

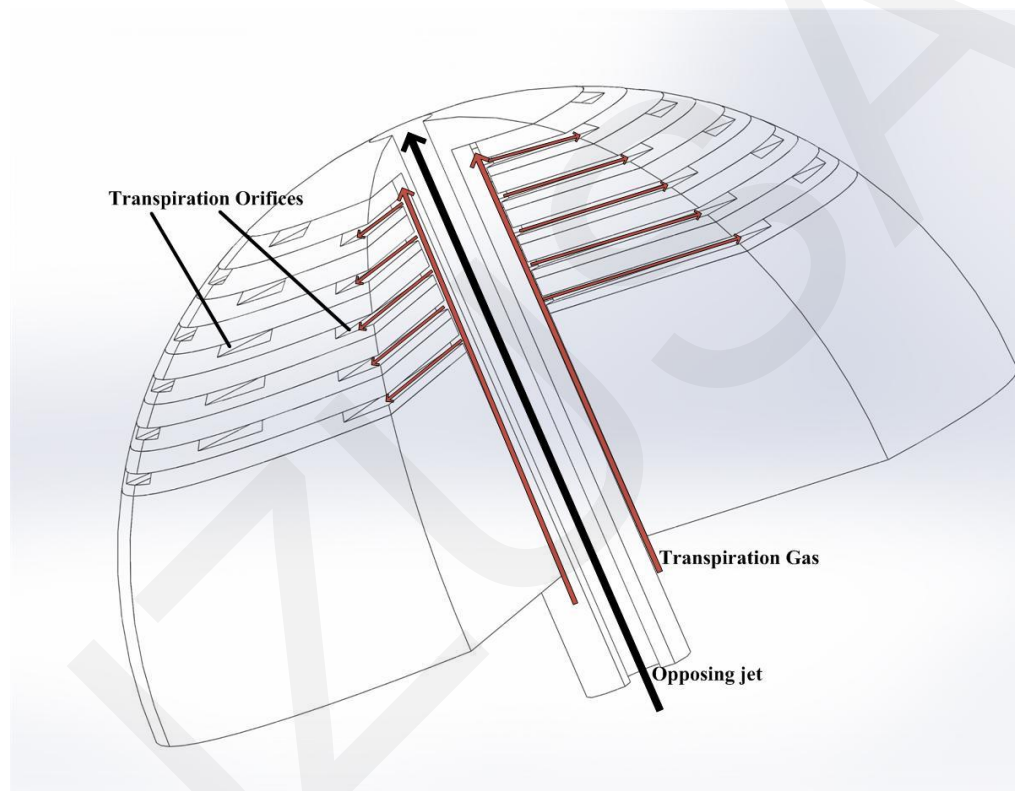
Influence of angle of attack on a combined opposing jet and platelet transpiration cooling blunt nose in hypersonic vehicle

