Towards standardized measurements of atmospheric aerosol particle number concentration

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Keywords: Standardization, number concentration, fine particles, CPC

Regulatory measurements of atmospheric aerosol particle concentration are to this date all based on measuring the mass of the particles. Ultrafine particles (diameter below 100nm) have insignificant contribution to the total mass of particles. The growing awareness of the importance of the ultrafine particles has raised a question of measurement metric of atmospheric particle concentration. Instead of mass, aerosol number concentration should be measured. Technology for particle number concentration measurement has been available commercially from 1980 (McMurry, 2000). Condensation particle counters grow particles using condensation of a working fluid (e.g. n-butanol) to increase the particles size up to optically detectable sizes, and then counts them individually by using laser particle counting method.

In order to measure particle number concentration of atmospheric aerosol in accurate and reproducible manner a standardized method is needed. This method is being developed by CEN / TC 264 / WG 32. The scope of the work is to describe standard method for determining the particle number concentration in ambient air in the range up to about $10^7$ cm$^{-3}$ for averaging times equal to or larger than 1 min. The size range of the measurement is from 7 nm up to a few micrometres in particle diameter.

The standard method describes both particle sampling and counting. The counter should have 50% lower cut-off limit of 7 ± 1 nm and use n-butanol as a working fluid. Detection efficiency should exceed 90% at < 14 nm and the upper limit should be above 1000 nm ± 100 nm. The CPC should be able to measure concentrations between lower limit of 10-100 cm$^{-3}$ up to upper limit of at least 10 000 cm$^{-3}$ with a slope of 1 ± 0.05. The dynamic range should be at least 3 orders of magnitude and the response time should be below 5 s.

The sampling in the standard method takes into account the relative humidity of the sample, diffusion losses for 7nm particles and the particle concentration of the sample. The relative humidity should be kept lower than 40%. Three cases should be considered with respect to the temperature conditions: 1. if the room temperature is higher than 22°C no aerosol dryer is needed if the ambient dew point never exceeds 10°C, 2. if the dew point is between 10°C and the room temperature, the instrument flow shall be dried, 3. in case that the dew point temperature is above the room temperature, the sample flow shall be dried before entering the room. The total losses for 7nm particles in the total sampling system should be less than 30%. Dilution should be used if without dilution the CPC would be in the photometric measurement mode.

The standard describes a list of test and measurement procedures that should be taken into account while performing standardized measurements. They include all the important parameters that will affect the total accuracy and reproducibility of the measurement. The standard includes variety of quality assurance and quality control procedures to ensure high quality measurements. Also some informative information about the data reporting is given based on the EUSAAR project.