The effect of hydrogen addition on the aerosol properties of combustion generated nanoparticles from premixed ethylene flames

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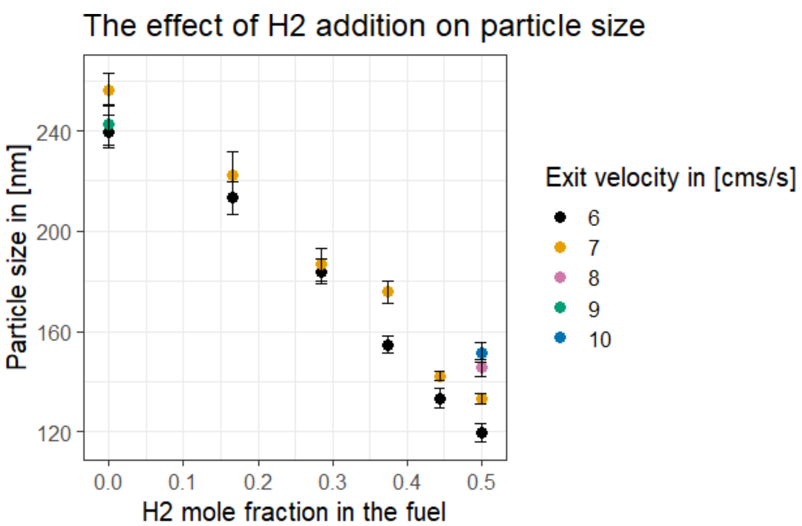
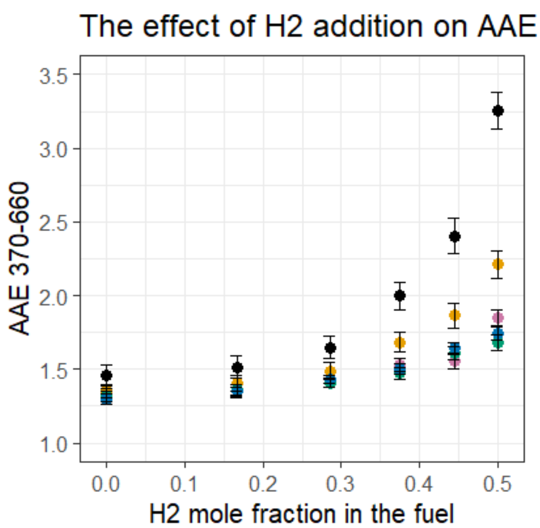
Black carbon (BC), or soot, induces significant climate warming by multi-wavelength radiation absorption. Colored organic carbon (brown carbon or BrC) contributes significantly as well in the near-UV region. This study explores optical, physical, and thermo-chemical properties of combustion-generated carbonaceous aerosols. Using premixed burner-stabilized 1-D flat flames with varied H_2/C_2H_4 ratios and exit velocities 6 to 10 cm/s to account for flame temperature. The equivalence ratio (fuel to air) is maintained at 2.3, the study spans hydrogen fractions in the fuel from 0% to 50%.

An AE43 aethalometer is used in parallel to filter sampling to compute the Angstrom Absorption Exponent (AAE), OC/EC ratios and the Mass Absorption Cross section (MAC) of both BC and BrC. Additionally, sampled aerosol is methanol-dissolved to find the Mass Absorption Efficiency (MAE) of the BrC. A Scanning Mobility Particle Sizer (SMPS) is used to analyze aerosol size distribution. Preliminary results for particle size and AAE are presented below.





All values for AAE were found to be well above 1, indicating the presence of BrC in all conditions. Increasing H_2 mole fractions increase the AAE and roughly halves the mean particle size, especially at lower exit velocities and thus colder flames. The AAE exceeds 3 and the mean particle size decreased from 240nm to 120nm. A larger AAE corresponds to more light absorption by BrC due to the larger AAE of BrC compared to the AAE of BC. Hydrogen addition has a larger effect on the particle size and change in AAE compared to flame temperature. Our current hypothesis states that BrC may serve as precursor for BC formation, given its smaller size and incomplete transformation to BC under conditions characterized by colder flames or elevated H_2 concentrations in the fuel.