A novel probe to investigate corrosion relevant particles in boilers of waste incineration plants

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Keywords: waste incineration, sampling probe, particle size distribution, chemical analysis
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Although the particulate phase in the boilers of waste incineration plants has for a long time been under suspicion to essentially drive the corrosion of the superheater tubes, it has not been comprehensively characterized to the present. In former works, the aerosol was usually exhausted from the boiler and subsequently diluted and cooled, in order to make it available for conventional aerosol measurement techniques (Deuerling, 2010). However, at high temperatures this method involves tremendous artefacts such as condensation of salt vapours during cool-down. Furthermore, sticky chlorine-containing micron particles, which are assumed to be most crucial for the corrosion, deposit in the goose-neck bend of conventional probe inlets and cannot be analysed as single particles.

Therefore, we developed within the frame of the project VOKos a novel sampling probe, which allows the collection of particles in the interesting size range and largely suppresses condensation artefacts.

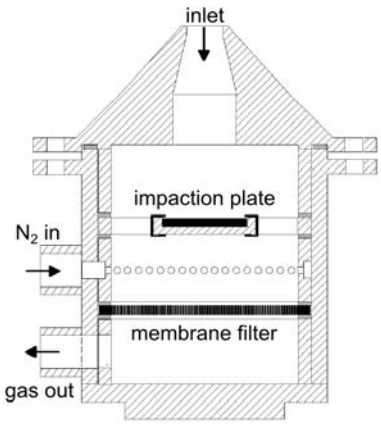

Figure 1: Cross section of the sampling probe.

The probe consists of two stages: Firstly, larger particles are sampled on an impaction plate. Secondly, the remaining smaller particles are collected on a nickel membrane filter with well-defined pore size and pattern. Together, a broad particle size range from a few 10 nanometres up to several 100 µm is covered. Before and after sampling, the probe is flushed with an excess of clean nitrogen heated to the sampling temperature, which on the one hand avoids condensation of salts and post-reactions and on the other hand facilitates well-defined sampling times.

Both types of substrates are well-suited for scanning electron microscopy (SEM), which provides a comprehensive investigation of the size distribution, morphology and chemical properties of individual particles. Using computational fluid dynamics (CFD), the collection efficiencies of the impactor as well as of the membrane filter have been studied in detail. Based on the results, a detailed data evaluation strategy has been developed to deduce the airborne particle number and mass size distributions from counting the collected particles in SEM images.

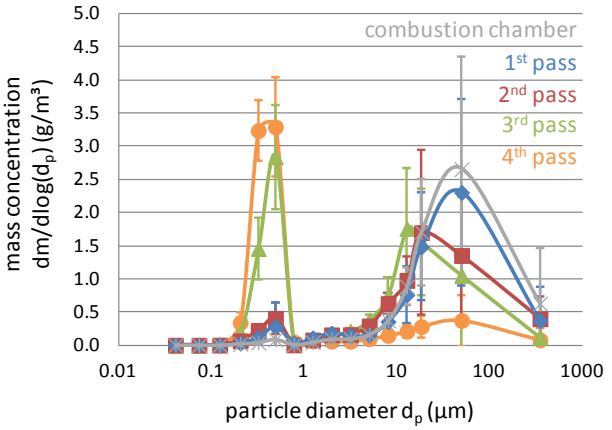

Figure 2: Evolution of the airborne particle mass size distribution in the course of the boiler.

The probe has been successfully employed for measurements in the combustion chamber (1250°C) and the four passes (250 - 950°C) of the waste incineration plant Schweinfurt (GKS) to characterize the evolution of the aerosol on its way through the boiler. As shown in Fig. 2, the concentration of particles with sizes between 0.1 and 1 µm grows by condensation of salt vapours during cooling, whereas the mass concentration of larger particles decreases due to deposition losses. We show that especially particles with sizes of several micrometers, which were difficultly to measure up to now, contain high chlorine fractions.

This work has been supported by the Federal Ministry of Education and Research (BMBF) within the project VOKos (Grant No 03X3589).

Deuerling, C.F. et al. (2010): *Aerosol Sci. Technol.* **44**, 1.