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A RAPID METHOD TO CALCULATE THE VISCOUS FORCE BASED ON LOCAL INVISCID FLOW FIELD PARAMETERS

Abstract

With the substantial increase in computation speed and increasing improvement in CFD calculation methods, the CFD method based on inviscid Euler equations has been able to finish calculating the flow characteristics very quickly. While in order to attain higher accuracy flow characteristics, the CFD methods based on full Navier-Stokes equations of viscous flow should bring a high cost : complicated and high quality grid generation difficulty, large time of full convergence for long-running flow calculations. Therefore, in engineering applications, especially for complex aircraft, the prediction of aerodynamic performances mainly relies on the combination of CFD method based on inviscid Euler equations and rapid engineering method for caculating skin viscous force with high efficiency and good accuracy. The CFD method of inviscid Euler equations could obtain the inviscid aerodynamic components, and the rapid engineering calculation method could obtain the viscous force component. The rapid viscous force calculation methods are usually based on the theory of boundary layer, in which the free stream parameters are treated as the boundary layer edge parameters and the aircraft geometry need to be simplified and approximated. However, for complex aircraft, especially in hypersonic conditions, interferences in free stream by aircraft components are very serious, so that the flow parameters out of the boundary layer vary greatly from free flow parameters, so this engineering method for caculating skin viscous force would have a great deviation in theory. In fact, the CFD method based on calculation of the inviscid Euler equations has already achieved accurate flow parameters out of the boundary layer; in view of this, we establish the reference temperature method with local invicid flow parameters derived from invicid CFD method, in order to predict the skin viscous force of hypersonic vehicle. The method was compared with a CFD method based on the full Navier-Stokes equations, and showed a good accuracy and very high computation efficiency.