Numerical Prediction and Experimental Verification of Shock Oscillation for a Hypersonic Inlet at Low Supersonic Mach Numbers

YU Anyuan, YANG Dawei, WU Jie, NI Hongli, LE Jialing

Science and Technology on Scramjet Laboratory，Hypervelocity Aerodynamics Institute of CARDC,Sichuan Mianyang 621000，China

Numerical prediction and experimental verification of shock oscillation for a hypersonic inlet at low supersonic mach numbers are conducted in this paper. The prediction uses three-dimensional quasi-steady calculation, two-dimensional quasi-steady calculation, and two-dimensional unsteady calculation. The Mach numbers calculated is Ma3, Ma3.5, Ma4.0. The angles of attack(AOAs) are the same as 0-Deg. The inlet geometry includes the whole path from forebody to combustor, with a throttling door installed at the outlet. The calculation shows that the shock oscillation doesn't occur when the inlet is not throttled in the range of Ma3 to Ma4. But when the inlet is throttled to a certain extent, the shock oscillation occurs at once. The experiments are launched in the 0.6m×0.6m cold-flow blow-down wind tunnel. The geometry is three-dimensional, of which the symmetric plane is identical with the calculation. The mach numbers in the experiments are also Ma3, Ma3.5, Ma4.0. The AOAs are 0-Deg. The outlet of the model adopts a throttling door too. The experiments show that when the inlet is not throttled, there is no shock oscillation in the inlet. While the throttling door is closed to some extent, the shock oscillations happened at once. The experimental results verify the calculations approximately. Further calculation shows that whether the shock oscillation of a hypersonic inlet at low mach numbers happening or not, and the frequency characteristics of shock oscillation are related to the geometry of the inlet. The paper also discusses the mechanism of the shock oscillation associating numerical calculations.

