Measurement of Soot Particle Size Distributions from a Well Stirred Reactor-Plug Flow Reactor

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Soot is a common by-product resulting from the combustion of fossil fuels. Release of soot into the atmosphere by combustion processes contributes to environmental and health hazards and decreases the efficiency of combustion processes since carbonaceous particulates represent incomplete combustion. On the other hand, soot formation is desirable in certain applications such as industrial furnaces since the presence of soot greatly enhances radiative heat transfer. The challenge is to be able to control soot formation for a specific task. Unfortunately, understanding the mechanisms responsible for soot formation remains a daunting task. The major steps in soot formation consist of fuel pyrolysis, polycyclic aromatic hydrocarbon (PAH) formation, particle inception, coagulation, surface growth, carbonization, agglomeration, and oxidation [1, 2]. The process of soot inception is the least understood aspect of soot formation.

A well stirred reactor (WSR) followed by a plug flow reactor (PFR) is being used to study polycyclic aromatic hydrocarbon (PAH) growth and soot inception. Soot size distributions were measured using a dilution probe followed by a nano-differential mobility analyzer (Nano-DMA). The dilution probe, based upon the design of Zhao *et al.* [3], was used to minimize both coagulation growth of the particles and thermophoretic deposition on the sampling tube. A rapid insertion probe was fabricated to thermophoretically collect particles from the reactor for transmission electron microscopy (TEM) imaging. Results are presented on the effect of equivalence ratio on the soot size distributions obtained from the Nano-DMA for fixed dilution ratio, the effect of dilution ratio on the soot size distributions obtained from the Nano-DMA for fixed equivalence ratio, and the effect of temperature on the soot size distributions obtained from the Nano-DMA for fixed equivalence ratio. Our soot size distribution measurements demonstrate that the mixing conditions in the flame zone affect whether or not a nucleation mode was detected in the size distribution.

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