EECPC—EXPLAINING THE K-FACTOR (CONCENTRATION CORRECTION MULTIPLIER)

APPLICATION NOTE EECPC-003

The Engine Exhaust Condensation Particle Counter, TSI Model 3790, is used as integral part of various PMP-compliant engine exhaust particle number concentration measurement systems for Euro 5 regulations.

The EECPC is a full flow particle counter, enlarging single ultrafine particles via a condensation process to single butanol droplets which can be easily detected in laser optics. Each single ultrafine particle is counted individual in a concentration range up to 10,000 p/cm³. The Model 3790 has a lower particle size detection limit of greater than 20 nm to meet the PMP's requirement for eliminating measurement of volatile and semi-volatile nanoparticles formed by nucleation of gaseous compounds.

Like other condensation particle counters the detection efficiencies are calibrated using monodisperse classified test aerosol. The reference instrument used for concentration response calibration at TSI is a Faraday cage aerosol electrometer (FCAE, TSI Model 3068B). For each EECPC calibrated at TSI, a correlation analysis is made. The result of this analysis is a linear regression ($C_{EECPC}=a*C_{FCAE}$) of the EECPC concentration measurement versus the concentration derived from the electrometer measurement. The slope (a) of this linear regression is reported in the calibration certificate. Reg 83 requires this slope to be within $0.9 < a < 1.1$.

The particle concentration detected is reported in 1/cm³. This needs to be converted to particles per km for certification testing according Reg 83. The conversion formula contains a k-factor, defined as calibration factor to correct the particle number counter measurements to the level of the reference instrument. This factor can be applied either internally within the EECPC or externally during the data conversion.

The EECPC offers the option to use the concentration correction multiplier (CCM, or k-factor in Reg83) implemented in its firmware. The factory setting for the CCM is 1.00, which is meant for external application of the k-factor. Every time the unit is serviced at TSI the CCM will be set back to 1.00. The service procedure at TSI ensures that the EECPC will be within PMP specifications ($0.9 < a < 1.1$). The calibration certificate reports the slope (a) of the regression analysis; CCM=1/a may be used as k-factor for internal correction of the EECPC's concentration measurement.

The EECPC firmware allows settings for the CCM between 0.5 and 2.0. Particle concentrations are internally multiplied with the CCM factor. Other data reports like raw counts are not affected.

Example: A calibration certificate reports that a particular EECPC unit reads 5% lower than the reference instrument (slope a = 0.95). The CCM could then be set to 1 / 0.95 = 1.053.

The CCM can be changed via serial command SCCM (set the concentration correction multiplier).

Example: SCCM,1.053

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