

Standards Development and Technical Support Report

Motorcycle Tailpipe Dilution CVS Study

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Abstract

The motorcycle exhaust dilution system has been evaluated for water condensation and its ability to maintain static pressure variations within ± 0.25 kPa as measured at the tailpipe of a test vehicle. After multiple runs over the Urban Dynamometer Driving Schedule with a large displacement motorcycle, virtually no water condensation was observed in the system and the static pressure variations ranged from -0.14 to -0.13 kPa.

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Introduction

In the process of diluting motorcycle exhaust prior to entry into the Constant Volume Sampler (CVS), two requirements must be met as described in §86.509 (b) and (c) of the motorcycle regulations: 1) static pressure variations at the tailpipe of a vehicle tested by EPA must be capable of remaining within ± 0.25 kPa of the static pressure variations measured during a dynamometer driving cycle with no connection to the tailpipe, and 2) the location of the dilution air inlet shall be placed and the flow capacity of the CVS shall be large enough to virtually eliminate water condensation in the system. A new exhaust dilution system has recently been designed and built for use in motorcycle testing at EPA. Prior to being put into use, it was necessary to determine if the new system was capable of meeting the above requirements. The purpose of this report is to describe the findings of that study.

Summary and Conclusions

--Static pressure variations at the tailpipe of the test vehicle remain within -0.14 and -0.13 kPa of the static pressure variations at the tailpipe during the urban driving schedule. This is well within the closest tolerance specified in the motorcycle regulations.

--Virtually no water condensation was observed in the exhaust dilution system after multiple testing of a large motorcycle over the Urban Dynamometer Driving Schedule.

Discussion

The objective of this study was to evaluate the exhaust dilution system presently used in the motorcycle test cell. This evaluation stemmed from two requirements as specified in the motorcycle regulations regarding the dilution system.

A) Sections 86.509(b)(1) and (c)(1) state that the static pressure variations at the tailpipe of the vehicle tested by EPA must be capable of remaining within ± 0.25 kPa of the static pressure variations measured during a dynamometer driving cycle with no connection to the tailpipe.

B) Sections 86.509(b)(4) and C(4) state that the location of the dilution air inlet shall be placed and the flow capacity of the CVS shall be large enough to virtually eliminate water condensation in the system.

A. Static Pressure Variation

The static pressure variations were evaluated using a 15 cm. long stainless steel tube connected directly to the test vehicle's tailpipe. The test vehicle was a two-stroke, three cylinder, Suzuki GT-750 displacing 738cc.

Both the positive displacement pump constant volume sampler (PDP-CVS) and the critical flow venturi constant volume sampler (CFV-CVS) were used. The exhaust dilution system is depicted in Figure 1.

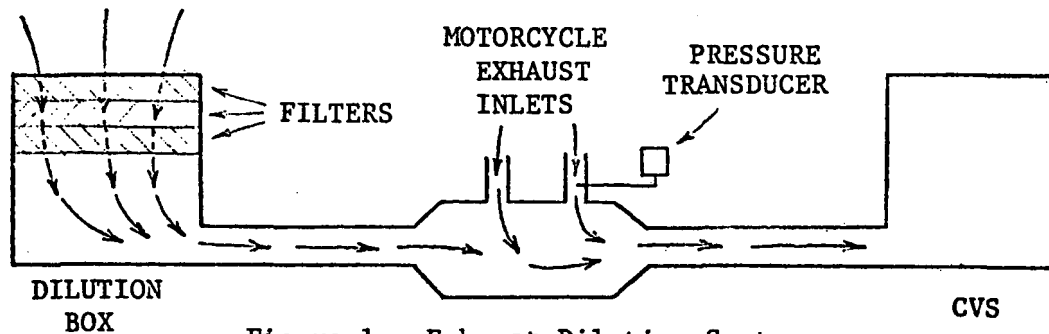


Figure 1 - Exhaust Dilution System

The static pressure at the tailpipe of the test vehicle with no connection (other than the short measurement tube) ranged from 0.00 kPa at idle to a maximum of +0.02 kPa during high RPM acceleration. Initially during this evaluation the static pressure at idle was about -0.29 kPa which is outside of the desired minimum static pressure of -0.25 kPa. After modifying the flow path in the dilution box, with the tailpipe connected to the dilution system and the CVS pump turned on, the static pressure ranged from -0.14 kPa at idle to -0.11 kPa during high RPM acceleration. Therefore, the difference in static pressure variations ranged from -0.14 to -0.13 kPa which is well within the ± 0.25 kPa tolerance that EPA must be capable of maintaining. This is summarized in the following table.

Difference in static pressure (in kPa) between operation
with and without exhaust system connections

	Necessary capability of EPA	At Idle with re- stricted flow path	During Driving schedule after modifying flow path	Without motorcycle connected and after modifying flow path
PDP-CVS	± 0.25	- 0.29	- 0.14 to - 0.13	- 0.14
CFV-CVS	± 0.25	- 0.29	- 0.14 to - 0.13	- 0.14

This table also includes a static pressure reading with the CVS pump operating and with the motorcycle tailpipe connection point blocked. This was done because the static pressures in the system were below atmospheric and by introducing exhaust volume into the system, this acted to reduce this difference. This procedure was necessary to simulate a small displacement motorcycle with a very low exhaust volume flow rate. Even under such conditions the exhaust dilution system is within the desired static pressure tolerance.

B. Water Condensation

Using the test vehicle, five sequential urban driving schedules were performed. Though water condensation was observed in the tailpipe connectors, virtually no condensation was observed in the exhaust dilution system or in the cyclonic separator of the CFV-CVS.

Recommendation

When an exhaust dilution system is designed for use in motorcycle testing, it is recommended that the design consider both the potential for water to condense in the system and flow restrictions which could significantly reduce the static pressure as measured at a test vehicle's tailpipe.

After installation of a new dilution system, pressure tests should be performed to assure compliance with the requirements specified in §86.509 of the motorcycle regulations.