RAWAN ALKANDARI and V'YACHESLAV AKKERMAN, Dept. of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV, 26506. Effect of Mechanistic Surface Conditions on Extremely Fast Flame Acceleration in Obstructed Cylindrical Pipes

The Bychkov model of extremely fast flame acceleration in obstructed cylindrical pipes [Combust. Flame 157 (2010) 2012] employs a number of simplifying assumptions, including those of slip and adiabatic surfaces of the obstacles and the pipe wall. In the present work, the influence of various mechanistic surface conditions on the combustion process in cylindrical pipes with in-built parallel, tightly-spaced obstacles is scrutinized by means of the computational simulations of the axisymmetric combustion equations with fully-compressible hydrodynamics and Arrhenius chemical kinetics. Specifically, nonslip and slip surfaces are compared for the obstacles blockage ratio α in the range $1/3 \le \alpha \le 2/3$ and the spacing between the obstacles Δz in the range $0.25 \le \Delta z/R \le 2.0$. It is shown that the impact of surface friction on flame acceleration is minor, 1.3~3.5%, being positive in a pipe with $\Delta z/R = 0.5$ and negative for $\Delta z/R = 0.25$. With the fact that the real boundary conditions are neither slip nor nonslip; but in between these categories, the present study thereby justifies the Bychkov model and makes its wider applicable to the practical reality. While this result can be naively anticipated and elucidated by the very fact that the flame dynamics is mainly driven by burning in the unobstructed portion of an obstructed pipe (i.e. far from the wall), the situation is, however, qualitatively different from that in the unobstructed pipes, where the flame dynamics in the events of slip and non-slip walls differ drastically (quantitatively) and conceptually (qualitatively).

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