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IN-SITU LASER SPECTROSCOPY OF CO, CH4, AND H2O IN A PARTICLE LADEN LABORATORY-SCALE FLUIDIZED BED COMBUSTOR

ABSTRACT

The pyrolysis, devolatilization and char combustion of bituminous coal and biomass (beechwood, firwood) were investigated in a laboratory-scale fluidized bed combustor by tunable diode laser spectroscopy. Individual fuel particles were suspended in the free board of the unit. The bed temperature was 800 deg C, the oxygen partial pressure 0 to 20 kPa (0-10 vol.%). Two Fabry Perot type tunable near infrared diode lasers were deployed for quantitative in-situ species concentration measurements. CH4 and CO were measured simultaneously during devolatilization and char combustion in-situ 10 mm above the surface of the fuel particles as well as H2O using laser spectroscopy. Sand particles were passing the probing laser beam path. Be sides the resonant absorption of the laser light by CO, CH4 and H2O, severe and strongly transient non-resonant attenuation by partial blocking of the beam and beam steering effects occurred. By wave length tuning the two laser sources, species concentrations could be determined. The measured absorbances had to be corrected for the real temperature measured at the position of the probing laser beam. In addition, CO, CO2 and O2 were de termined ex-situ by conventional methods. A spatial profile in side the FBC of major species (CH4, CO, CO2, O, H, OH) was calculated using a chemical kinetics program for a single fuel particle in a plug flow reactor geometry. The results were compared to the experimental findings. Good agreement was found. Tunable diode laser spectros copy was found to be an aptmethod of determining quantitative species concentrations of multiple gases in a high temperature multiphase environment.

KEYWORDS

coal, biomass, pyrolysis, in situ laser spectroscopy, tunable diode laser, concentration measurements, carbon monoxide, methane, water, combustion, devolatilization, modeling

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