

Measurements of laminar flame speeds of acetone/methane/air mixtures

Abstract:

The effect of acetone on the laminar flame speed of methane/air mixtures is investigated over a range of stoichiometries at atmospheric pressure and room temperature. The liquid acetone is vaporised and seeded into the methane/air mixture at 5%, 9% and 20% of the total fuel by mole. The experiment is performed using the jet-wall stagnation flame configuration and the particle imaging velocimetry (PIV) technique. Laminar flame speeds are derived by extrapolating the reference flame speed back to zero strain rate. Experimental results are compared to numerically calculated values using a base methane chemical kinetic mechanism (GRI-Mech 3.0) extended with acetone oxidation and pyrolysis reactions from the literature. The experimental results show that acetone addition does not affect the laminar flame speed of methane significantly within the range of concentrations considered, with a stronger effect on the rich range than under fuel-lean conditions, and that the peak laminar flame speed of acetone in air is ~ 42.5 cm/s at $\phi = 1.2$. Simulation results reveal that the most important reactions determining acetone laminar flame speeds are $\text{H} + \text{O}_2 \rightarrow \text{O} + \text{OH}$, $\text{OH} + \text{CO} \rightarrow \text{H} + \text{CO}_2$, $\text{HO}_2 + \text{CH}_3 \rightarrow \text{OH} + \text{CH}_3\text{O}$ and $\text{H} + \text{O}_2 + \text{H}_2\text{O} \rightarrow \text{HO}_2 + \text{H}_2\text{O}$. Comparison of the expected disappearance of acetone relative to methane shows that the former is a good fluorescent marker for the latter.