Autoignition characteristics of coke oven gas in hot air coflow

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Abstracts

The conventional steel industry burns coal in the blast furnace (BF), producing substantial CO_2 emissions. Therefore, developing low-carbon BF technology is urgent for the target of carbon neutrality in 2050 worldwide. Coke oven gas (COG), a valuable hydrogen-rich by-product from the carbonization process of coke production, can be recovered and injected into BF for combustion and reduce overall CO_2 emission. However, the autoignition characteristics of COG jet in convective hot air surroundings have not been reported yet and require further study. In this work, the COG fuel was simulated as 60%H_2/30%CH_4/10%CO composition, and the autoignition characteristics were investigated using a coaxial jet burner under 550–750°C convective hot air coflow. Kinetic modeling of the ignition process was computed using a close homogeneous module in CHEMKIN with detailed chemical mechanisms to identify temperature, species profile, and dominant reactions for ignition. In addition, CH_4 blended with H_2 as fuel was also discussed for comparison with COG to elucidate the fuel effect on ignition. The experimental results demonstrated that COG can be auto-ignited to form a stabilized jet diffusion flame at tube exit when hot air coflow reaches 650°C while pure methane fuel cannot. However, adding 10% of H_2 to CH_4 promotes the ignition to form the flame. Simulation results revealed that increasing H_2 concentration on CH_4 fuel significantly reduces the autoignition temperature and ignition delay time because of the significant free radicals promoting chain reactions that accelerate the overall reactivity. This study provides insight into the autoignition of hydrogen-rich gas in hot air, which is conducive to applying COG in hydrogen-based BF for combustion in the future.

Keywords: Autoignition, coke oven gas, jet in coflow, kinetic modeling