Multi-fuel Reaction in a Catalyst Segmentation and Cavity Microreactor

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Abstract

A novel design concept for the enhancement of multi-fuel (CO/H2/CH4) 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. 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. 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. The existence of cavities appreciably extends the stable operational range of the micro-reactor for a wide range of inlet flow velocities due to stabilizing the flame and serving as a heat source to enhance the reaction. These features allow the proposed catalyst configuration to be applied to various small-scale power and heating generation systems.

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