CONICAL FLOWS NEAR V-SHAPED WINGS WITH ATTACHED SHOCK WAVES ON LEADING EDGES

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To study the flow over V-shaped wings of different geometry with supersonic leading edges, computational codes of second order approximation based on a method of different grids with boundary conditions that take into account specific characteristics of the flow near the leading edge were developed. The numerical analysis of the disturbed flow around V-shaped wings in the model of an ideal gas at a Mach number M=3 in the presence of angles of attack and slide was carried out, as well as experimental studies using a special optical method for visualizing supersonic conical flows. It was particularly determined that the structure of the flow in the plane of symmetry near V-shaped wings without a sliding angle undergoes a stepwise change when a Mach configuration of shock waves is realized and the angle of attack is increased. If there is one singular point in the salient point of the cross wing outline at small angles of attack in the shock layer, then there are three critical points in the plane of symmetry of the flow at a certain angle of attack, which depends on the geometry of the wing, one of which is still located in the salient point of the cross wing outline, and two others - at a finite distance from the salient point. The first critical point is a singularity of the nodal type, the second one – of the saddle type – is the point of spread, the third critical point located near bridge like shock of the Mach configuration of shock waves. The third critical point for streamlines can be both of the nodal and saddle types. In the second case two eddy Ferry singularities are formed on the left and right of the symmetry axis, located at the “top” of the two contact discontinuities, coming out from the critical point on the symmetry axis. Positions of the critical points relative to the wing outline kink, depending on its geometric parameters, are determined, as well as transformation of the topological flow pattern in the shock layer having a sliding angle. Comparison of some theoretical and experimental data on the flow structure in the shock layer has shown its satisfactory fit, which indicates the possibility of obtaining data on the actual flow in the Euler model. It is shown that a fundamental property of the turbulent boundary layer separation - the intensity match of the oblique shock in the λ-configuration of shock waves, formed over the area of separation, and the level of the "pressure plateau" remains valid in the symmetric and nonsymmetric conical flow, relating to the free type of interaction. The entropy calculation of the particles, passing oblique and breakdown shock waves in the λ-configuration of shock waves, with the developed separated flow in symmetric and nonsymmetric conical flows, led to the conclusion that the principle of minimum entropy production is realized in the λ-configuration of shock waves formed at the "free" interaction of shock waves and turbulent boundary layer. Its manifestation is the conical nature of the flow with the turbulent boundary layer separation, observed in the experiment.

The work has been done under the sponsorship of the Russian Foundation for Basic Research (Project No. 12-01-00343).

Computation was made on a supercomputer MVS-100K of the Joint Supercomputer Center of the Russian Academy of Sciences.