

Modeling and Measurements of Size Distributions in Premixed Ethylene and Benzene Flames

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Abstract

The present study demonstrates the major differences in the evolution of the particle size distributions (PSDs), both measured and modeled, of soot in premixed benzene and ethylene flat flames. In the experiments, soot concentration and PSDs were measured by using a scanning mobility particle sizer (SMPS, over the size range of 3 to 80nm). The model employed calculations of gas phase species coupled with a discrete sectional approach for the gas-to-particle conversion. The model includes reaction pathways leading to the formation of nano-sized particles and their coagulation to larger soot particles. The particle size distribution, both experimental and modeled, evolved from a single particle mode (the nucleation mode) to a bimodal size distribution. An important distinction between the results for the ethylene and benzene flames is the behavior of the nucleation mode which persists at all heights above the burner (HAB) for ethylene whereas it was greatly suppressed at greater HAB for the benzene flames. The explanation for the decreased nucleation mode at higher elevations in the benzene flame is that the aromatics are consumed in the oxidation zone of the flame. Fair predictions of particle-phase concentrations and particle sizes in the two flames were obtained with no adjustments to the kinetic scheme. In agreement with experimental data, the model predicts a higher formation of particulate in the benzene flame as compared with the ethylene flame.

