

**CAMBUSTION** Application Note DMS11

**Installation of DMS500 for Engine Exhaust Sampling**

**Introduction**

Sampling engine exhaust requires careful sample handling techniques to avoid compromising the measurement or damaging the instrument.

The DMS500 may be directly connected to an engine exhaust, including pre- or post-aftertreatment, with no requirement for further sampling accessories.

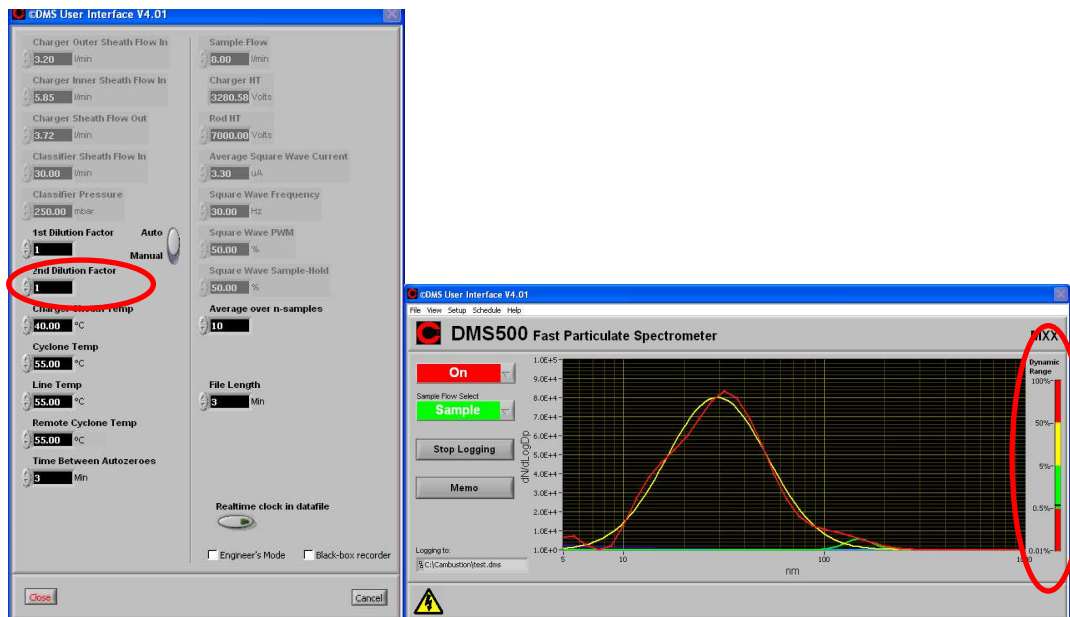


**1. Need for variable dilution**

The concentration of particles in engine exhaust varies widely, with extremely high concentrations encountered in engine-out Diesel exhaust. Downstream of a Diesel Particulate Filter these concentrations may be reduced by around a factor of 1000, and can even be lower than in the engine intake air. Gasoline exhaust particle concentrations often fall between these two extremes.

Once detected, particles remain inside the DMS500 until they are cleaned by the operator. To extend this cleaning interval, it is essential to dilute the incoming gas. Since the concentration varies, this dilution should be continuously variable.

The DMS500 provides two stages of dilution. The 2<sup>nd</sup> dilution stage may be varied in software to maintain good signal to noise, while maximising the cleaning interval. See the instrument manual for further information.

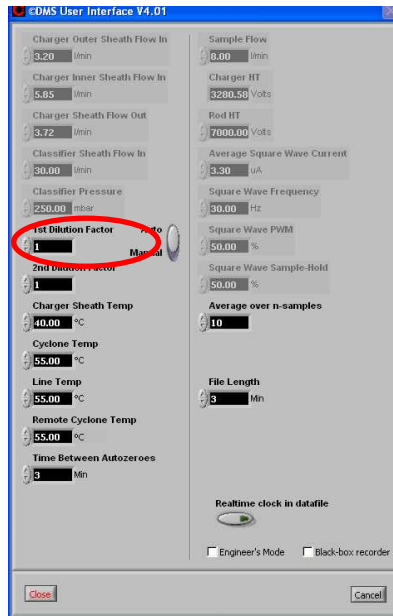


**2. Avoiding water condensation**

When operating on a hydrocarbon fuel, engine exhaust contains a significant proportion of water vapour. As the exhaust cools, this water will condense. For gasoline exhaust at  $\lambda = 1$  condensation will occur if the temperature falls below 55 °C. Since parts of the DMS500 operate at room temperature, water would condense inside the analyzer.

The DMS500 incorporates mass flow meters which can be permanently damaged (requiring replacement and recalibration) if water is allowed to condense inside the analyzer.

To prevent condensation the incoming engine exhaust is diluted with *dry* compressed air in the 1<sup>st</sup> dilution stage, which is controlled via the User Interface software.



For gasoline exhaust a 1<sup>st</sup> dilution setpoint of 5:1 must be used to prevent damage when sampling raw exhaust.

For diesel exhaust a 1<sup>st</sup> dilution setpoint of 4:1 must be used.

Refer to the analyzer manual for more information on each case.

