Abstract

Non-reactive transient LES investigations of an aerodynamic mixer suitable for pulsed detonation engines.

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This paper presents the non-reactive transient LES numerical analysis of an aerodynamic mixer to determine the self-induced oscillation of two parallel jets. The mixer represents a novel concept design of the combustible mixture-delivering system for a pulsed detonation combustor. Since the air enters the combustor at high speed, an alternative to the classic air swirler, based on profiled channels, was sought. Such a solution is the mixer presented here, based on the azimuthal oscillations induced by a couple of high-speed jet entering a ring shaped channel. The main goal of the simulation is to gain insight into the aerodynamic interaction between the two jets throughout the mixer. The transient flow analysis is conducted to solve the unsteady self-introduced oscillations. The most relevant flow features, the coherent structures, are analysed at different locations throughout the annular plenum chamber and on its circumference. The vortices that develop have an impact on the physical quantities of interest, especially on pressure and velocity distribution. Furthermore, the vortical structures are more complex, due to the interaction between the two jets and have more significant effect upon the pressure waves travelling inside the plenum. This interplay is beneficial for the mixing process at high Mach numbers which are needed to initiate the detonation process. Hence, for a complex characterisation of the flow field, not only pressure and velocity visualizations are provided, but also vorticity and helicity, to be able understand the development and movement of the vortices. Since, the main focus is to capture the small coherent structures, the time resolution of the simulation is very low. Based on 2D and 3D flow field snapshots in time and at various spatial regions of interest, it has been revealed that the travelling pressure waves have self-introduced oscillatory behaviour and that the vortices are being advected along the principal axis of the mixer until the outlet, where they change direction. This article contributes to a better understanding of the mixer aerodynamics, capabilities and suitability for a pulsed detonation engine.