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Hypersonic Propulsion Requirements for Sustained Hypersonic Flight for Air Transportation

Authors : James Rate, Apostolos Pesiridis

Abstract : In this paper, the propulsion requirements required to achieve sustained hypersonic flight for commercial air transportation are evaluated. In addition, a design methodology is developed and used to determine the propulsive capabilities of both ramjet and scramjet engines. Twelve configurations are proposed for hypersonic flight using varying combinations of turbojet, turbofan, ramjet and scramjet engines. The optimal configuration was determined based on how well each of the configurations met the projected requirements for hypersonic commercial transport. The configurations were separated into four sub-configurations each comprising of three unique derivations. The first sub-configuration comprised four afterburning turbojets and either one or two ramjets idealised for Mach 5 cruise. The number of ramjets required was dependent on the thrust required to accelerate the vehicle from a speed where the turbojets cut out to Mach 5 cruise. The second comprised four afterburning turbojets and either one or two scramjets, similar to the first configuration. The third used four turbojets, one scramjet and one ramjet to aid acceleration from Mach 3 to Mach 5. The fourth configuration was the same as the third, but instead of turbojets, it implemented turbofan engines for the preliminary acceleration of the vehicle. From calculations which determined the fuel consumption at incremental Mach numbers this paper found that the ideal solution would require four turbojet engines and two Scramjet engines. The ideal mission profile was determined as being an 8000km sortie based on an averaging of popular long haul flights with strong business ties, which included Los Angeles to Tokyo, London to New York and Dubai to Beijing. This paper deemed that these routes would benefit from hypersonic transport links based on the previously mentioned factors. This paper has found that this configuration would be sufficient for the 8000km flight to be completed in approximately two and a half hours and would consume less fuel than Concord in doing so. However, this propulsion configuration still result in a greater fuel cost than a conventional passenger. In this regard, this investigation contributes towards the specification of the engine requirements throughout a mission profile for a hypersonic passenger vehicle. A number of assumptions have had to be made for this theoretical approach but the authors believe that this investigation lays the groundwork for appropriate framing of the propulsion requirements for sustained hypersonic flight for commercial air transportation. Despite this, it does serve as a crucial step in the development of the propulsion systems required for hypersonic commercial air transportation. This paper provides a methodology and a focus for the development of the propulsion systems that would be required for sustained hypersonic flight for commercial air transportation.

Keywords : hypersonic, ramjet, propulsion, Scramjet, Turbojet, turbofan
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