A New Effective Unipolar Charger for Calibration and Validation of Commercial Particle Number Measurement Systems

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The cancer-causing effects as well the influence on the climate is a well known problem of diesel soot particles. Therefore the European Union forces the car manufacturers with the current and upcoming emission standards Euro 5b and 6 to limit the emitted particle number of the diesel engines.

So far the industry is using a complex sample preconditioning system for removing the volatile particles and to dilute the aerosol. The non-volatile particles are counted afterwords by a Condensation Particle Counter. The hole system has to be calibrated by the manufacturers as well be validated during the operation due to altering effects. Therefore a system is necessary, which produces a highly reproducible aerosol and a suitable counter as a reference. The regulations dictates that the CPCs have to have their cut-off at 23 nm and a counting efficiency of 90 % at an electrical mobility diameter of 41 nm.

To validate such a particle counting system a spark discharge soot generator can be used together with a differential mobility analyzer and an electrometer as reference counter. To provide a sufficient high number of charged particles as well as to avoid of the commonly used Krypton-85 bipolar charger, due to security issues, an efficient, cheap and stable charger is needed. For this reason we developed a new unipolar charger based on the indirect photoelectric diffusion charging of aerosol particles published by Bucholski and Niessner (1991).

The charger consists of an elliptically grooved, electrically grounded alumina block. In one focus of the ellipse an UV lamp ($\lambda = 254$ nm) is fixed to focus the photons on the surface of a non-porous, non-graphitized carbon rod in the second focus. The rod is covered by a quartz glass tube, where the aerosol gets sucked through. Inside of the tube a grounded metal grid is fixed to apply a weak electrical field. Due to the photoelectrical effect electrons get emitted from the surface of the rod and create ions by attachment processes with the oxygen molecules in the mixing air. Due to diffusion the electrons can collide with the aerosol particles and charge them in the usual way.

This method seems to be very stable over a long time period and shows no performance loss because of the totally chemical inert surface of the rod. Beside this fact the charging efficiency shows up to be sufficient high for a practical use. Together with a spark discharge generator, DMA and an electrometer a reproducable calibration and validation system for commercial particle number measurement systems can be provided.

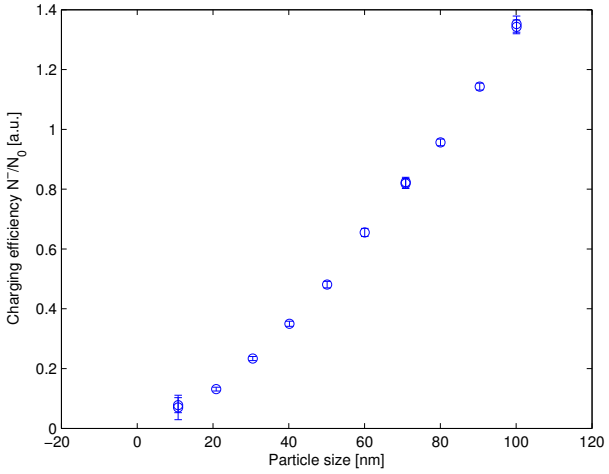

Figure 1: The size dependency of the charging efficiency of the indirect photoelectric diffusion charger for a spark discharge aerosol (GFG 1000, Palas, Germany).

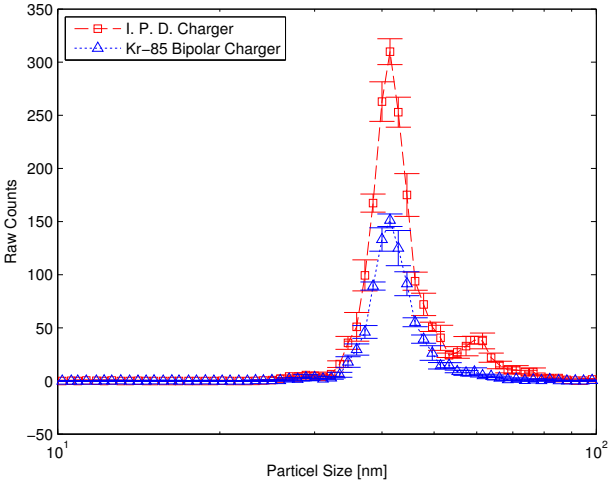

Figure 2: A comparison between the indirect photoelectric diffusion charger and a new Kr-85 bipolar charger (350 MBq) for a 41 nm spark discharge aerosol measured by a SMPS.

Bucholski, A., Niessner, R. (1991) *Journal of Aerosol Science* **22**, 111–115.