A new calibration method for optical particle counters in the size range of 0.2 to 8 µm

M. Weiß, L. Mölter

1Palas GmbH, 76229, Karlsruhe, Germany

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Several papers about the calibration of light-scattering aerosol spectrometers (e.g. Friehmelt, 2000, Heim et al., 2008) already exist. However, the calibration of the Optical Aerosol Spectrometers (OAS) is still extensively discussed and issue of standardization committees (e.g. ISO/FDIS 21501-1). There are three significant reasons for this: 1.) An OAS has to be calibrated with respect to its counting efficiency and its size resolution. 2.) There is still no unique procedure available to calibrate optical particle counters in an expanded size range. A calibration related to the counting efficiency is often limited to a maximum size range of about 800 nm, the maximum mobility diameter that can be classified by commonly used Different Mobility Analysers (DMA). 3.) The effort which is necessary in order to calibrate OAS is large and time-consuming and therefore routinely not applicable for a quality control standard.

For this reason a calibration method has been developed that can be used to calibrate OAS with respect to the counting efficiency and the size resolution (see Fig. 1). The method is based on an improved aerosol generator for DEHS (MAG 3000) which produces monodisperse droplets in the size range of 0.2 to 8 µm. Additionally, the generator is able to keep the concentration constant which makes it suitable for reliable and reproducible measurements. In order to calibrate OAS, the aerosol of the generator is diluted into a channel with clean air to reduce the concentration, to avoid coincidence problems and to enable isokinetic sampling for the OAS. In contrast to a calibration procedure with a DMA as classifier for a monodisperse aerosol (Heim et al, 2008), the method with the MAG 3000 as a constantly producing monodisperse aerosol generator makes the calibration of OAS possible up to 8 µm. Moreover, this method is much cheaper in terms of technical requirements and less time-consuming which makes it applicable for quality standard controls.

The procedures to evaluate the measured distributions in order to characterize the size resolution and to measure the counting efficiency with a reference device are discussed. It is also shown that the described method is suitable for the calibration of OAS and the results are comparable to a calibration method with a DMA as a classifier for a monodisperse aerosol.

The above-described method has been used to characterize the size resolution and to measure the counting efficiency of the newly developed white light aerosol spectrometer welas® digital 2000 in the size range of 0.2 to 8 µm. In contrast to the predecessor welas® 2000 the welas® digital 2000 has a digital signal processing and a logarithmic A/D-converter (the former welas® had an analog signal processing and a linear A/D-converter). This improvement enhances the counting efficiency of the welas® digital and improves the size resolution for particles smaller than 1 µm. Additionally, the method has also been used to characterize the LAS-X II® (PMS) and to compare its size resolution and the counting efficiency with the welas® digital 2000. As the welas® digital 2000 can be equipped with five different sensors for concentrations from 1 P/cm³ to 10^6 P/cm³, it is further shown that all sensors can be calibrated with the described procedure.

Since this calibration method is an accurate and cost-efficient method to calibrate OAS, it is now used as a quality control for all welas® digital systems.

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Figure 1. Set-up to calibrate light scattering aerosol spectrometers with a constantly producing monodisperse aerosol generator (MAG 3000). Different OAS are measured consecutively.
