The Design and Study of Osculating Curved Cone Waverider-based Airbreathing Integrated Hypersonic Vehicle

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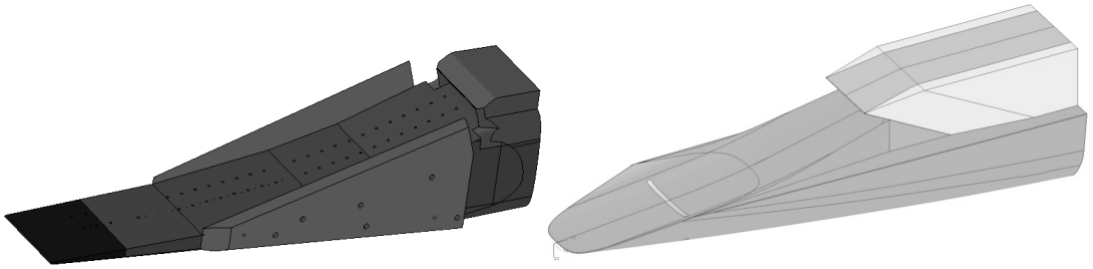
In the present airbreathing integrated hypersonic vehicle design, a new osculating curved cone method which streamlines tracing axisymmetric flow fields of isentropic compressing waves is used to create the waverider lower surface and inlet lip inner surface. The shape of the vehicle upper surface is governed by the inward deviation from the FCT as a function of axial location and the determination of the primitive flow variables on the upper surface requires application of an accurate yet rapid computational analysis which is accomplished through the application of a first order scheme utilizing the axisymmetric method of characteristics. 2D and 3D MOC tools that can quickly design and analyze nozzle geometries are developed and the performance of SCRAMJET engine is evaluated by 1D method. The aerodynamic performance of the inlet configuration is not comparable to that of the pure waverider shape, but is comparable to previously tested 4 stage ramp inlet model (Fig.1). Compared with the comparative reference model, the flow coefficient and the recovery coefficient of total pressure are increased by 4% and 50%, respectively (Table.1). The uniformity coefficient of inlet outlet is increased by 10%. A model of about 3 meters length (Fig.2) is developed that integrates vehicle components, including canopies, engine components, and control surfaces, with spanwise truncated waverider shapes for a design Mach number of 6. Computational fluid dynamics (CFD) solutions (Table.2) are obtained and the results show the component build-up effects and the aerodynamic characteristics of the fully integrated configurations, including net positive thrust and good longitudinal stability characteristics.



4 stage ramp inlet　　Curved cone waverider inlet

Fig.1 Configurations of 4 stage ramp and curved cone waverider inlet

Table.1 Performance of 4 stage ramp and curved cone waverider inlet

Main	4.5		6	
Model	4 stage ramp inlet	Curved cone waverider inlet	4 stage ramp inlet	Curved cone waverider inlet
Self restart performance	yes	yes	yes	yes
Flow coefficient	0.627	0.707	0.885	0.922
Recovery coefficient of total pressure	0.483	0.671	0.363	0.544

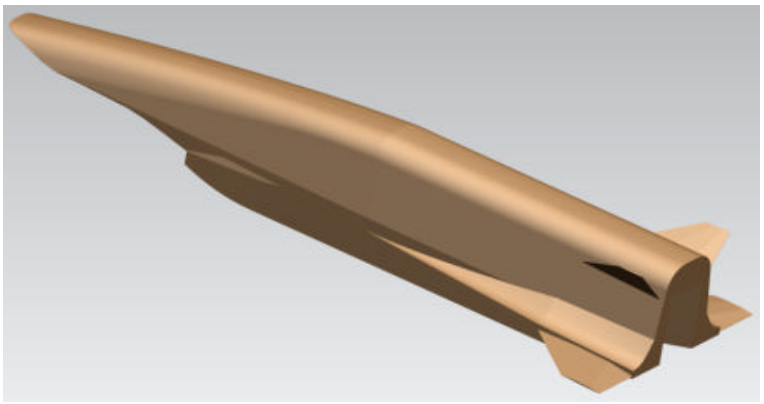


Fig.2 Airbreathing integrated hypersonic vehicle

Table.2 Computed aerodynamic performance

		C_A	C_N	C_{mz}
Engine unworking	**CFD**	**0.2976**	**0.3228**	**0.0328**
Engine working	**CFD**	**-0.0532**	**0.3424**	**0.0452**