Atmos. Chem. Phys. Discuss., 8, S9441–S9445, 2008
www.atmos-chem-phys-discuss.net/8/S9441/2008/

Atmospheric Chemistry and Physics Discussions

ACPD

8, S9441–S9445, 2008

Interactive Comment

Interactive comment on "Performance evaluation of a high-resolution parallel-plate differential mobility analyzer" *by* J. P. Santos et al.

Anonymous Referee #1

Received and published: 25 November 2008

General Comments:

This paper describes a nicely engineered parallel plate mobility analyzer and measurements of ion mobilities produced by different neutralizers and chargers. The work is a nice contribution that could make some stronger statements about the importance of humidity, a factor that influences all mobility analysis of aerosols by affecting the charge distribution. The paper overstates the novelty of the apparatus described, and fails to cite key references. Moreover, the presentation of the design is insufficient to meet the basic standard of scientific discourse, to present the work in sufficient detail that a knowledgeable researcher in the field could fully evaluate it or reproduce it.

I address the last point first. The authors provide considerable detail about the flow rates, the radioactive ionizer, and some of the plumbing, but none of the critical dimensions are stated. The length, height, and width of the classification channel should all be stated. The basic characteristics of the so-called trumpet should also be provided, i.e., at a minimum the contraction ratio should be specified, and it should be stated whether the contraction was only in the height dimension or also in width. If both dimensions were varied, the contraction in each dimension should be specified. These dimensions are critical to understanding the performance of the instrument. While the authors totally neglect edge effects in their analysis (a reasonable first order approximation), the side walls of the channel do alter the flow so it is not strictly parallel as a simplistic 2-dimensional model would suggest. The authors suggest that the width of the entrance and exit slots can be varied arbitrarily. They need to describe how and the extent to which they ensured that the sample flow entering the classification region is uniform over the length of the sample entrance slot. Once they provide that information, it will be possible for the reader to evaluate the causes for the lower than ideal resolution.

The authors suggest that the width of the entrance and exit slots may be narrower than the channel. If that is the case, lateral diffusion may reduce the transmission efficiency just as diffusion in the migration direction reduces the resolution. The authors need to discuss how they deal with the lateral nonuniformities in their system.

The authors achieve an impressive resolving power of about 40 at the highest voltages, but theory predicts a value of almost 90. The authors provide some suggestions for this result on p. 17646. Another possible explanation is edge effects, i.e., the flow is not the ideal two-dimensional flow that they model. The authors state that there has been no systematic study of the effect of slit width on resolution. That is not true. Eichler et al. (*Aerosol Sci. Technol.* 29: 1-49, 1998) and Chen et al. (*J. Aerosol Sci.* 30: 983-999, 1999) have both performed careful analyses and improved resolution of DMAs as a result.

The paper fails to cite a number of key references to similar instruments. The first

ACPD

8, S9441–S9445, 2008

parallel plate differential mobility classifier was produced by Erikson in 1918, and was applied to gas ion mobilty measurements, with those ions produced by a radioactive ionizer. More recently, Zhang and Wexler (*International Journal of Mass Spectrometry* 2006) described a modern, miniaturized version, albeit one with much lower resolution than the present instrument. Another parallel electrode analyzer that avoids the edge effects inherent in the present instrument is the radial differential mobility analyzer (Zhang et al., *Aerosol Sci. Technol.* 23: 357-372, 1995; and the SMEC, Fissan et al. *Aerosol Sci. Technol.* 24: 1013, 1996). The RDMA also avoids a number of the fabrication challenges of the CDMA that the authors describe in the introduction, although the previous instruments have not been designed to attain the resolving power of the present instrument.

In the introduction, the authors indicate that the DMA electrodes are held at constant potentials. The most common use of the DMA today is as a component of the scanning mobility particle sizer in which the voltages are continuously ramped. That might not be desirable for the present application in which the focus is on attaining very high resolving power, but might be worth mentioning to explain the reasons.

The introduction states that the resolving power of the early instruments was too low to measure mobilities of ions with similar mobilities. While this is true, the way it is stated makes it sound as though the instruments were inferior. In fact, no mobility analyzer can attain high resolution of ions or particles that are much smaller than those for which the instrument was designed, or with mobilities that are much higher than the design range. Moreover, the maximum attainable resolving power is determined by the flow rate ratio; the earlier instruments attained resolution near that for which they were designed, for the particles that they were designed to measure. Had the developers of the earlier instruments that are criticized attempted the high resolution that the present authors seek, counting statistics would have limited the value of the resulting measurements. The authors should state the limitations of the earlier measurements in an objective and unbiased way.

ACPD

8, S9441–S9445, 2008

Interactive Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

The authors describe a loop circuit for the sheath flow. This is standard in the TSI SMPS system, and may well be used in other DMAs. Moreover, it has been used for many years in aeerosol research, e.g., Rogak et al., *Aerosol Sci. Tech.* 18: 25-47, 1993; Han et al.,*J. Nanoparticle Res.* 2: 43-52, 2000; and others). The use of some method to remove particles/ions from the recirculated flow is, again, standard, although the electrostatic precipitator used in the present study produces lower pressure drops than do the filters of the earlier work. One important component of those earlier applications that seems to be missing here is a cooler in the recirculation loop to ensure that the pump does not heat the sheath flow. This may be critically important to the part of the paper in which the authors are studying water clustering on ions since the thermodynamic state may be altered. The authors should document the temperature rise in the recirculating sheath or otherwise comment on how they have prevented this bias.

The performance evaluation needs to be rewritten to make clear what ions they are examining in each experiment. The resolution was inferred from measurements of electrosprayed THAB ions, but which THAB ions were studied, monomer, dimer, singly charged, etc.

In the applications (section 4) they provide detail on the charger that belongs in the methods section. This section is probably the most valuable contribution of the paper due to its importance in the interpretation of DMA size distribution measurements. Unfortunately, unless the authors have ensured that their sheath recirculation system does not alter the temperature of the sheath gas and, thereby, its relative humidity, the measurements may be only a qualitative indication of what might be done with proper care. If the RH in the sheath is the same as that in the incoming sample, the authors should make comment on this important issue. If not, they should either remove this section or repeat the experiments with suitable controls. They should note that it is the water activity, or relative humidity, that will determine the extent of clustering, not the absolute humidity that they report.

p. 4, l. 1: “trajectories ... mix up” is poor wording

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 17631, 2008.