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Numerical Investigation on Three-dimensional Shock Train Structures in Rectangular Isolators

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Abstract

The understanding of the formation of shock trains in high-speed engines is vital for the improvement of engine design. The formation of these flow structures in a narrow duct, driven by the presence of the viscous effects on the walls, is an extremely complex process that is not fully understood. This investigation demonstrates the high sensitivity of the shock train to the solving equations. The establishment of the shock train in the duct mainly depends on the way that the boundary layer develops on the walls. The k-ω Wilcox model confirms to be the most suitable to accurately reproduce the subtle features close to the solid boundary. The assumption of two-dimensional flow is not completely accurate for describing internal flows where the three-dimensional effects from the shock wave/boundary layer interactions cannot be neglected. The centreline flow properties show that the first shock wave has the same strength in the two- and three-dimensional cases. However, in the three-dimensional case the thinner boundary layer behind the leading shock allows the flow to expand more in the subsonic region causing a stronger deceleration of the flow behind the first shock.

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