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# A Study on the Effect of LPG/$H_2$ Blended Combustion on the Soot Formation Limit in a Counterflow Diffusion Burner

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Blending hydrogen ($H_2$) with hydrocarbon fuels is widely recognized as an effective approach to reduce soot emissions. However, the effectiveness of $H_2$ strongly depends on the type of hydrocarbon fuel and combustion conditions, and under certain conditions, $H_2$ addition may even promote soot formation. Therefore, a systematic and in-depth understanding of the role of $H_2$ is required. This study aims to investigate the effect of $H_2$ addition on the soot formation limit in an LPG-based non-premixed flame using a counterflow burner. The influence of $H_2$ is systematically analyzed by varying the hydrogen blending ratio (10-40%), considering its chemical, dilution, and transport effects associated with fuel and oxidizer flow characteristics. A high-sensitivity intensified charge-coupled device (ICCD) camera was equipped, enabling visualization of soot formation regions and flame luminosity. In addition, a chemical kinetic-based approach is considered the soot formation characteristics of flame.

The results show that increasing the $H_2$ blending ratio shifts the soot formation limit toward the fuel-rich region while reducing the overall soot formation tendency. This behavior is attributed to both the dilution effect of $H_2$ and the increased concentrations of H and OH radicals, which suppress the formation of soot precursors. Furthermore, the high diffusivity of $H_2$ alters the mixing characteristics within the flame, leading to structural changes in the soot formation region. Kinetically, the chemical effect of $H_2$ is primarily associated with the suppression of soot precursor formation and nucleation processes, which are closely related to the inhibition of initial aromatic species formation pathways.

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