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Comparison of Horiba PN-PEMS with Laboratory grade PN systems

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Euro VI regulations require Particle number (PN) measurement for engine certification as well as in-use conformity. PN-PEMS developed for in-use testing are conceptually like PN instruments (AVL Particle Counter, Horiba SPCS etc.) for laboratory testing which are based on PMP protocol. The only difference is that PN-PEMS are allowed to have corona discharger for counting particles in addition to condensation particle counter (CPC). Recent studies have shown up to $\pm 50\%$ difference for corona discharger based PN-PEMS but much better correlation with the CPC based PN-PEMS. Thus, Cummins selected CPC based Horiba OBS-ONE PN-PEMS for demo at Cummins Technical Center, Indiana where it was evaluated against different units of AVL Particle Counter at CVS and RAW sampling locations.

This study was divided in two phases. In the first phase, Particle numbers were measured from the same location at the Constant volume sampling (CVS) tunnel. For this, Cummins 6.7 L, 10 L and 13 L engines were used. Brake-specific Particle Number (BSPN) levels of 10^{10-11} and 10^{13} were generated by selecting Cummins engines equipped with DPF or without DPF in aftertreatment systems. Horiba PN-PEMS reported $14 \pm 12\%$ lower BSPN on an average from 82 various test cycles for the PN levels of 10^{10-11} . This data also showed the ability of the PN-PEMS to accurately report BSPN at lower levels which has been an issue with corona discharge based PN-PEMS. In case of engine out BSPN levels (10^{13}), PN-PEMS on an average reported $8 \pm 7\%$ lower than AVL 489 units for 66 test cycles. The short-term repeatability and reproducibility of the PN-PEMS was also evaluated with the non-DPF engine and would be reported in the presentation. In the second phase of this study, PN-PEMS was measuring from the raw location and AVL 489 was measuring from partial flow sampling systems. For 53 different test cycles of 10^{10-11} BSPN levels, Horiba PN-PEMS recorded $14 \pm 12\%$ lower numbers than AVL Particle Counter. Which shows similar results as CVS measurement. During 11 FTP cycles' engine out measurements (BSPN 10^{13} level) from raw location, PN-PEMS had $26 \pm 6\%$ lower numbers, which shows higher difference than other studies. From more than 200 various test cycles data, overall study suggests $12 \pm 11\%$ lower measurement of Horiba PN-PEMS compare to PMP systems. Among them, 75% measurements were within $\pm 20\%$ range of PMP systems.