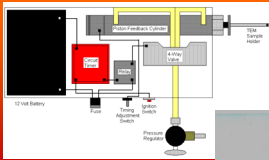


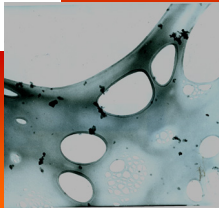
Characterization of Young Soot from an Inverse Diffusion Flame



Nathan Orton, JoAnn Lighty, Eric Eddings, Adel Sarofim
Validation Team

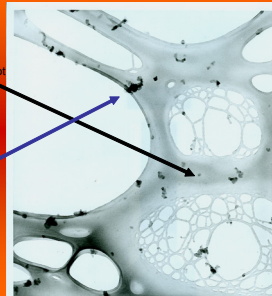


Thermophoretic Sampling provides TEM samples which provide information on soot Morphology.

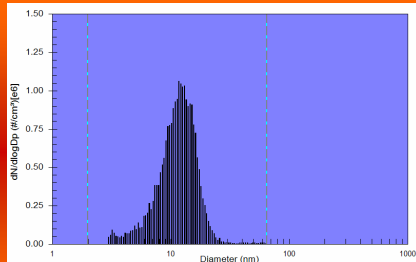
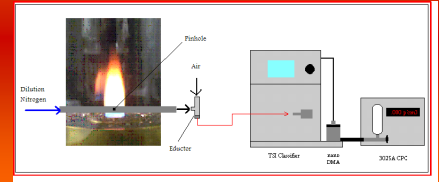


The Majority of the soot particles are small, young soot as viewed by the small, spherical particles.

A few larger soot agglomerates can also be seen.

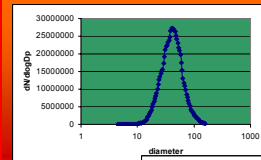
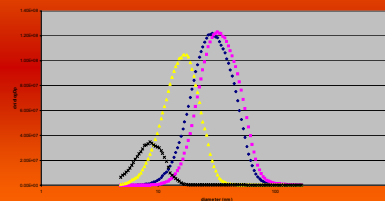


Dilution and SMPS Sampling Systems



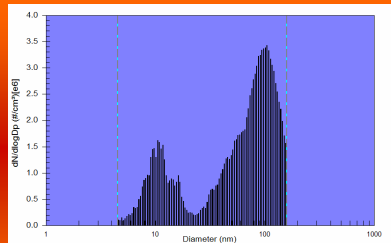
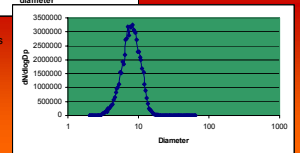
The nano DMA is capable of measuring particle sizes smaller than 3 nm. The long DMA could miss this entire peak.

Importance of Dilution



SMPS measurements show that there is a peak at about 50nm for a premixed ethylene flame.

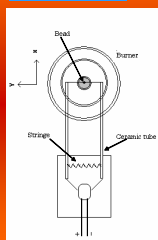
The same measurements show a peak at 9 nm for an ethylene inverse diffusion flame. This shows that the IDF provides much younger and smaller soot.



High above the flame, there appears to be a bimodal distribution. The primary particle peak is still near 10 nm and the coagulation peak is about 90 nm.

Gas temperature and thermophoretic deposition on thermocouples

Thermocouple set up



Energy balance equation

$$\dot{Q}_c T_c = k_p N_b (T_c^4 - T_w^4/24) \quad (1)$$

G equation

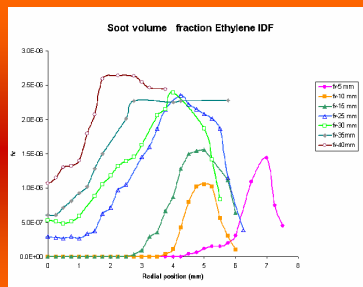
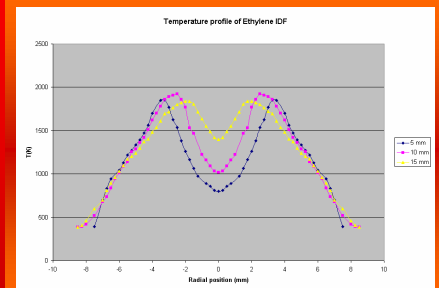
$$G = 1.46(1/\rho)^{0.7} \cdot (T_w/T_c)^{0.7} \approx 0.76 \quad (2)$$

Linear equation in function of time

$$G(t) = \text{Slope} \cdot t + G_0 \quad (3)$$

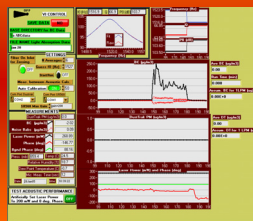
$$\text{Slope} = \beta \cdot T_w$$

$$\beta = 5.8 \times 10^{-12} \cdot T_w^{2.65}$$



PA analysis of optical properties

By comparing mass concentrations measured by photoacoustic methods and standard methods, light absorption can be compared for old and young soot.



Future Work

- SMPS
 - Distributions at different locations and fuel dilutions
- PA
 - Determination of optical properties
- TEM
 - Morphology at varying locations and fuel dilutions
- Thermocouple
 - Repeat temperature and soot volume fraction measurements with improved measurements and calculations

