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Nanoparticle Emission Characteristics during Methane Pyrolysis in a Laminar Premixed Flame

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Abstract : This study investigates the physical characteristics of nanoparticles generated during pyrolysis of methane in hot products of a premixed propane-air flame. An inverted burner is designed to provide a laminar premixed propane-air flame (35 SLPM) then introduce methane co-flow to be pyrolyzed within a closed cylindrical chamber (20 cm in diameter and 68 cm in length). The formed products are discharged through an exhaust with a sampling branch to measure emission characteristics. Carbon particles are sampled with a preheated nitrogen dilution system, and the size distribution of particles formed by pyrolysis is measured by a scanning mobility particle sizer (SMPS). Dilution ratio is calculated using simultaneously measured CO2 concentrations in the exhaust products and diluted samples. Results show that particle size distribution (PSD) is strongly affected by dilution ratio and preheating temperature. PSD becomes unstable at high dilution ratios (typically above 700 times) and/or low preheating temperatures (below 40° C). At a suitable dilution ratio of 55 and preheating temperature up to 70° C, the median diameter of PSD increases from 20 to 220 nm following the introduction of 0.5 SLPM of methane to the propane-air premixed flame. Furthermore, with pyrolysis of methane, total particle number concentration and estimated total mass concentration of particles in the size range of 14 to 700 nm, increase from 1.12 to 3.90 *107 cm-3 and from 0.11 to 154 µg L-1, respectively.

Keywords : laminar premixed flame, methane pyrolysis, nanoparticle physical characteristics, particle mass concentration, particle number concentration, particle size distribution (PSD)
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