

Interactive comment on “Evaluation of the new capture vaporizer for Aerosol Mass Spectrometers (AMS) through laboratory studies of inorganic species” by Weiwei Hu et al.

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This manuscript presents laboratory evaluation of the standard vaporizer (SV) and newly designed capture vaporizer (CV) of an Aerodyne aerosol mass spectrometer (AMS). It is an important step toward better understanding of the physical and chemical processes in the AMS vaporizer/ionizer. We have some comments on the manuscript, which might be helpful to improve the clarity of the presentation.

(1) Thermal decomposition products and relative ionization efficiency (RIE)

RIE is an important parameter for the quantification, as it is the basis for estimating the ionization efficiencies of various compounds that are not directly determined by routine

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calibrations. RIE depends on the thermal decomposition process of aerosol particles. Figure 3 clearly indicates that major thermal decomposition products from NH_4NO_3 and $(\text{NH}_4)_2\text{SO}_4$ were systematically different between the SV and CV. This means that the coefficients a , b , etc. of Equation [1] and [2] were different.

$\text{NH}_4\text{NO}_3 \rightarrow a \text{NH}_3 + b \text{HNO}_3 + c \text{NO}_2 + d \text{NO} + \text{others}$ [1]

$(\text{NH}_4)_2\text{SO}_4 \rightarrow a \text{NH}_3 + b \text{H}_2\text{SO}_4 + c \text{SO}_3 + d \text{SO}_2 + e \text{H}_2\text{O} + \text{others}$ [2]

The values of a , b , etc. represent the relative abundances of the thermal decomposition products in the ionization region and would be important for the interpretation of the RIE_{SO_4} values for the SV and CV (e.g., L259-262).

In order to discuss this point more quantitatively, it would be helpful to roughly estimate the values of a , b , etc. based on the fragment ratios. It may be true that the AMS ion source can produce more fragmentation than the NIST database because of the higher temperatures of neutral molecules, as the authors suggested. However, the temperature dependence of the fragment ratios in Figure 4c suggests that this effect is minor, at least for SO_x . The authors could use the values of a , b , etc. from the fragment ratios, along with electron ionization cross sections, to predict the RIEs and compare them to the measured RIEs.

(2) Collection efficiency (CE)

The improvement of the CE is the center of this manuscript, and we would expect more discussion on this issue. The temperature dependences of the AMS/CPC (CE) and molar ratios of acids to NH_4 in Figure 9 are interesting but need further investigation. The data for sulfate is not consistent with the authors' argument that the thermal decomposition of sulfate is complete in the CV at the vaporizer temperature (T_v) of $> 300^\circ\text{C}$ (L307-309). The authors speculate that the decreased AMS/CPC ratios for nitrate and sulfate at higher temperatures were due to interaction with the vaporizer surface (based on signals in chopper-closed mode). However, this assumption is not

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well supported considering the significant difference in the temperature dependence among the AMS/CPC ratios, molar ratios, and closed signals.

(3) Minor points

- The authors mention that the results for ammonium contradict the suggestion by Murphy (2016) (abstract, L43-44). This point is not a major conclusion of the current manuscript (but it appears so as it is written in the last sentence of the abstract). More importantly, Crenn et al. (AMT, 8, 5063-5087, 2015) showed large variability in RIE_NH4 for various ACSMs. We suggest the sentence could be deleted.

- Our recent papers regarding the development of the new particle trap and ambient intercomparison are cited in the introduction (L90-92). There are various factors affecting the ambient intercomparison result, including the collection efficiency, vaporization efficiency, choice of the calibration material, and size-cut of the aerodynamic lens. Although a regression slope of 0.7 was observed between our instrument and a sulfate particle analyzer, it was not entirely due to the CE but mostly attributed to the size-cut. Note that the definition of CE is different between our instrument and AMS because the AMS CE includes both physical collection and vaporization.

- The manuscript presents many results, some of which are difficult to interpret or may not be very critical for demonstrating the concept of the new CV. The behavior of chloride is very complicated because of possible chemical interaction with the vaporizer (Figure 9 and 11, also Drewnick et al., AMT, 2015). The results in section 3.1.4 (beam position) and 3.1.5 (production of CO2) are interesting, but somewhat beyond the major scope of this manuscript. We suggest that these results could be removed or shortened. The quantification of chloride could be published elsewhere after the authors obtain more conclusive dataset.

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