Secondary organic aerosol emissions from a flexi-fuel gasoline engine operated with gasoline-ethanol blends: First results with the new photochemical emissions aging reactor

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Combustion processes are the major anthropogenic sources of particulate and gaseous pollutants, causing significant environmental and health effects. One of the main challenges for the assessment of the effects of combustion emissions is their transformation in the atmosphere, due to photochemical aging reactions. Traditionally atmospheric reactions of various biogenic and anthropogenic emissions have been studied in laboratory chamber setups. More recently different flow tube reactors have been developed to achieve a wider degree of oxidant exposure times and a continuous aging process (e.g. Kang et al., 2007). In this work, a recently developed photo-oxidation flow tube reactor was applied to study the photochemical aging of ethanol and gasoline fueled car engine emissions.

The reactor is constructed from stainless steel tube (Ø 34 cm) which has four 254 nm UV lamps assembled at the inner walls. The lamps are surrounded by quartz glass tubes, which are flushed with cooling air. Ozone and water vapor are added into the reactor to produce OH radicals via photolytical decomposition of O_3. The OH exposure times were estimated by measuring D9-butanol gas decay with HR-PTR-ToF-MS (Ionicon) during the experiments. Ozone concentration and lamp intensities were varied to achieve the desired OH exposure times.

The engine applied for the experiments was AUDI turbo charged flexi-fuel gasoline engine and two different gasoline-ethanol fuel mixes (E5 and E85) were used. Both the New European Driving Cycle (NEDC) and selected steady state conditions were used in the emission study.

The emissions from the engine were first diluted and then introduced to the tube reactor. Finally, downstream the tube reactor the aerosols were sampled to the aerosol measurement instruments, including HR-AMS (Aerodyne Research Inc.), SMPS (TSI) and Aethalometer (Magee Scientific).

With both fuels the photochemical aging clearly increased organic aerosol emissions (Fig. 1). It was also observed that the oxidation state of the aerosols increased with OH-exposure with E5 fuel case as expected. This increase was not clear for the E85 fuel case and already the primary organic aerosol exhibited relatively high oxidation states. The ozone exposure alone also affected the emissions by increasing the oxidation state of E5 fueled emissions, while there was no increase in OA.

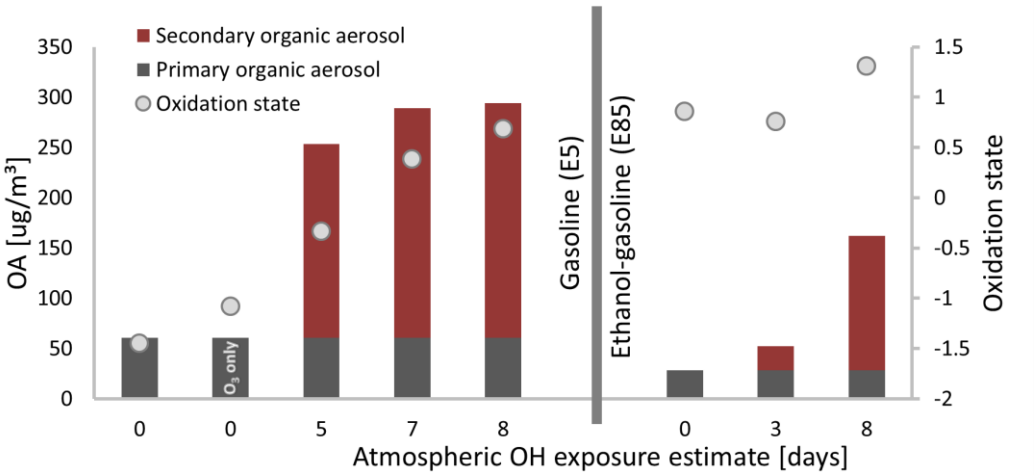

Figure 1. Primary and secondary organic aerosol emissions and oxidation state of the aerosols measured with SP-HR-AMS.

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