International Conference on Numerical Combustion
Rome, Italy, October 14-17, 2025
www.icnc2025.com

Numerical study on detonation in dilute ammonia droplets

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Liquid ammonia has attracted increasing interest as a low-carbon fuel due to its high volumetric energy density. This study numerically investigates detonation propagation and emission formation in a two-dimensional planar channel filled with a gas mixture containing dispersed liquid ammonia droplets. The coupled effects of initial pressure and temperature on detonation dynamics and droplet evaporation are analyzed. Results show that high temperature and pressure promote detonation propagation, while high pressure suppresses the evaporation rate of liquid ammonia. The phase change effect is found to be secondary compared to thermal and compressible effects, leading to more significant detonation acceleration and heating under high-pressure and high-temperature conditions. Notably, NOx emissions in the post-Mach stem region are substantially higher than those in the post-incident wave region. Further, NOx formation and consumption under Chapman–Jouguet equilibrium conditions are quantified under varying initial pressures and temperatures. This work provides insights into the detonation characteristics of ammonia-based fuels, supporting their potential utilization in clean combustion systems.