Gideon Udochukwu, Department of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV, 26506, and V'yacheslav Akkerman, Department of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV 26506. Numerical simulations towards optimizing the burner design for efficient staged pressurized oxy-coal combustion.

Staged pressurized oxy-coal combustion (SPOC) – a technology developed at Washington University at St. Louis (WUSTL) – is nowadays a promising tool for low-cost/emissions, high-efficiency power generation. The present computational simulations, performed at West Virginia University (WVU) by means of the ANSYS Fluent package, compliment the experimental research for better understanding of the impacts of turbulence, fluid flow, flame/particle dynamics, and heat transfer on oxy-coal combustion. Here, CO_2 is injected alongside the coal, for its carriage, while a small amount of CH_4 is also injected alongside the coal to maintain a steady flame. Out of 100 kW in a lab-scale reactor, 10 kW originates from CH_4-air burning and 90 kW comes from coal combustion. Steady and unsteady RANS simulations are performed resulting in an asymmetric flame shape. Three causes of the flame asymmetry are hypothesized: (i) coal injection, (ii) onset of the shear-layer instability due to various stream velocities and densities in a shear layer, where mixing occurs, and (iii) presence of the vortex shedding due to the flow past a bluff body, which is used to stabilize the flame. As a result, an impact of the presence of coal on the flame symmetry is demonstrated, and a benchmark at which further increase of coal would result in flame asymmetry is found. The present simulations also shows occurrence of the vortex shedding when the flow passes over a disk in the reactor used to stabilize the flame, constituting a potential reason for the periodic flame oscillations experienced in the result.

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