Direct Sampling of Engine Exhaust with the DMS500

Introduction

Sampling engine exhaust requires careful sample handling techniques to avoid compromising the measurement or damaging the DMS500.

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 removed by cleaning. 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.

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 the stoichiometric air fuel ratio (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 1st dilution stage, which is controlled via the User Interface software.

The air supplied from the test bench must be oil free, and have a dew point of -3°C or lower. ISO 8673 Class 1.4.1 or better.

The 2nd dilution stage may be varied in software to maintain good signal to noise, while maximising the cleaning interval.

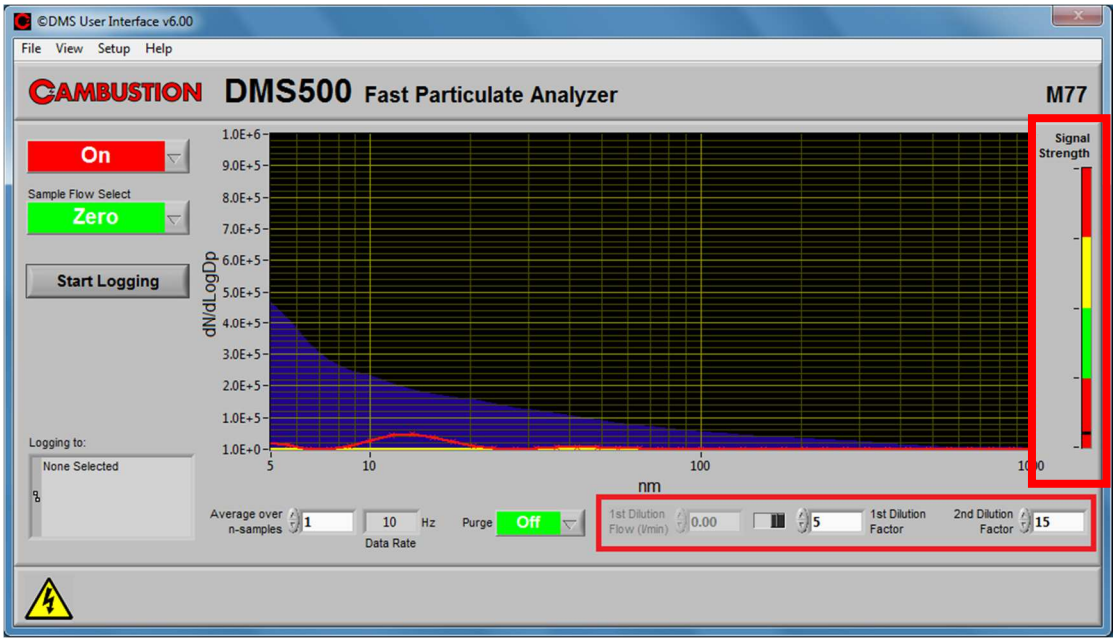

Figure 1 1st and 2nd dilution factor settings and Signal Strength indicator

See the instrument manual for further information.

2. Avoiding water condensation

For raw engine exhaust a 1st dilution factor of 5:1 must be used to prevent damage.

Contact Cambustion if fuels with a higher water production in combustion (e.g. methane, ethanol) are to be used.

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.

A temperature of 150ºC is recommended for both the Remote Cyclone and Heated Line.
A temperature of 80ºC is recommended for the Sample Block.

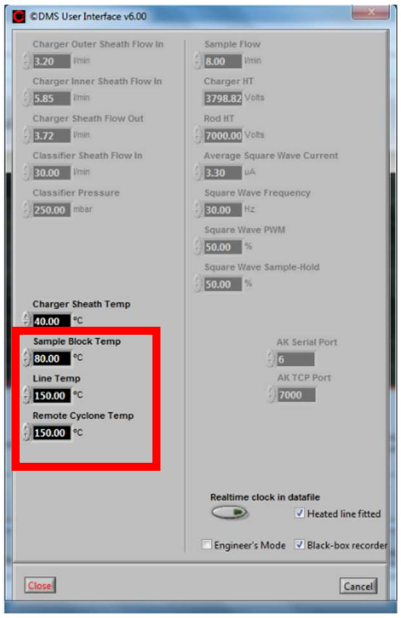

Figure 2 Temperature setpoints

4. Connection to the exhaust

The intake end of the heated sample line will accept any Swagelok fitting with a ¼ BSP thread.

A tapered fitting is required to ensure sealing, but the fitting should *not* be of the bored through type.

PTFE tape should be applied to the threads to ensure sealing.

