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# RESEARCH ON THE AERODYNAMIC HEATING FEATURE OF PLANE-SYMMETRIC AIRCRAFT

**Abstract**

In hypersonic flight, aerodynamic heating is one of the most annoying problems. There are various engineering algorithms, equations, and numerical methods been developed for calculating vehicle's aerodynamic heating in the past century for regular configuration, such as sphere, plane and cone configuration. There is a bunch of exact solutions obtained by analytic method for them, among which Fay  Riddel's equation is of the most famous.

But for plane-symmetric configuration along with turbulence transition in the flight, the past engineering methods such as Zoby's axis-symmetric analog method are not appropriate for the aerodynamic heating computation any more. So we adopt a new method, local streamline method(LSM), to compute the aerodynamic heating, which proves to be high efficiency, rigorously theoretical, and stable. The heat flux distribution of a whole surface can be obtained with this method, yet taking turbulence transition into account. We use finite volume method(FVM) to solve Euler equation to obtain vehicle's outer flow field, and then take it as input parameters to calculate surface heat flux.

We studied two cases(flight altitude of 40km and 30km), calculated the aerodynamic heat distribution of a plane-symmetric vehicle, and inspected the influence of inflow parameters on vehicle's aerodynamic heating feature.

Under the same inflow condition the heat flux distribution on individual azimuth line shows that, aerodynamic heat on fin front is far more hasher than that on the center line of windward side. The comparison under different inflow condition shows, heat flux on stagnant point at flight altitude 30km is 36 percent higher than that at 40km, which is due to the denser atmosphere at lower altitude, whereas on windward side the difference between two altitude is slight.

But at the start point of turbulence transition spot, the heat flux at flight altitude 30km is 91 percent higher than that at 40km, which proves that the heat flux on fin front is more sensitive to the inflow parameters. This is mainly because the radius of curvature of the fin front is less than that of nose's.

The calculation process shows that LSM method is an effective method on the aerodynamic heating prediction of plane-symmetric configuration, and with apparent advantages over the traditional engineering algorithms. The research on plane-symmetric configuration shows that, aerodynamic heating on fin front is not only harsh but also sensitive to inflow condition because of turbulence transition.