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Numerical Investigation on Shock Train Control and Applications in a Scramjet Engine

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Different factors which help to control the shock train in the scramjet isolator and combustor were analyzed via numerical investigations, and were applied to a whole scramjet engine in the working environment. A streamline traced Busemann inlet is proposed and simulated along with an isolator. During the combustor design, the influence of boundary layer thickness, slot bleeding, cavity and hydrogen injection position on the basic combustor performance with uniform inlet flow condition are investigated, and it was found that the boundary layer bleeding could prevent the shock train from moving upstream, and the cavity could further enhance the combustion efficiency. By arranging hydrogen injections at certain intervals, it could reduce the combustion back pressure. An improved basic model by integrating the aforementioned advantages is then numerically studied. The results have shown that the improved combustor model contained a section of shock train which can reduce the loads on the isolator. Another model with bleeding slots in the isolator is also found able to raise the maximum chemical equivalence ratio from 0.7 to 1, but unfortunately it comes with undesirable combustion efficiency decrease.

Nomenclature

Ma = Mach number

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