ON APPLICATION OF IDEAL GAS MODEL FOR OPTIMIZATION OF A BODY CONFIGURATION IN SUPERSONIC FLOW

A.B. Gorshkov, V.I. Lapygin, V.A. Mikhalin, T.V. Sazonova, D.M. Fofonov

Central Research Institute of Machine Building
141070, Korolev, Russia

Application of the local method of tangent wedge for calculating the aerodynamic coefficients of a body in supersonic flow is discussed. Here it is made provision for refining the formulas of this method through computation of ideal/viscous flow around this body. Use of such method in iterative procedures of numerical optimization of body configurations permits to reduce significantly run time keeping accuracy of CFD methods for determining the aerodynamic coefficients.

Application of ideal gas model and local method for solving the variational problem in class of conical wings with blunted leading edges shows that the results agree for both optimal wing configuration and maximal lift-to-drag ratio.

It follows from analysis of the variation al problem solution based on local model of interaction that optimal body configuration can be found without refinement of the tangent wedge formulas.

Computations of flows around optimal wing and winged reentry vehicle at flow velocity $V = 5$ km/s and $V = 6$ km/s conducted using ideal, equilibrium inviscid, equilibrium and non-equilibrium viscous models demonstrate weak influence of physical-chemical processes in shock layer near lifting configurations on values of their aerodynamic coefficients. Optimal delta wings with blunted leading edges have slightly convex, close to planar, windward surface. Lift-to-drag ratio of these wings is close to LDR of delta wings with planar edges with the same volume and radius of bluntness.

The investigation demonstrates the practicability of using the local model of interaction for solving problems on optimal configurations in supersonic flow. More complicated models (ideal/viscous gas) should be used for refinement of aerodynamic characteristics of the body found.

Key words: supersonic aerodynamics, optimal configuration, tangent wedge formulas