Application note

Use of Pegasor M -sensor & Mi3 in GDI and GPF measurements
(Gasoline Direct Injection and Gasoline Particle Filter)

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

Background

PPS-M (used also in Pegasor Mi3 product) offers significant benefits when testing GPF-equipped vehicles. Competing measurement devices require complex sampling systems that are sensitive to sampling conditions and may cause considerable time delay and signal distortion. PPS-M overcomes these shortcomings.

PPS M is the world's fastest exhaust particle sensor that can be used in dilute (e.g. CVS) and raw (e.g. tailpipe) sampling. Low sensitivity to pressure and temperature fluctuations makes this the ideal instrument to measure particles directly at the exhaust line, thus decreasing costs and space requirements, leading to overall much higher productivity in the test cell.

Exhaust particles from GDI + GPF configurations are distinctively different than their diesel counterparts. Surface properties, morphology and size range of gasoline exhaust nanoparticles much more depend on fuel properties (e.g. alcohol blend), engine design (air guided or spray guided combustion) and aftertreatment configuration (TWC + GPF, 4WC, or other). As a result, techniques based on photoacoustic detection are prone to increased uncertainty due to their dependence on particle surface properties. Instead, PPS-M is based on diffusion charging and electrical detection of particles, which do not depend on surface properties. As a result, PPS-M much closer matches results of the regulatory PN measurement technique.

Below are some practical recommendations on how to use the PPS-M for sampling GDI exhaust:

1) PPS-M works at best when exhaust gas temperature is at the 100-300°C. This avoids water condensation and thermophoretic losses.

Extreme temperatures downstream of the GPF (often in excess of 700°C) may damage the sensor. In this case, a sampling line of sufficient length is required to decrease sample temperature to the recommended range, before this enters the PPS-M. A heated sample line (i.e. at 200°C) is recommended to decrease thermophoretic losses.

The sensor electronics temperature should be kept below 50°C to avoid noise to the measurement signal. Sufficient distance between sensor electronics and exhaust tube or thermal protection is recommended in case of extreme exhaust temperature.

Cold-start events in a GDI vehicle may produce condensed water that can block the sensor sample path. A heated line is also recommended in this case to keep the sample path clean. Installation of the inlet probe upwards can also prevent liquid collecting or pooling in the exhaust pipe from entering the sensor.

2) PPS-M sample flow is not prone to pressure fluctuations as long as the inlet and outlet are at the same pressure. Always remember to return the PPS-M outlet back in the exhaust line, at same pressure conditions that the inlet samples from.

Unlike other systems, the PPS-M can be used both when the tailpipe freely exhausts to the atmosphere or when connected to the CVS, that causes small underpressure.

Overpressure up to 1 bar can be handled by the sensor. This makes it possible to sample upstream of GPF as well. For higher overpressures – that are not expected in the exhaust line – a special calibration is required.

When using the PPS-M upstream of the GPF, its outlet needs also to be returned upstream of the GPF so that it is at the same pressure as the inlet. Retaining different pressure levels between the outlet and the inlet will not harm the sensor but it will affect the measurement quality.

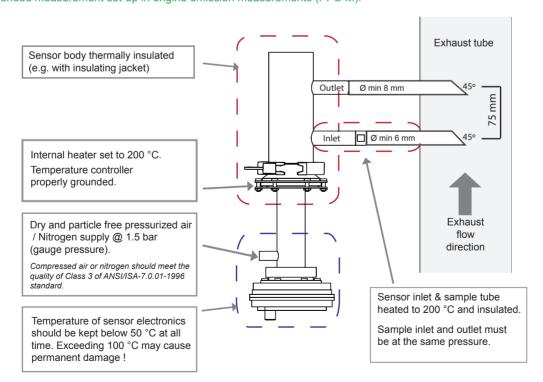3)   PPS-M operates on very small pressure difference between the inlet and the outlet. When this is used with a sampling line, it needs to be reminded that very long or thin sampling lines may throttle the flow and thus affect the measurement. Sampling lines of 2 m long and 8 mm internal diameter, without diameter change from the sampling tip to the sensor inlet are recommended. Sampling lines of high volume should be avoided to decrease signal delays and smearing.

4)   Nitrogen or synthetic air @1.5bar can ideally be used as a carrier gas for the PPS-M operation. Nitrogen makes sure that no oxidation further takes place after the sample has been drawn in the sensor. When laboratory-grade compressed air is used, this needs to be humidity, particle and free of any organics. Using Pegasor filter dryer unit to clean up PPS-M carrier gas is therefore highly recommended. The sensor calibration does not change regardless of whether nitrogen, synthetic air or compressed air is used.

5)   More than one PPS-M may be used in parallel along the exhaust and sampling line, e.g. in-between different aftertreatment devices and at the CVS to check the efficiency of individual systems. Before conducting such tests, it is advisable to connect all sensors to the same sampling point (e.g. all inlet sampling from the same point and all outlets exhausting at a nearby point, e.g. at the tailpipe) to make sure you read the same signal. The individual signals should not differ by more than 5% for steady state operation.

Recommended measurement set-up in engine emission measurements (PPS-M):

Sensor body thermally insulated (e.g. with insulating jacket)

Internal heater set to 200 °C. Temperature controller properly grounded.

Dry and particle free pressurized air / Nitrogen supply @ 1.5 bar (gauge pressure).

Compressed air or nitrogen should meet the quality of Class 3 of ANSI/ISA-7.0.01-1996 standard.

Temperature of sensor electronics should be kept below 50 °C at all time. Exceeding 100 °C may cause permanent damage !

Exhaust tube

Outlet   Ø min 8 mm   45°

75 mm

Inlet   Ø min 6 mm   45°

Exhaust flow direction

Sensor inlet & sample tube heated to 200 °C and insulated.

Sample inlet and outlet must be at the same pressure.

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