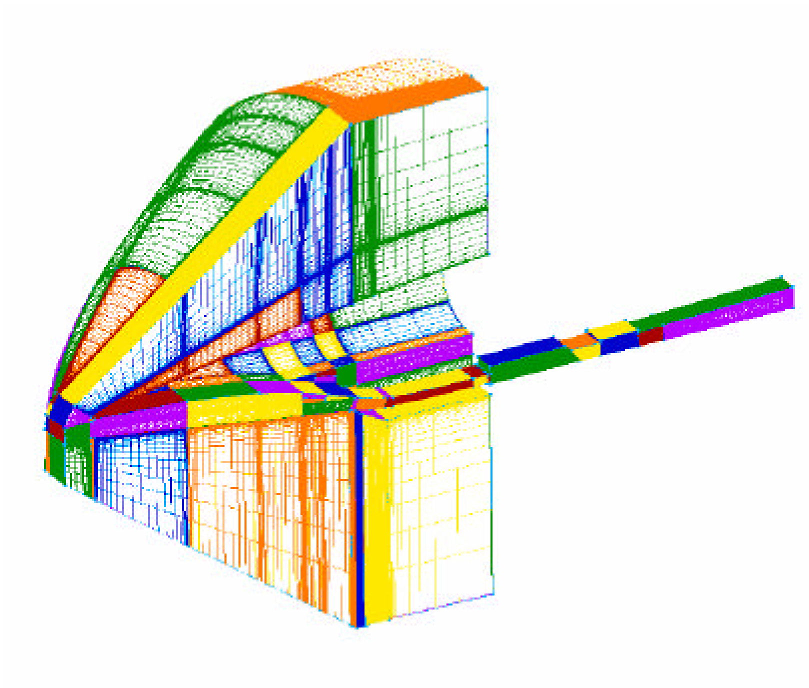

Fig 1　the three-dimensinal mesh

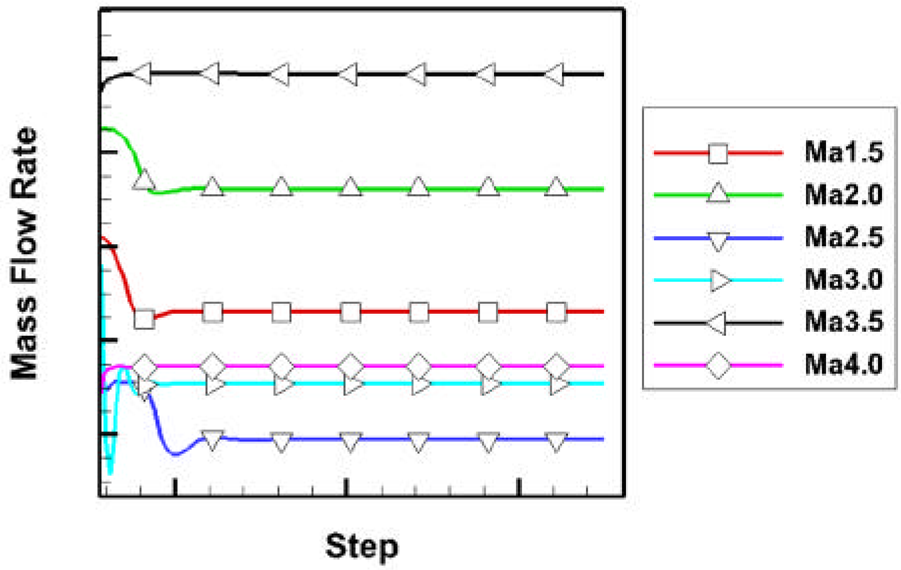

Fig 2　the calculation shows no oscillation occured without throttling of the inlet

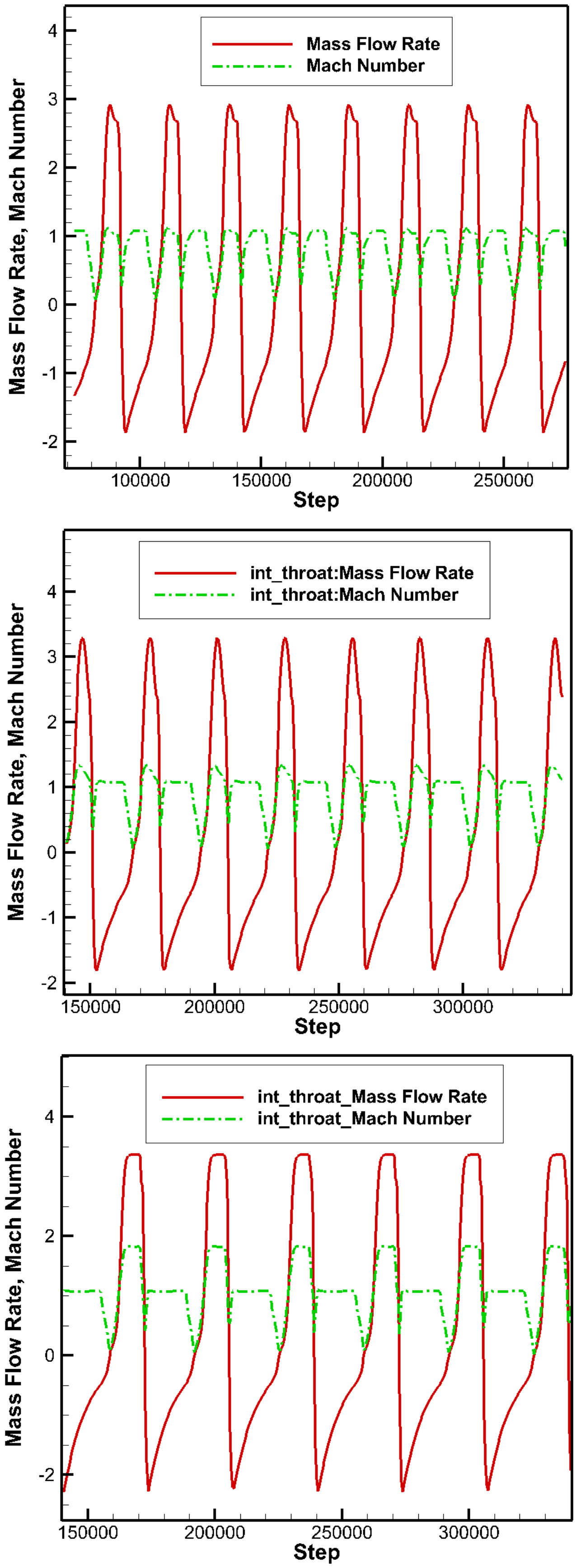

Fig 3 the calculation result shows oscillation occurred with the inlet is throttled
(Top: Ma3.0; Mid: Ma3.5; Bottom:Ma4.0)