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

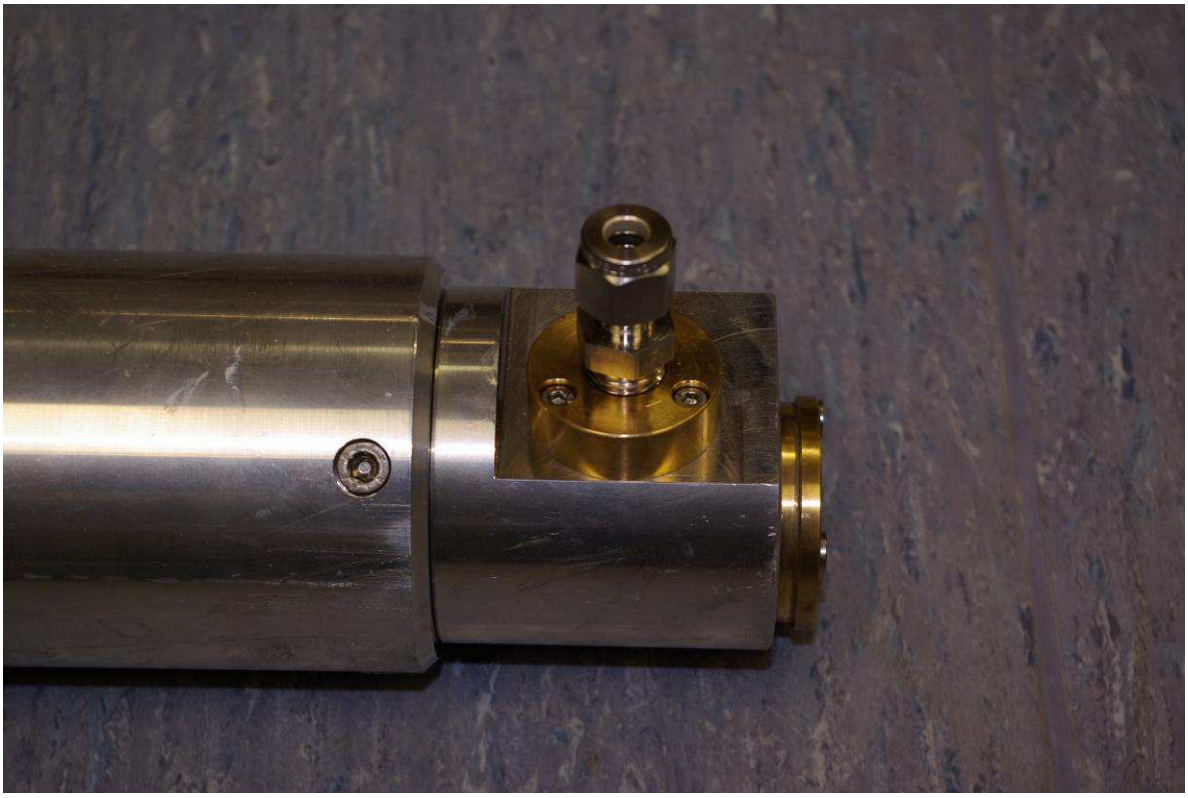

Figure 3 Heated line with SS-6M0-1-4RT Swagelok fitted

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 maximum 200mm or 8 inches in length.

Longer pipe runs, in particular unheated pipes run under a vehicle on a chassis dynamometer, will lead to condensation. This can damage the DMS500 and will affect the quality of the data.

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 6).

