Sunita Pokharel, V'yacheslav Akkerman, Department of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV, 26506 and Mohsen Ayoobi, Division of Engineering Technology, Wayne State University, Detroit, Michigan, 48202. Scrutinizing premixed syngas combustion and its dynamics in micro-scale.

Increasing demands in the next-generation power-generation device such as unmanned aerial vehicles (UAV), microsatellite thrusters, micro-chemical reactors and sensors calls for fuels with high specific energy and low emissions to meet the current demand of green energy. Fuel-lean synthesis gas (syngas) meets both these requirements exhibiting promising route to clean and green environment. Thus, it is of critical importance to characterize syngas combustion and understand its properties in micro-combustion industry. In addition to complicated flame dynamics in microscale systems, varying the syngas-fuel mixture composition as well as the boundary conditions and geometry of a combustor significantly affect the burning process in the system. This work investigates the characteristics of a premixed syngas flame in a horizontal two-dimensional micro-channel of length 20 mm and half-width 1 mm by means of computational simulations using the ANSYS Fluent commercial solver. A fixed temperature gradient is employed at the upper wall such that the temperature grows linearly, from 300 K at the inlet to 1500 K at the outlet, to account for the conjugate heat transfer. The chemical kinetics of the combustion process is imitated by the San Diego mechanism with 46 species and 235 reactions, which is implemented using the Chemkin mechanism in ANSYS Fluent. Stoichiometric premixed burning of a syngas fuel comprised of carbon monoxide (CO), methane (CH4) and hydrogen (H2), with various compositions and inlet velocities, is considered. These results are postprocessed to characterize various combustion properties such as ignition, stabilization and extinction properties and FRIE event. It is further shown that how instability can be eliminated by increasing the inlet flow velocity to form a stable, stationary flame. As a result, it is demonstrated how various combustion characteristics depend on the inlet velocity and composition of a syngas mixture.