ABDULAFEEZ ADEBIYI, AMANDA CATHRENO, ELIZABETH RIDGEWAY, V'YACHESLAV AKKERMAN, Dept. of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV, 26506. Oscillating vs Accelerative Trends of Premixed Flame Propagation in Open Obstructed Channels

Due to a flame-generated jet-flow along a centreline, premixed flames accelerate extremely fast and may even trigger a detonation when propagating in a semi-open obstructed channel (one end of the channel is closed; a flame is ignited at this end, and it moves towards the open extreme). However, industrial and laboratory pipes often have both ends open, with a flame ignited at one of them, which is also the case in the present work. Specifically, flame propagation through a "tooth-brush" of obstacles, in-built in an open channel, is studied by means of the computational simulations of reacting flow equations, with fully-compressible hydrodynamics, transport properties and Arrhenius chemical kinetics. The parametric study includes various blockage ratios, spacing between the obstacles, and thermal expansion ratios. Depending on these parameters, either flame oscillations, or acceleration, or their sequence are observed. While the oscillations are generally inherent to relatively narrow channels, in wider ones, the accelerative trend eventually dominates over the oscillations. All these trends differ conceptually from ultrafast acceleration in semi-open channels, where the entire flame-generated flow is pushed towards a single exit, while with two extremes open, this flow is distributed between the upstream and downstream ones, thereby moderating flame propagation. The flame oscillations are essentially nonlinear; the oscillation period grows with the blockage ratio but decreases with the thermal expansion. In fact, these oscillations can be treated as fluctuations around quasi-steady solution, thereby supporting the recent experiments, modelling and theory of premixed flames in open obstructed channels, which all yielded steady or quasi-steady flame propagation prior to the onset of fast flame acceleration.