methodology, simulation of NACA 0012 airfoil icing process was made. The influence of the surface roughness on the structure of the flow field, the distribution of the pressure, friction and heat transfer coefficients, as well as the lift and drag, the stall angle were estimated.

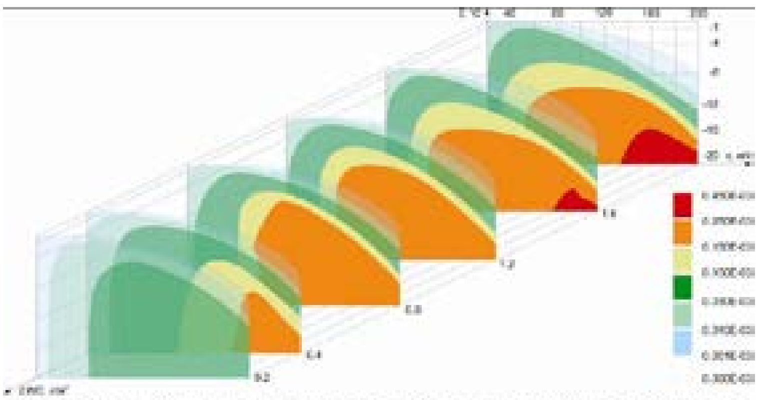

Figure 1: The specific mass of ice accumulated for 120 sec on the NACA 0012 airfoil surface for various liquid water content, temperature and velocity of airflow, L = 0.53 m, d_s = 20 μm, H = 1 km.

Biography

Sergey V Alekseyenko is an Associate Professor, Lecturer of Oles Honchar Dnipro National University, Department of Mechatronics. He has experience in the sphere of the numerical simulation of the hydro aerodynamics and, heat and mass transfer processes in the areas with free boundaries. His actual scientific interests are computational prediction of ice growth on aircraft surfaces, analysis of the effects of ice growth on aircraft aerodynamics and performances, icing physic.

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