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Supersonic Combustion (Scramjet) Containing Flame-Holder with Slot Injection

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Abstract : In order to improve mixing phenomena and combustion processes in supersonic flow, the current work has concentrated on identifying the ideal cavity parameters using CFD ANSYS Fluent. Offset ratios (OR) and aft ramp angles () have been manipulated in simulations of several models, but the length-to-depth ratio has remained the same. The length-to-depth ratio of all cavity flows is less than 10, making them all open. Hydrogen fuel was injected into a supersonic air flow with a Mach number of 3.75 using a chamber with a 1 mm diameter and a transverse slot nozzle. The free stream had conditions of a pressure of 1.2 MPa, a temperature of 299K, and a Reynolds number of 2.07x107. This method has the ability to retain a flame since the cavity facilitates rapid mixing of fuel and oxidizer and decreases total pressure losses. The impact of the cavity on combustion efficiency and total pressure loss is discussed, and the results are compared to those of a model without a cavity. Both the mixing qualities and the combustion processes were enhanced in the model with the cavity. The overall pressure loss as well as the effectiveness of the combustion process both increase with the increase in the ramp angle to the rear. When OR is increased, however, resistance to the supersonic flow field is reduced, which has a detrimental effect on both parameters. For a given ramp height, larger pressure losses were observed at steeper ramp angles due to increased eddy-viscous turbulent flow and increased wall drag.

Keywords : total pressure loss, flame holder, supersonic combustion, combustion efficiency, cavity, nozzle
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