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Noise and separation reduction by the dimpled surfaces

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The separation flow is observed when the bluff body, for example, car, train, airplane or ship is streamlined. In separation region, the large-scale vortex structures are generated which under certain conditions form the Karman vortex street. These large-scale vortex structures are sources of intense hydrodynamic noise. The use of dimpled surfaces before region of the boundary layer separation reduces the separation areas, and also the scale vortex structures. This reduces the streamlined body drag, the flow noise and the wake behind the bluff body. The mechanisms of formation and evolution of the coherent vortex structures inside boundary layers on streamlined bodies and in separation flow over cavities, which generate pseudosound fluctuations, have been comprehensively studied in the work. Physic simulations of vortex flow have carried out in a wind tunnel, in a hydrodynamic trough and in a narrow hydrodynamic channel on the streamlined hydraulically smooth flat hard and inside cavities in the form of half-cylindrical trench, cross-streamlined oval dimple, hemispherical and deep spherical dimples. Different visualization methods of the flow have been applied in experimental investigations. Also the complex measured techniques are used to determine various kinematical and dynamical parameters of boundary layer, separation flow both inside and behind cavities. Characteristics of the pressure and velocity fields were determined by the miniature piezoceramic sensors of pressure fluctuations, piezoresistive sensors of static and dynamic pressure, hot-wire and hot-film anemometers. Integral, space-time correlation and wave-number frequency spectral characteristics of vortex flow and pseudosound wall-pressure fluctuations were analyzed in detail. Verification of experimental results for canonical external and internal flows was done. The forming features of coherent vortex structures were detected in boundary layers and in separation flows. The different types, trajectories of motion of coherent vortex structures, which are generated inside cavities and are injected outside in boundary layer, and wide-scale geometrical, frequency and temporal characteristics of velocity and pressure fields of coherent vortex structures for different streamlined surfaces and flow regimes have been defined. It was shown that the miniature piezoceramic pressure fluctuation sensors, which have a flush-mounted at the streamlined surface, do not any cause perturbs into the external flow under investigation and allow to reliably identify the coherent vortex structures in real temporal scale. The set of recommendations for generation processes of stable or quasi-stable vortex structures with minimum form drag and given parameters were proposed for different streamlined regimes of cavities.

Biography

V Voskoboinick has completed his PhD in 1993 and Doctor of Engineering Sciences in 2013 in Mechanics of Fluid, Gas and Plasma from Institute of Hydromechanics of the National Academy of Science of Ukraine. He is the leading scientist of Department of Hydrobionics and Boundary Layer Control of Institute of Hydromechanics NASU. His current research is interdisciplinary and focuses on a wide range of topics within the field of fluid mechanics, hydroacoustics, bioengineering, heat and mass transfer. He has published more than 200 papers in reputed journals and conference proceedings.

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