Optical investigations of soot of different maturity

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There is a large uncertainty about the climate forcing effect of aerosol particles originating from combustion sources (IPCC). Hence studies of the optical properties of these aerosols are important to understand their interaction with sun radiation. The mini-CAST 5201C (Jing Ltd) is used to create soot with different characteristic properties in a laboratory environment in order to mimic soot of different maturity or from different sources. Measurements were made using various instruments, and in this work results are mainly shown from optical techniques, such as a diode laser extinction setup (Simonsson *et al.*, 2015) and an Aethalometer. By evaluating the Ångström coefficient, α, i.e. the wavelength dependence, from the measurement data for different types of aerosols, information about the aerosol structure and composition can be obtained.

Methods

The mini-CAST 5201C was used at six operation points to produce soot of different characteristics, where the operation point 1 (OP1) represents more mature soot with generally larger sizes and OP7 younger and generally smaller particles. The soot stream was led through a pipe system, either through a thermodenuder (TD; 250°C), the TD plus an oven (500°C) in series, or through a by-pass line (room temperature). The particles were characterized using numerous techniques; a diode-laser extinction system, an Aethalometer, Laser Induced Incandescence (LII), Raman Spectroscopy and a Scanning Mobility Particle Sizer (SMPS). Detailed chemical characterisation was carried out with a Soot Particle Aerosol Mass Spectrometer (SP-AMS). The Ångström coefficient was extracted measuring the light extinction using 4 wavelengths (extinction) and 7 wavelengths (Aethalometer) to obtain the spectral absorption dependence.

Conclusions

The diode laser extinction measurements and the Aethalometer data showed similar Ångström coefficients for the different operation points. In Fig. 1 the Ångström coefficient is presented for the Aethalometer data. It is shown that the mini-CAST operating points produces soot of very different optical characteristics. OP1 and OP3 gives α≈1, which is a value representative for mature soot. The higher operation points 6 and 7 show much stronger wavelength dependence and hence a much higher value of α than 1. SMPS data shows that the OP1 contains larger soot particles and that the particles are smaller for higher operating point number. The general trend is that the Ångström coefficient is relatively independent of heating, at least for OP 1, 3, and 5. This indicates that the Ångström coefficient is more correlated with the refractory soot core than with the material evaporated at the higher temperatures. Only for OP6 and OP7 there is an indication that a minor part of the α-dependence is related to the evaporated material. This interpretation is in contrast to recent studies that linked UV absorbing constituents (Brown Carbon) with low volatility organic aerosol components (Saleh et al. 2014).

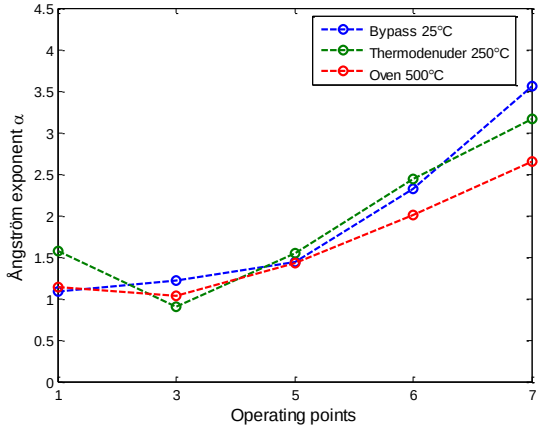

Figure 1. The Ångström coefficient for the different operating points as they pass the by-pass line, are heated to 250°C and heated to 500°C.

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Jing Ltd, www.sootgenerator.com
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