



Technical Support Note

Title: Using a Hard Seal Exhaust Port for Improved Diagnostics

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Overview:

The purpose of this document is to provide some general guidelines regarding the effects of air dilution in the exhaust gas sample, its prevention by using a hardseal gas port for access of exhaust gas upstream from the tailpipe, and the collateral diagnostic benefits from having direct port access to exhaust gas before and after the Catalytic Converter on closed-loop systems.

Exhaust Gases – Principle of Combustion:

The purpose of the engine is to use the oxygen in ambient air (about 21%) to oxidize the hydrogen and carbon atoms in the fuel – producing heat as a result, and then to use this heat to create mechanical power. To do this, the engine intakes ambient air, mixes it with the correct ratio of fuel, intakes it into the cylinder, ignites it, and uses the heated expanding gas to create power. The air/fuel mix is balanced by the carburetor or fuel injection control system so that there should be just enough oxygen in the combustion gas charge to burn all of the fuel in it. A perfectly balanced air/fuel mixture (exactly enough oxygen to combine perfectly with the fuel) is called Stoichiometric – and spark-ignited engines seek to maintain air fuel mixtures close to stoichiometric throughout the range of rpm and power settings, independent of the fuel being used.

The complete oxidation of hydrogen produces H₂O (water) and the complete oxidation of carbon produces CO₂ (carbon dioxide) – so these are generally referred to as the ‘natural’ products of combustion. Most of the water vapor in the exhaust condenses into liquid water and the rest remains a vapor and is not measured by the gas analyzer. The Carbon Dioxide remains a gas and is measured by the analyzer, so it is a good indicator of combustion.

Getting an undiluted exhaust gas sample – how to look for air dilution:

Often it is difficult to get an undiluted exhaust gas sample from the vehicle tailpipe for analysis – due to low exhaust gas volume and pulsations at low rpm’s, insufficient or difficult probe insertion, or an extraneous air leak. However, the levels of O₂ and CO₂ in the measured gas often can be used to determine the relative amounts of exhaust gas to ambient air in the gas sample that is actually being delivered to the gas analyzer.

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Ambient air has about 20.6% O₂ and 0.1% CO₂ in it, while pure exhaust gas has 1.0% or less O₂ and 15.0% (Gasoline) or 12.0% (LPG) CO₂ in it. This extreme difference in the relative amounts of O₂ and CO₂ in the two gases can be used to tell how much of the gas being measured is real exhaust gas and how much is ambient air. These relative ratios determine how much air dilution is present. Almost all air dilution comes from the use of tailpipe gas sampling and can be prevented by the use of a Hard Seal Exhaust Port located upstream of the tailpipe, where it is isolated from the ambient air.

Additional benefits of Direct Port access in closed loop systems:

Tailpipe exhaust gas, even if it is undiluted, often does not show the diagnostician what the state is of the engine-out gases in a closed loop system with a Catalytic Converter. The Catalytic Converter modifies the engine-out gases, so he is seeing the result of the Engine/Catalytic Converter combination – and neither one alone. The ability to install a gas sampling port before the catalytic converter as well as after it buys two benefits:

1. The port before the Catalytic Converter is true engine-out gases, and only reflects the engine operating characteristics. This means the engine performance can be isolated and observed.
2. The Catalytic Converter performance can also be isolated and observed – as the gases above are also the Catalytic-Converter-In gases. By comparing the gas contents of the two ports, the Catalytic Converter oxidation and reduction performance can be assessed.

How to Assess Air Dilution in the sample gas:

When the probe is first inserted in the exhaust pipe (engine running), you should expect to see the indicated O₂ reading go down from 20.6% to 1.0% or less within about 10 seconds. If the O₂ level does not go down low enough – but stabilizes at a higher than expected reading, this is an indication that air dilution exists, and the level of air dilution can be determined by multiplying the excess O₂ reading (subtract the normal O₂ reading from the indicated O₂ reading first) by 5%. A good number to obtain is less than 10% air dilution, or less than 2.0% excess O₂ in the gas being measured. If you see more than this, you should correct it by installing a Hard Seal Exhaust Port before the tailpipe.

The Benefits of Bridge P/N 001183 Hard Seal Exhaust Port:

The installation of a Hard Seal Exhaust Port (e.g. Bridge P/N 001183) allows exhaust gas to be sampled without concern about air dilution. The location of the port can be established by the technician so that he has tool access to the exhaust system for port installation and so that he can easily attach the flexible sample line to the port adapter. The port is installed by drilling a 10MM hole in the exhaust pipe, and crimping a 6MM nutsert into the hole. A 6MM adapter is then screwed into the nutsert, and the Hard-Seal

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braided flexible line attached. After testing, the flexible line and adapter are removed, and the gas port sealed with a 6MM bolt and washer – and the port remains installed for later access.

This method totally removes the chance for air dilution, and allows for much greater accuracy in engine tuning. It then makes the built-in Lambda (Air Fuel Ratio) and Combustion Efficiency calculation capabilities built in the Bridge Model 9004 and 9005 Series much more accurate – as well as increasing the credibility of the CO and HC readings on the Bridge Model 9003, 9004, and 9005 gas analyzers.

Using a Hard Seal Exhaust Port – while understandably a less simple approach than using a tailpipe probe – greatly improves the performance of gas analysis for engine tuning and diagnosis, as well as isolating the Catalytic Converter for enhanced diagnosis - resulting in much more credible and repeatable gas concentrations.

We have commonly had real cases of 20% to 50% air dilution and post-CAT gas diagnosis that hid many engine issues – so this is truly a large and unrecognized problem in the field, and we strongly recommend that a Hard Seal Exhaust Port similar to those found in P/N 001183 be used in all cases where precision tuning or engine / CAT diagnosis is required.

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