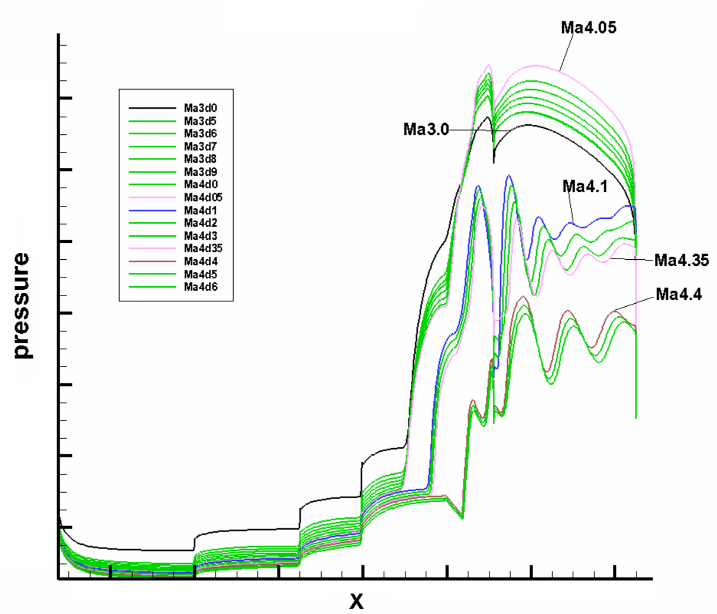

Fig 4 the calculated pressure distribution along the centerline of the model

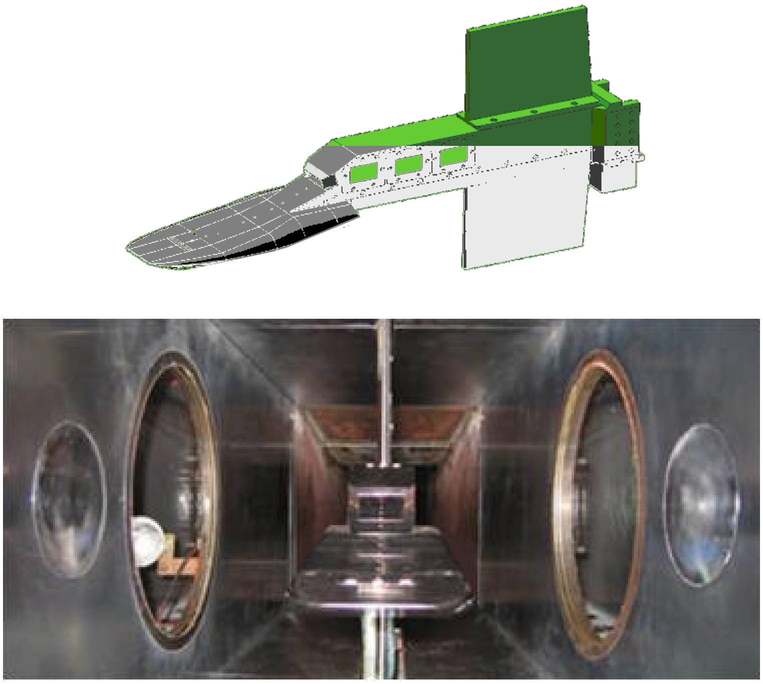

Fig 5 the model in the wind tunnel

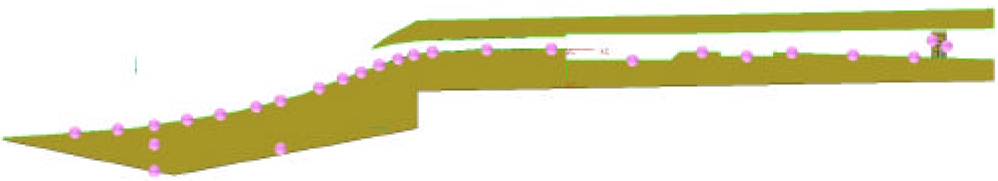

Fig 6 the dynamic pressure transdusers installed in the model

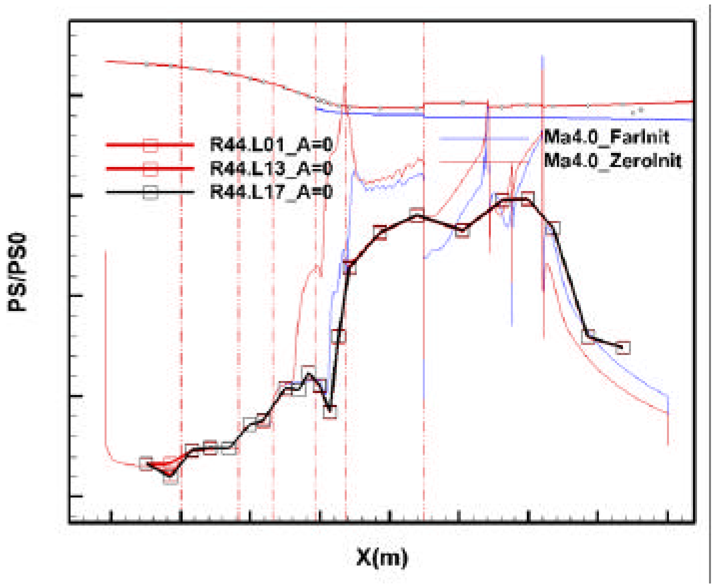

Fig 7 the experimental result at Ma4(without throttling)