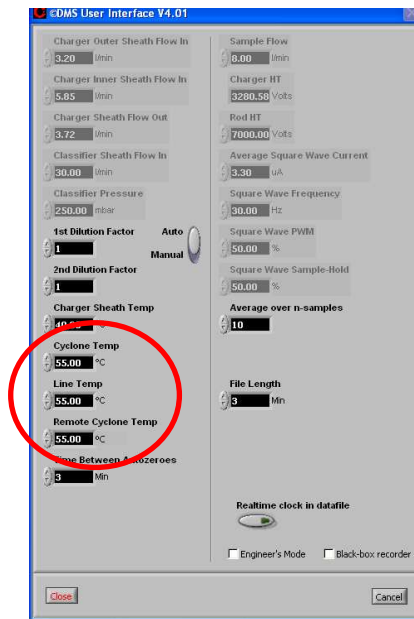
### 3. Preventing Particle Formation

Condensation of volatile compounds (e.g. hydrocarbons, sulphates) can cause the generation of new particles inside the sampling system (example condensing water vapour at the tailpipe on a cold day).

To prevent this, it is desirable to keep the sample gas hot until it reaches the analyzer. This is accomplished using an electrically heated sampling line, controlled from the User Interface software.

For gasoline exhaust sampling, a heated line temperature of 150°C is recommended. For Diesel exhaust a lower temperature of 80°C is usually sufficient.

For more information and advice on temperature setpoints refer to the analyzer manual.



#### 4. Connection to the exhaust

The intake end of the heated sample line will accept any Swagelok fitting with a 1/4 BSP thread. A tapered fitting is required to ensure sealing, but the fitting should *not* be of the bored through type.

Recommended fittings are either SS-400-1-4RT or SS-6M0-1-4RT.



Figure 1 Heated line with SS-6M0-1-4RT Swagelok fitted

The connection to the exhaust is by stainless steel tube. Since the flow from the exhaust is relatively low (typically 2 litres per minute) a 6mm or ¼ inch outer diameter tube is recommended. This tube should be around 150mm or 6 inches long.

An appropriate Swagelok fitting welded into the exhaust will allow easy installation / removal of the line, and can be blanked off when the analyzer is not being use. This fitting *should* be of the bored through type, to allow the sampling tube to protrude into the exhaust (see Figure 4).



Figure 2 Swagelok fitting welded into exhaust, with blanking plug fitted

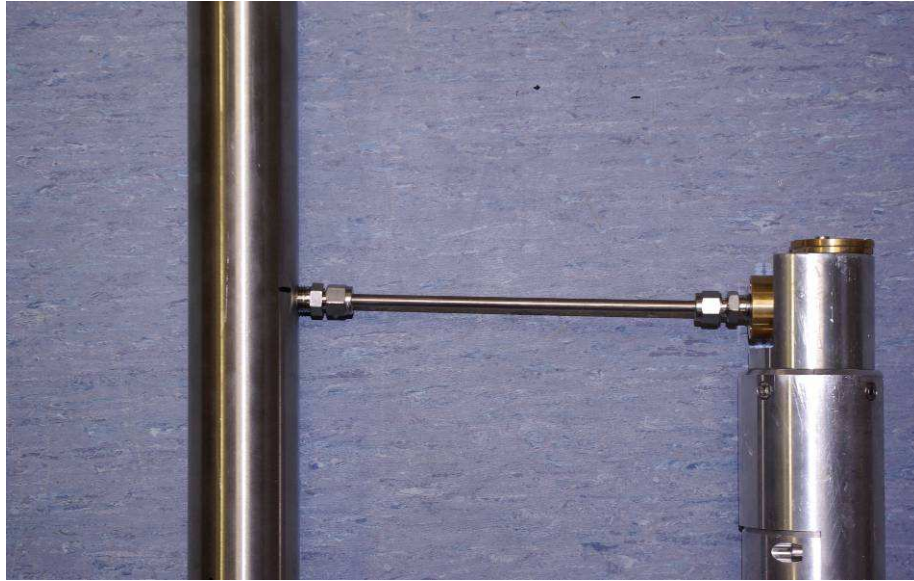


Figure 3 Heated sample line connected to exhaust

When selecting the sample point in the exhaust, insert the probe into the bulk flow of the exhaust, rather than sampling from the wall. Otherwise cooling of the exhaust at the walls and condensation / loss of particles may produce incorrect results.

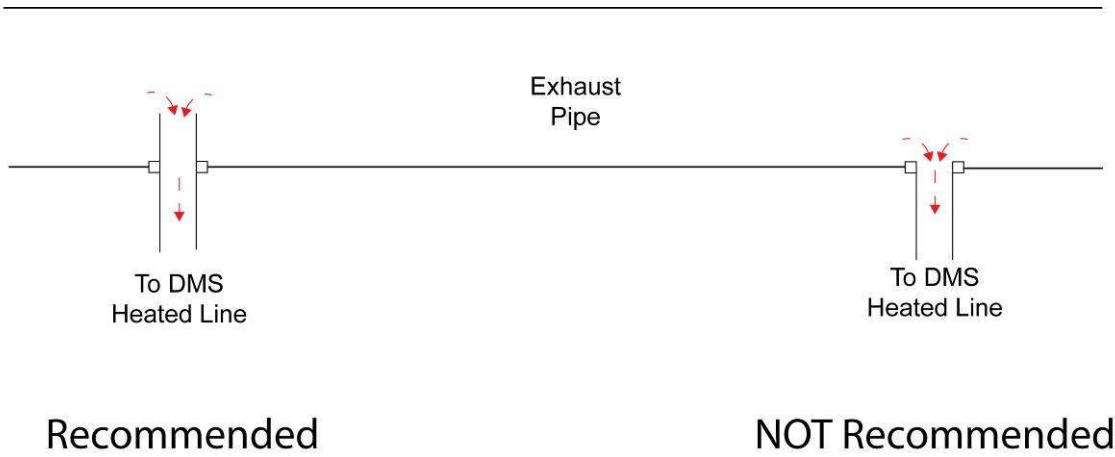


Figure 4 Installation of Swagelok / pipe in exhaust