Application note

Negative Precharger in Emission measurements

! For correct use of Pegasor M -sensor (PPS-M) or Mi3, please read carefully product manuals and Application note for general engine emission measurements.

Background

Pegasor particle measurement technology relies on escaping current technology. The current signal is the difference between current leaving the sensor (as ions attached to particles) and current coming into the sensor. Normally an aerosol is net neutral, or very close to it, meaning we can disregard the incoming current. Some aerosol processes, however, produce strongly charged aerosols, or ions, which can distort the signal in some cases.

Figure 1 shows charged ions below the 23 nm cutoff band, which causes weaker signal from the particles above the cutpoint, or even negative signal, when there are very few larger particles.

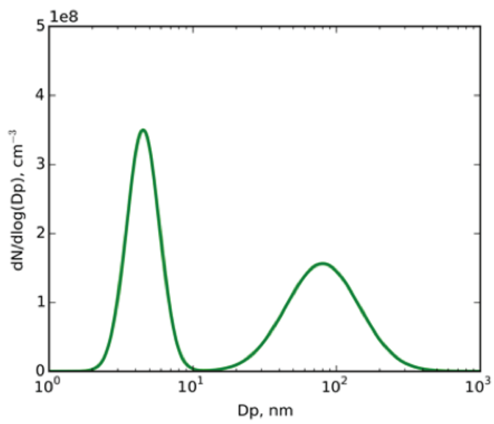

Figure 1:
Particle size distributions with small charged particles and ions, below cutoff size.

The technologies most prone to this behavior are modern Gasoline Direct Injection (GDI) engines as well as advanced diesel engines with Diesel Particulate Filter (DPF) and Selective Catalytic Reduction (SCR) systems with urea injection. A prerequisite for any charge or ion problems are very low signal levels in the first place, as high particle concentration dissipates and distributes the excess charge very rapidly.

Removing any ions and bringing larger particles to a known charge state removes the problem of ions or charged particles, and this is what the negative precharger is designed for.

Typical signs of charged particles are 1. Negative spikes in the data, especially at transients and 2. Slowly drifting, low signal values, in connection with level changes after transient.

Laboratory reference

Laboratory measurements were done with 50 nm DOS test aerosol to determine the user correction factor at different dilution ratios. Correction factor of 0.57 is recommended for use with Mi3 (Fig. 2). For standalone use with PPS-M, the added dilution fed through the PC dilutes the sample, which gives a slightly higher correction factor of 0.66.

For best accuracy when used with PPS-M it is recommended to measure the inlet flow of the PPS-M and set the user correction factor with:

$$CF = 0.54^{*} \frac{(Q\_Sample\ [lpm] + 1.0\ [lpm])}{(Q\_Sample\ [lpm])}$$

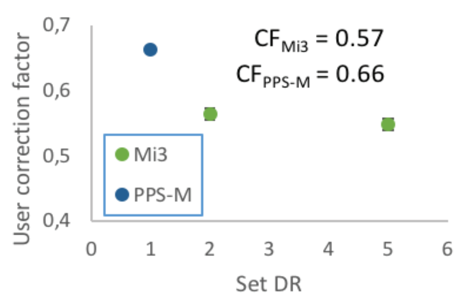

Figure 2:
User correction factor as determined by DOS test aerosol.

www.pegasor.fi

Address: Hatanpään valtatie 34 C
33100 Tampere
Finland

Tel. +358 10 423 7370
Vat reg FI2175488-0

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Case study: gas engine

Precharger was tested in a diesel-piloted gas engine with a simultaneous measurement without a Precharger to assess the charge state of the particle emission as well as the operation of the precharger (Fig 3).

The lowest signal (No precharger, corona off) is below -1 pA, while the highest signal without the precharger is below 1 pA. This means that in this application the net charge of the exhaust is substantial, and using precharger eliminates the charge effect, while using the corona gives a tool to estimate the charging level of the aerosol.

When corona is shut down on the sensor connected with precharger, the signal level drops to below 30% of the original, suggesting that large fraction of the heavily charged particles are below the 23 nm cut size.

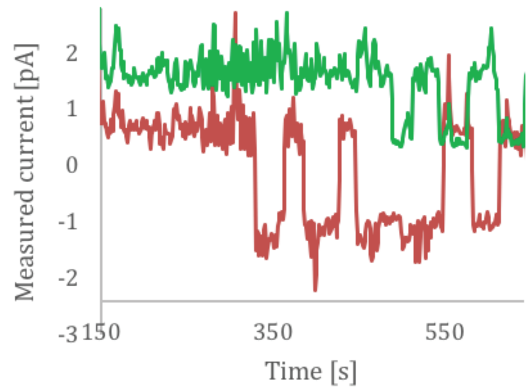

Figure 3:
Measured signals from sensors both with and without a precharger. PPS-M without precharger was deliberately shut down to noncharging state to show the charge effect of the emission.
Note the low signal levels in all cases.

Conclusion

Ions or strong charging of particles in emission can cause distorted signal when measured with PPS-M or Mi3, but generally there are easy ways to detect the problem and solve it.

Problems can arise when measuring very low signal levels in connection with some of the latest technologies in gas, gasoline or diesel engines, but in most cases there is no need for concern. Primary symptom is negative signal spiking at transient loads.

Precharge is an easy, plug and play system for Mi3 to solve charge related problems in emission measurement.

For further details, please contact Pegasor or your local supplier for further details and support.