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Geometrical model

A combined opposing jet and platelet transpiration TPS

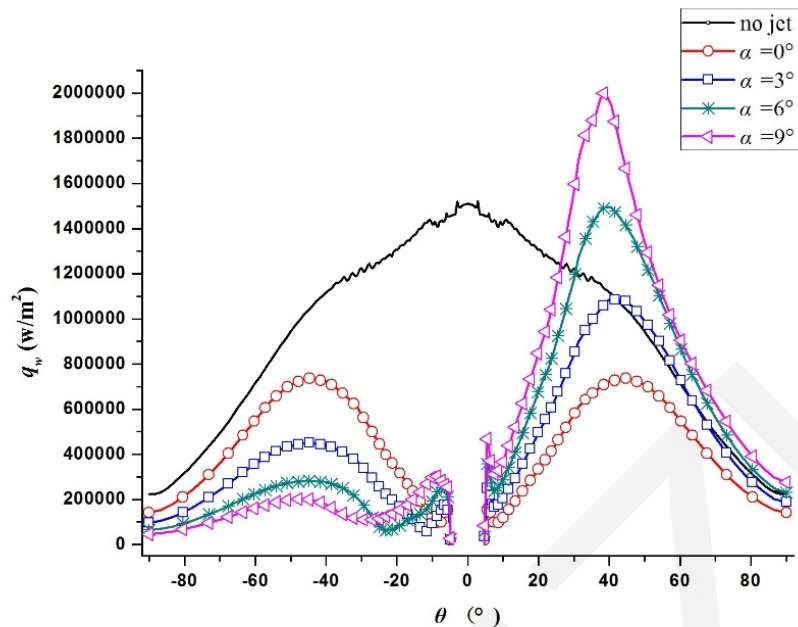


Stagnation region: Opposing jet TPS to push the bow shock wave away

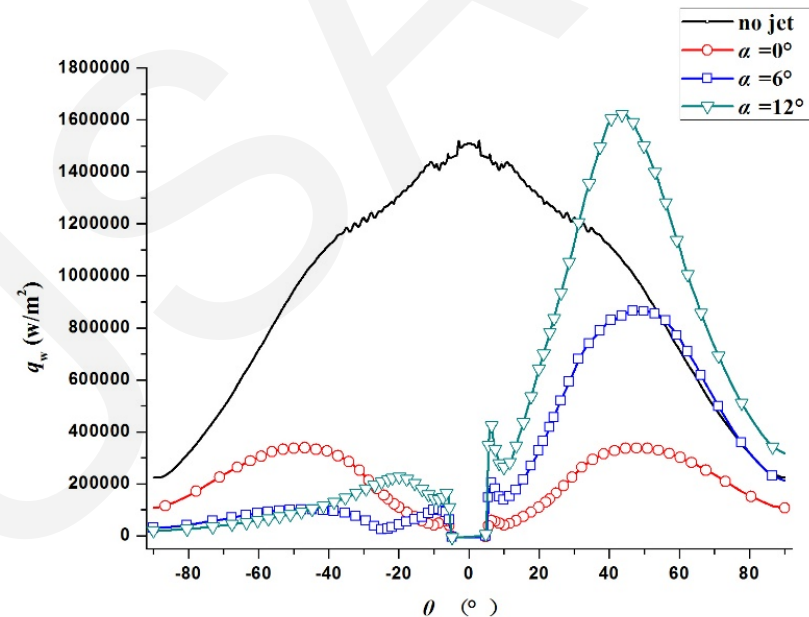
Shoulder region: Platelet transpiration TPS to reduce the aerodynamic heating of reattachment shock wave

Application of the combined TPS

Heat flux distribution in opposing jet TPS



$PR=0.1$

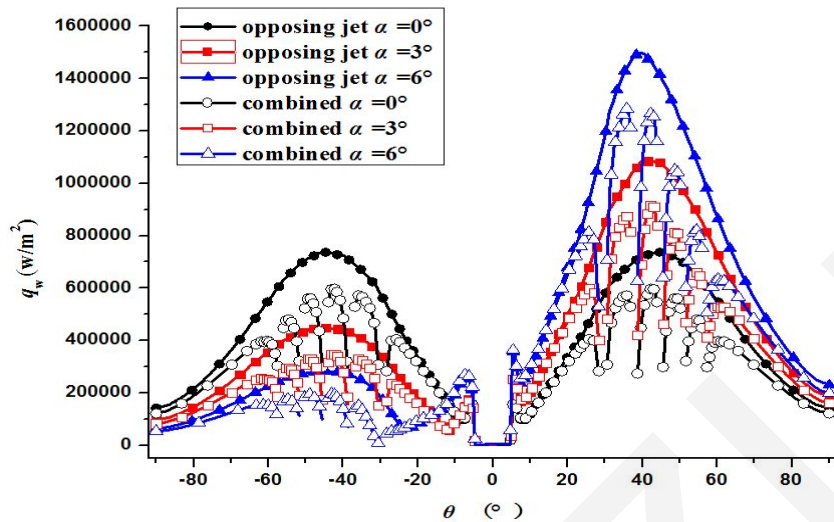


$PR=0.2$

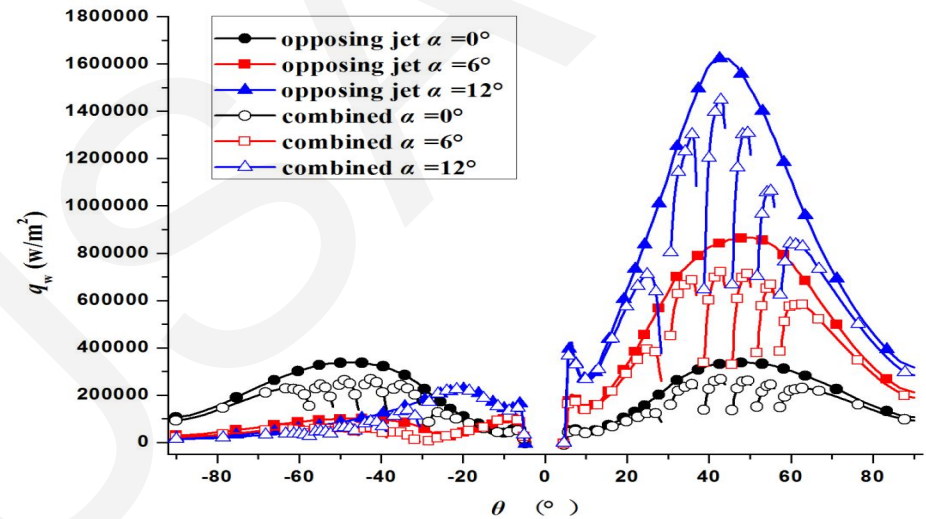
The maximum heat flux exceeds the heat flux at stagnation without injection when the angle of attack is sufficiently large, so the opposing jet TPS then becomes invalid.

Application of the combined TPS

Heat flux distribution in combine TPS



$PR=0.1$



$PR=0.2$

A combined opposing jet and platelet transpiration TPS is used to overcome the problem. A platelet transpiration device is introduced on the windward side to strengthen local cooling efficiency while the opposing jet protects the entire nose-tip from aerodynamic heating especially in the stagnation region

Conclusions

1. The flowfield is no longer symmetrical with the effect of angle of attack. The recompression shock wave is strengthened on the windward side with increased angle of attack, and is inverse on the leeward.

2. The heat flux increase in the windward with the increased angle of attack, exacerbating the thermal environment of vehicles. The TPS lost its efficiency when the angle of attack is large enough, and then the maximum heat flux is bigger than that without TPS.

3. The transpiration gas could improve the thermal protection properties of the windward side in combined TPS, the maximum heat flux reduction could reach 20% of that without transpiration.