On the dynamics of H_2 – CH_4 turbulent flames in bluff body burner

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The pressing challenges of global warming due to greenhouse gases have unlatched the scientific endeavors for the search for clean and affordable energy. The reduction of emissions of CO_2 and NOx becomes an ever-increasing trend across the globe. The addition of hydrogen (H_2) proves to be a favorable candidate in reducing such emissions. However, insights pertaining to the effect of H_2 addition over the local interaction between turbulent flame and flow dynamics are limited. Hence, this study aims at investigating the effect of H_2 addition in lab-scale bluff-body burner using time-resolved optical diagnostic tools. We have employed, PIV and chemiluminescence imaging (OH*)/ PLIF (OH) in simultaneous fashion to delineate the flame – flow interaction dynamics across various concentration levels of hydrogen in a CH_4-H_2 fuel mixture. The operating modes such as constant thermal power and momentum flux ratios are considered. Across the two modes, experiments are carried out with the different H_2 volumetric concentration levels viz. 20 %, 50%, 80%, and 100 %.

In a global sense, reduction in flame length and increased levels of OH intensity are observed for the hydrogenated flames. Furthermore, a localized extinction between the flame in the recirculation zone generated by the bluff body and the main upper lifted flame causes the intermittent ejection of flame pockets in the pure methane flame. However, the same phenomenon is ceased with H_2 addition. This reveals hydrogenated flames exhibit higher strain resistance than methane flame. Finally, proper orthogonal decomposition (POD) is implemented over the instantaneous flow/scalar fields to capture the dominant flow structures across various operating modes.

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