Redesign of a thermodenuder and assessment of its performance

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A thermodenuder (TD) is an instrument that enables near real time separation of total volatile and non-volatile particle concentrations in combustion fumes by conditioning exhaust emission samples in the ultrafine particle regime. The TD is designed to strip off the volatile and semi-volatile fraction (short chained hydrocarbons) attached to the surface of particles by thermal desorption (Abduhl-Khalek & Kittelson, 1995). A TD is suitable for use with instruments like SMPS (Scanning Mobility Particle Sizer) and is essential for the determination of dry and wet aerosol fractions of combustion processes.

This project describes the development and application of a TD, based on the concept proposed by Wehner *et al*. (2002). This redesigned instrument, denoted here as QUT-TD, includes easy parameter control, better accessibility to key elements of the instrument, a direct heating system based on a galvanically separated AC-power unit, and the direct detection of the gas temperature. These features keep the temperature gradient stable and, at the same time, prevent unexpected sample transformations due to uncontrolled condensation and nucleation under supersaturated conditions. It was then tested and compared under laboratory conditions with the commercially available TSI-TD (TSI Model 3065). The difference between these two instruments becomes obvious when using a NaCl-DEHS aerosol. As shown in Figure 1, a distinct peak shift of the heterogeneously nucleated aerosol occurs from the larger (wet aerosol) to the lower diameter range (dry aerosol). The QUT-TD accomplishes this already with a desorber temperature of 350°C, whereas the TSI-TD only partially achieves this condition even though the desorber stage was heated up to the maximal possible temperature of 400°C. The obtained M-shaped pattern is a strong indicator for recondensation of the desorbed volatile fraction onto the solid particle fraction still within the desorber stage (Burtscher *et al*., 2001). Temperature profiles of the TSI-TD revealed that the design of the heater stage (Wehner *et al*., 2002) favour temperature fluctuations and are most likely due to the different thermal properties of steel and glass, especially at its interface.

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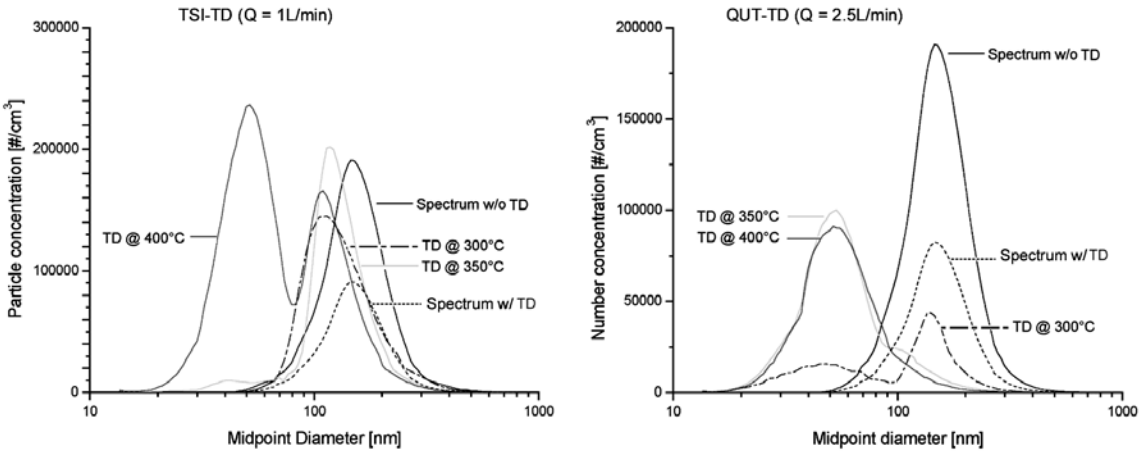

Figure 1. TD Size distribution of DEHS-NaCl aerosol at various temperatures sampled with an SMPS system.