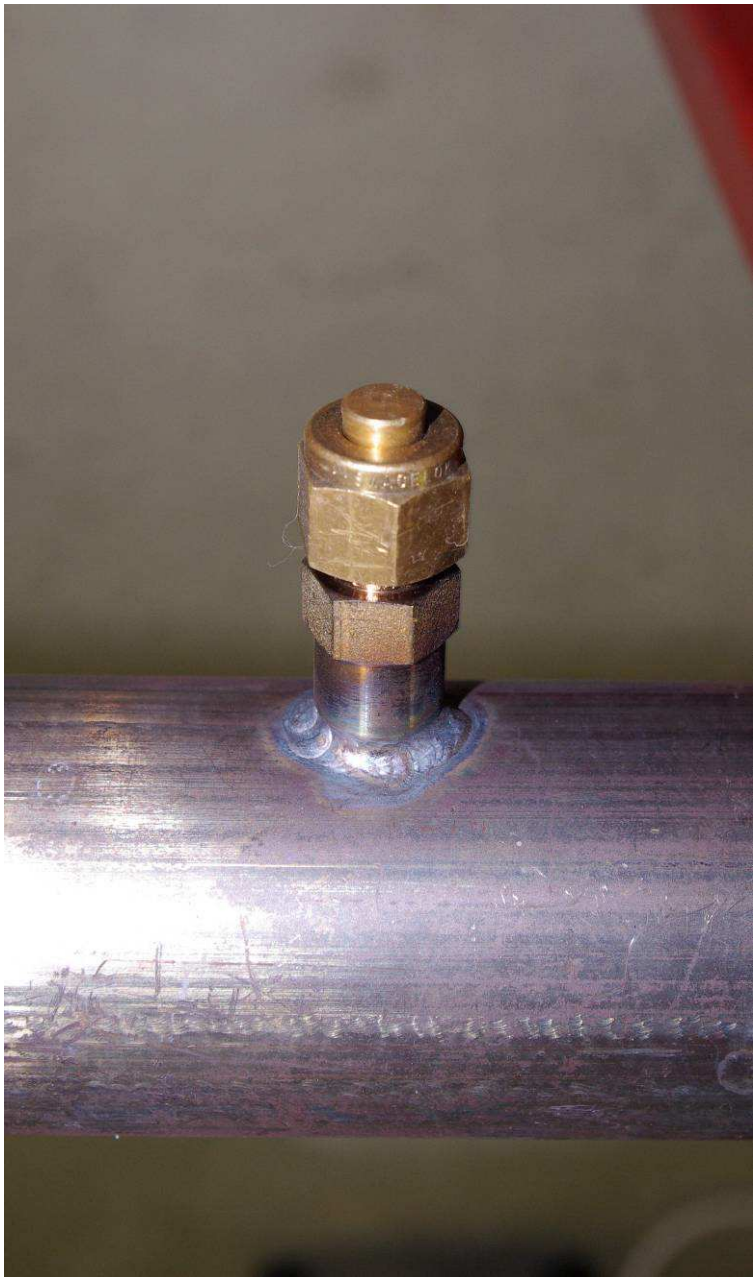

Figure 4 Swagelok fitting welded into exhaust, with blanking plug fitted

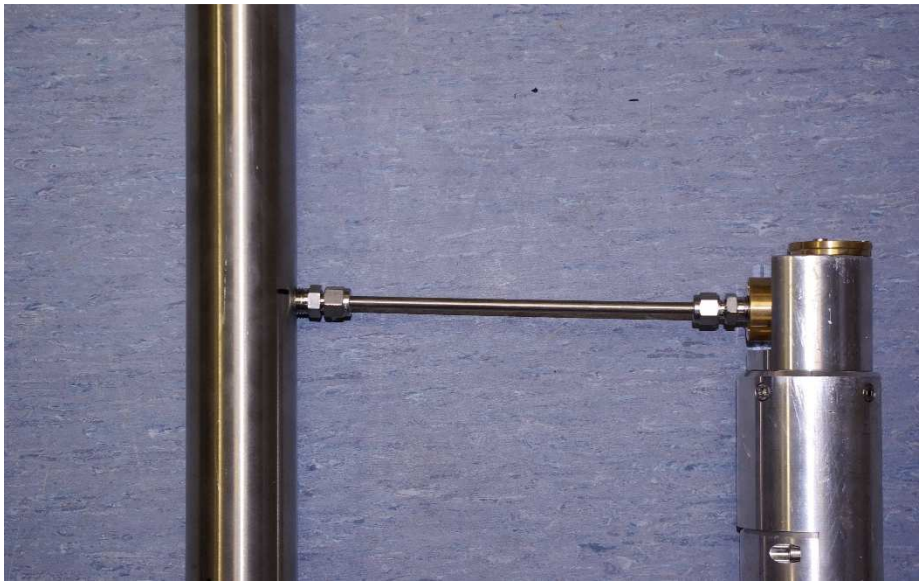

Figure 5 Heated sample line connected to exhaust

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.

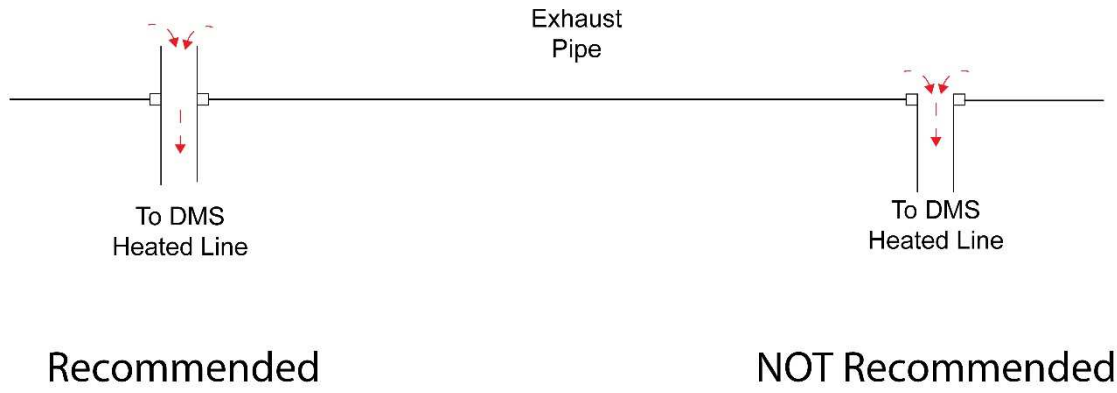

Figure 6 Installation of Swagelok / pipe in exhaust