

## ***Interactive comment on “Influence of particle charging on TEOM measurements in the presence of an electrostatic precipitator” by N. K. Meyer et al.***

**N. K. Meyer et al.**

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Response to referees comments:

We thank the Referees for their comments and offer the following in response.

Anonymous Referee #1

Special comment:

It is unclear how relevant this effect is for ambient measurements for which most TEOM instruments are used. A short statement from the authors should be included (the authors only state that the found "effect demands further investigation" &#8211; conclusions section, last sentence).

&#8594; Ambient aerosols are generally thought to carry low net charges. This combined with lower mass concentrations found in ambient air than those observed during direct analysis of bio-mass combustion would suggest that the observed electrostatic effects may not be as readily observable in ambient cases. However, this would require further analysis which was outside the scope of these initial investigations

Minor comments:

Page 437, line 1: "In contrast with collecting filter samples, ..." should be changed to "In contrast to the gravimetric determination of particle mass collected on filters, ...".

&#8594; Suggested phrase substituted

Page 437, lines 5/6: The sentence "...and is known to be influenced by the presence of a volatile fraction ..." is unclear. The signal of a PM instrument should of course be influenced by (semi-)volatile fractions as long as they are in the particle phase at ambient conditions. Are you here referring to the known volatilization losses in beta attenuation monitors due to heated sampling lines?

&#8594; Yes, sampling lines are heated in beta attenuation monitors as a means of preventing positive mass bias from absorbed water vapor. However, heating of sample lines can lead to significant negative mass bias where particles are comprised of (semi-)volatile materials (Baron and Willeke, pg 394)

The manuscript has been changed to read:

Water vapor is prevented from positively biasing mass measurements by passing the aerosol through heated sample lines, however this technique is known to negatively bias mass measurements via significant volatilisation of (semi-) volatile species from which the aerosol is comprised

Page 437, lines 12/13: "(e.g. Dust Trak)". Please give the complete information about product and manufacturer.

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&#8594; The Dust Trak is a commonly available optical particle counter from TSI Inc. This has now been included in the MS

Page 437, line 26: The mentioned factor of 1.03 seems too small (only three percent correction for volatilization losses?). Please check.

&#8594; This is the value described in the EPA report. That said, my personal opinion is that the 30% factor reported by Green, Fuller, et al is a more likely value.

Page 438. lines 2/3: "...are known to vary with location as source weightings vary ..." should be changed to something like "... are known to vary with season and locations as source contributions vary ...".

&#8594; Suggested phrase substituted

Page 438, line 22: "...with organic carbon (OC) between 1 and 5%, ..." should be changed to "...with organic carbon (OC) contributing between 1 and 5% to total mass, ...".

&#8594; Suggested phrase substituted

Page 441, line 18: Should note "...could contribute to ...".

Anonymous Referee #3

General comments:

The manuscript describes a topic of significant interest for the scientific community. The paper is well written. The authors suggest a possible reason for their observation but clearly state that further investigation of the effect of particle charge on TEOM derived mass concentrations is necessary. Unfortunately the described effect of particle charge on TEOM measurements has not been verified against standard filter based measurements in this manuscript. Instead of comparing the performance of a new measurement method for the test of ESP on wood burning appliances with the gold standard a CPC is used to demonstrate unchanged particle number concentration with and with

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out neutralizer. Although measurements with the CPC support the conclusions drawn by the authors these measurements are not sufficient to exclude all other possible effects of particle charging that might influence mass concentrations measurements in their experimental setup. Even with comparable particle number concentrations actual mass concentrations depend on the shape of the particle number size distribution. To exclude changes of the shape of the number size distribution on observed mass concentrations (e.g. due to changed agglomeration rates with and without neutralizer) further information must be provided to the reader. Such information should preferably include filter based measurements or measurements of the number size distribution with an SMPS. The latter would, however, require proof of unchanged shape factors of the measured aerosol to exclude measurement artifacts. Without further data the observed effect particle charge is still interesting but the manuscript lacks the proof that it can be attributed to the TEOM.

¶ In answer to the main critique of Referee 3, (the absence of supporting evidence in the form of filter data) we have decided to include a portion data which was intended for a paper specifically focusing on the comparison of filter and TEOM results. The data (which can be found in the newly inserted figure 5) show that under normal operating conditions of the pellet boiler, close agreement (approximately 1:1) exists between filter measurements and TEOM measurements of particulate mass concentration. However, when the ESP is activated, TEOM measurements are shown to greatly overestimate concentration as given by the filters. Placing the neutralizer inline prior to the TEOM can annul this behaviour. I hope this additional information further supports our claims that TEOM measurements are indeed influenced by high particle charge loadings.

¶ To account for these changes the following phrases have been added to the text

Intro

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This electrostatic effect was crosschecked with particle mass concentration and particle number concentration measurements where no influence was observed. Placing a radioactive neutraliser prior to the TEOM leads to agreement between observed ESP efficiencies as measured by both the TEOM, mass filters and a CPC.

## Section 2 &#8211; Experimental

Filter samples were collected from the emission stack a distance of 0.5 metres from the ESP and according to the VDI guideline concerning measurement of particulate mass, VDI2066. Filters were preconditioned at 180 °C for 1 hour and then stored in a silica gel desiccator for a period of 8 hours. During sampling, filters were held at a temperature of 160 °C to prevent condensation of volatile species.

## Section 3 &#8211; Results

Finally, measurements were conducted directly comparing the relationship between mass measured using either filters or the TEOM (figure 5). When running the pellet boiler under normal operating conditions close agreement was observed between filter measurements and TEOM measurements of particulate mass concentration. However, when the ESP was activated, TEOM measurements were shown to greatly overestimate concentration as given by the filters. Placing the neutraliser inline prior to the TEOM removed the observed effect. This result further supports observations that TEOM measurements are indeed influenced by high particle charge loadings.

## Conclusion

This electrostatic effect was confirmed to be an artefact by comparing results against standard methods of measuring particulate number and mass concentrations (filters and CPC respectively)

## Specific comments:

1. The authors should briefly describe the concept of normalization to 13% O<sub>2</sub> as this may not be common knowledge of the readers of AMT

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¶ Single sentence added (I hope this to be satisfactory as a discussion on methods for comparing results between experiments, albeit important, is outside the scope of this work):

¶ Normalisation to a specified oxygen concentration permits comparison of results between test experiments conducted under different conditions.¶

2. The influence of aerosol dilution on the number or volume size distribution should be either described or given as a reference.

Again, this is outside the scope of this work, and should be assumed knowledge for practitioners.

3. The authors give two different descriptions of the physical setup of the tapered element. It would help to give one correct version.

We fail to see where 2 separate descriptions are given? Apologies.

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Interactive comment on Atmos. Meas. Tech. Discuss., 1, 435, 2008.

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