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Aerodynamic Heating and Drag Reduction of Pegasus-XL Satellite Launch Vehicle

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Abstract : In the last two years, there has been a substantial increase in the rate of satellite launches. To keep up with the technology, it is imperative that the launch cost must be made affordable, especially in developing and underdeveloped countries. Launch cost is directly affected by the launch vehicle's aerodynamic performance. Pegasus-XL SLV (Satellite Launch Vehicle) has been serving as a commercial SLV for the last 26 years, commencing its commercial flight operation from the six operational sites all around the US and Europe, and the Marshal Islands. Aerodynamic heating and drag contribute largely to Pegasus's flight performance. The objective of this study is to reduce the aerodynamic heating and drag on Pegasus's body significantly for supersonic and hypersonic flight regimes. Aerodynamic data for Pegasus's first flight has been validated through CFD (Computational Fluid Dynamics), and then drag and aerodynamic heating is reduced by using a combination of a forward-facing cylindrical spike and a conical aero-disk at the actual operational flight conditions. CFD analysis using ANSYS fluent will be carried out for Mach no. ranges from 0.83 to 7.8, and AoA (Angle of Attack) ranges from -4 to +24 degrees for both simple and spiked-configuration, and then the comparison will be drawn using a variety of graphs and contours. Expected drag reduction for supersonic flight is to be around 15% to 25%, and for hypersonic flight is to be around 30% to 50%, especially for AoA < 15^0. A 5% to 10% reduction in aerodynamic heating is expected to be achieved for hypersonic regions. In conclusion, the aerodynamic performance of air-launched Pegasus-XL SLV can be further enhanced, leading to its optimal fuel usage to achieve a more economical orbital flight.

Keywords : aerodynamics, pegasus-XL, drag reduction, aerodynamic heating, satellite launch vehicle, SLV, spike, aero-disk
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