Effects of catalyst segmentation with cavities on combustion enhancement of blended fuels in a micro channel

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Abstract

A novel design concept for the enhancement of CH4/CO/H2 multi-fuel combustion in a micro channel that uses the combined effects of catalyst segmentation and cavities is proposed. These effects and the combustion characteristics are evaluated using numerical simulation with detailed heterogeneous and homogeneous chemistries. The effects of a single multi-segment catalyst with and without cavities, respectively, are examined and discussed in terms of a multi-fuel mixture. In general, the chemical process of conventional catalytic combustion is a competition between heterogeneous and homogeneous reactions for fuel, oxygen, and radicals. The objective of using catalyst segmentation and cavities in a micro-reactor is to combine the advantages of heterogeneous and homogeneous reactions to enhance fuel conversion and to promote complete combustion in a short distance. In the proposed catalyst configuration, the heterogeneous reaction in a prior catalyst segment produces chemical radicals and catalytically induced exothermicity, and the homogeneous reaction is subsequently induced and anchored in the following cavity. H and OH radicals from both hydrogen and methane change the chemical pathway of CO oxidation. Full multi-fuel conversion and complete combustion can thus be achieved in a short distance. The existence of cavities appreciably extends the stable operational range of the micro-reactor for a wide range of inlet flow velocities. Moreover, cavities in a small-scale system can further stabilize the flame, and serve as a heat source to enhance the reaction. These features allow the proposed catalyst configuration to be applied to various small-scale power, heat generation and propulsion systems.

Keyword：numerical simulation, multi-segment catalyst, cavity, micro-reactor, multi-fuel