Towards Conceptual Models of the Properties of Fresh and Processed Carbonaceous Aerosol Emissions (Invited Keynote Talk)

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Published in: Proceedings of the 14th International Congress on Combustion By-Products and Their Health Effects

2015

Link to publication

Citation for published version (APA):
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Introduction
Exposure to carbonaceous aerosol is associated with cardiovascular and respiratory disease. At the same time, soot (black carbon) is a short-lived climate forcer. We need detailed knowledge about particles types and particle properties on the one hand and the link between these and the effects on health and climate on the other hand. Recently, time-resolved in-situ techniques to investigate particle chemistry and microphysics have become available. The aim of this presentation is to summarize new knowledge gained with these techniques on soot formation and oxidation during combustion, time resolved particle emissions and atmospheric aging of combustion aerosols.

Aerosol Mass Spectrometry (AMS) was used to sample diluted particles directly from combustion sources into a vacuum chamber, followed by vaporization, electron ionization (70 eV) and detection with Time of Flight Mass Spectrometry. Tandem mobility-mass analysis (DMA-APM) was used to investigate the particle mixing state and microphysical properties.

Crank angle resolved sampling of particles from a modern diesel engine showed that the oxidation rate rather than the soot formation rate is controlling the engine out soot concentration of a modern diesel engine. The evolution of the soot maturity during combustion will be discussed.

Upon addition of wood logs in wood stoves, very high emissions of organic particle mass is emitted. Elevated emissions of Black Carbon and PAHs are found in the flaming phase at excessive burn rates (Eriksson et al. 2014). Full cycle emissions show external mixtures containing both tar ball spherical particles and soot agglomerates. PAHs and other organic components are chemically degraded upon release to the atmosphere during both dark and UV aging. Aging affects also the toxicological properties (Nordin et al. 2015).

In gasoline exhaust, secondary organic particle emissions are an order higher than primary organic emissions (Nordin et al. 2013). Atmospheric processing changes diesel soot from agglomerated (Rissler et al. 2013) and hydrophobic to collapsed soot cores with oxidised thick hydrophilic coatings (Wittbom et al. 2014).

The first steps towards a conceptual model of carbonaceous aerosol emission characteristics will be discussed during the talk.

References:
Eriksson, AC, Nordin, EZ et al. (2014) Env. sci. & techn., 48, 7143-7150.