Technical Comments

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Comment on "Analysis of the Magnetohydrodynamic Energy Bypass Engine for High-Speed Airbreathing Propulsion"

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WE believe Riggins[1] unjustifiably and excessively penalizes the performance of the ideal magnetohydrodynamic (MHD) bypass engine (or ideal inverse cycle engine) in the section "Evaluation of the Performance of the Ideal Inverse-Cycle Engine" by comparing it to his definition of ideal ramjet/scramjet, in which all of the freestream kinetic energy is converted to enthalpy, thus allowing the combustion heat to be added at the maximum possible temperature. The ideal ramjet/scramjet as defined is in fact an ideal ramjet because the flow is always brought to rest in the combustor. This comparison is made despite the earlier correct assertions in the Introduction that it is impractical to bring the fluid to rest in the ramjet/scramjet inlet when the freestream Mach exceeds about 5 because the high temperatures result in chemical dissociation of the combustion products, which reduces combustion performance, and the high-temperatures and pressures, which cause severe structural problems. Consequently, as the author correctly concludes, when the freestream Mach number exceeds about 6, the flow must necessarily enter the combustor at supersonic speeds: Indeed, this is precisely why the device is called a scramjet. This is also the primary motivation for considering MHD bypass, which offers the promise of ameliorating supersonic combustion problems by reducing the flow velocity in the burner. It is interesting in this regard to note that the majority of the numerical examples given in Figs. 1 and 4–11 of Ref. 1 are for freestream Mach numbers greater than 6, the scramjet domain.

A far more appropriate and useful comparison could be made between the two devices by limiting the inlet compression or deceleration of the ideal ramjet/scramjet to the highest practical combustor entrance temperature. However, under this limitation, the ideal ramjet/scramjet and ideal MHD bypass engine would have identical performance because the combustion heat would be added at equal combustor inlet temperatures. This obvious conclusion serves to highlight the intended purpose of the MHD bypass system, which is to reduce the velocity in the combustor without altering the thermodynamic state of the flow. As the author observes, the value of lowering the velocity via MHD bypass is to increase mixing completion and combustion efficiency and to reduce aerodynamic drag and concomitant frictional losses in the core flow. The appropriate question, therefore, is to ask whether or not the improved flow conditions within the combustor outweigh the parasitic losses of the MHD device in the flowpath and external circuits, as well as the burden of carrying it around.

Consequently, the frequently repeated assertion of the author that the ideal MHD bypass or ideal inverse cycle engine must inevitably suffer greater total pressure or performance losses relative to the ideal ramjet/scramjet when operating in the scramjet regime does not help to resolve the question of whether or not the MHD bypass engine is a useful concept for improving scramjet performance.

Reference

[1]Riggins, D. W., "Analysis of the Magnetohydrodynamic Energy Bypass Engine for High-Speed Airbreathing Propulsion," *Journal of Propulsion and Power*, Vol. 20, No. 5, 2004, pp. 779–792.

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