Methods and limits of unipolar charged aerosol inversion

Z.N. Wei[1], L. Knobel[1], H.-J. Schmid[1]

[1]Chair of Particle Technology, University of Paderborn, Paderborn, Germany
Keywords: inversion, unipolar charger, electrical mobility, particle number size distribution
Presenting author email: zhongning.wei@uni-paderborn.de

The Scanning Mobility Particle Sizer (SMPS) is in widespread use for measuring the airborne particle size distributions and concentration which is electrical mobility based sizing techniques. In such a device the particles are classified according to the electric mobility. As a result after investigations an electrical particle mobility distribution is giving. But multiple charges per particle can result in particles of two different diameters but having the same electrical mobility. Therefore it is impossible or not easy to get the particle number size distribution directly. Thus the methods of conversion from electrical mobility particle distribution to particle size distribution are used extensively.

A NanoScan SMPS will be used for analytic unipolar charged nanoparticles. A patented unipolar charger charges more nanoparticles than bipolar charger, in other words, the bipolar charger has a lower charging efficiency, e.g., as pointed out in Wiedensohler (1988), over 90% of 10 nm particles would be neutral and could not be efficiently. Compared to the bipolar charging has the unipolar charging a higher charging efficiency (Tippayawong et al., 2011). Additionally the unipolar charger eliminates the need for radioactive material, which has less health risks and more regulations.

In a NanoScan a conditioner will be used in order to remove larger particles which could not be measured. Thus an electrical mobility particle distribution for the rest particles will be given by the TSI software. The measured mobility particle distribution for particles which are probably to have multiple charges and which can result in particles of two different diameters but having the same electrical mobility must be corrected and then the conversion from electrical mobility particle distribution to particle size distribution will be with the inversion routines calculated. But by the unipolar charger is the correction method encountered to limit, e.g. a lower resolution, lack of accuracy information for the larger particles. So we need to analysis and determine limits of the resolution and the size limit. And then these limits will be expected and quantified.

Furthermore we present the theory of a data inversion algorithm for the SMPS measurement. As pointed out in Stratmann et al. (1996), to convert from particle mobility distribution into particle size distribution, i.e. to calculate the number concentration of particles in size bin, a linear equation has to be solved. Where, the number of mobility bins, the number concentration in mobility and size bins and the probability of the particles to carry *n* elementary charges (or the charge number per particle) must be known. Namely the particle number size distribution will be calculated from the raw data, the measured electrical particle mobility. This method is called multiply charged inversion. If the unipolar charge distribution is principally known, it will be possible to obtain the particle number size distribution. The idea of this numeric method is under the assumption with a given number of sampling points of this particle number size distribution.

Wiedensohler, A. (1988). *An Approximation of the Bipolar Charge Distribution for Particles in the Submicron Size Range*. Jounal. Aerosol Science.

TSI, *Application Note SMPS-005.*

Stratmann, F., Wiedensohler A. (1996) *A New Data Inversion algorithm for DMPS-Measurements,* Institute for Tropospheric Research, Leipzig.

Intra, P., Tippayawong, N. (2011) *An Overview of Unipolar Charger Developments for Nanoparticle Charging*, Aerosol and air Quality Research.

Pfeifer, S., Müller, T., Wiedensohler A. (2012) *Enhanced multiple charge inversion algorithm for mobility size spectrometers,* Institute for Tropospheric Research, Leipzig.