GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW14379

Tuning Element Condensate Expulsion Test

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. The purpose of this standard is to determine the condensate expulsion performance of exhaust tuning element systems.

1.2 Applicability. This test procedure is applicable to all exhaust systems. It may also be applied to other exhaust system components (e.g., exhaust gas heat recovery units). In such a case, required modifications of the test set up, test conditions and test criteria shall be defined in the component's specification.

1.3 Remarks. Residual condensate in a tuning element may have a significant effect on its performance. Disturbing clunk or slosh noise may be a direct consequence of accumulated condensate. Accelerated corrosion of the lower tuning element wall or of tuning element internals may be the long term result.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

70/220/EEC

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- Component Technical Specification (CTS)
- Drawing IP64090250
- Subsystem Technical Specification (SSTS)

3 Resources

3.1 Facilities. Calibrated vehicle exhaust emissions roller test stand or equivalent test bench which is capable to run the specified driving cycle.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Instrumentation and recording equipment for the documentation of all test parameters.

3.2.2 Scale with an accuracy of ± 1 g or smaller.

3.3 Test Vehicle/Test Piece.

3.3.1 Test Vehicle. The test vehicle shall be equipped with a representative underbody and engine. It is recommended that the engine calibration level is 65% or higher. Design Release Engineer (DRE) and Validation Engineer shall approve any deviation.

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3.3.2 Test Piece. A new exhaust system is required. The risk for condensate accumulation in an exhaust tuning element depends on various factors like exhaust gas temperature, tuning element design, drain hole, etc. GM DRE and GM Validation Engineer shall mutually decide which tuning elements in an exhaust system shall be investigated during the test. If the exhaust assembly size exceeds the capabilities of the test facilities (e.g., the scale) the test sample might be equipped with additional connectors (e.g., flanges) at appropriate locations in the exhaust assembly. It must be ensured that this test sample modification does not affect the test result.

3.3.3 Test Fuel. If a tuning element design is being used with more than one type of fuel the different fuels shall be compared regarding condensate generation. The fuel which is expected to generate the largest amount of condensate shall be selected for this test.

3.4 Test Time.

Calendar time:	1 day
Test hours:	8 hours
Coordination hours:	2 hours

3.5 Test Required Information.

3.5.1 Driving Schedule.

3.5.1.1 Driving Cycle for Conditioning of Test Samples. Extra urban operating cycle, reference Table A3, Appendix A.

3.5.1.2 Driving Cycle for Condensate Expulsion Testing. The driving cycle in Appendix A, Table A1 is to be used for global vehicle programs. For applications dedicated to the European market driving cycle, Table A2, Appendix A, should be chosen. Regions apart from Europe or China could require an alternative driving cycle as a basis for this test. The responsible DRE shall choose the appropriate driving cycle and should document this in the Subsystem Technical Specification (SSTS), in the section titled, Condensate Discharge Provision.

3.5.2 Fuel. Fuel specifications for the affected vehicle applications.

3.6 Personnel/Skills. Technician basic skills needed:

- Ability to perform exhaust component changes
- Skilled in test bench usage and roller dyno

4 Procedure

4.1 Preparation.

4.1.1 Determination of the Maximum Allowable Condensate/Mass Volume. The maximum volume of allowable condensate after test run end, must be determined from the three-dimensional (3-D) data. The volume can be used to easily estimate the maximum allowable mass increase.

Exhaust system must be in vehicle position. For detailed description see Component Technical Specification (CTS).

4.1.2 Test Part Mass. The exhaust tuning element system shall be weighed before and after conditioning per 4.1.3 to verify that it is free of residual condensate, water absorbing oils, etc., prior to testing per 4.3. The measuring equipment (e.g., sensors, electrical connections) shall be attached properly to the test sample in order not to affect the measurement result.

4.1.3 Conditioning of Test Samples. Test vehicle and test pieces shall complete three (3) consecutive driving cycles as defined in 3.5.1.1. After conditioning, test pieces shall be dried with hot air, Temperature of Gas-flow (T_{gas}) at +100 °C, for 30 minutes to ensure test pieces are free of residual condensate, water absorbing oils, etc., prior to testing according to 4.3.

4.1.4 Test Setup. The test vehicle shall be set up on an exhaust emissions roller test stand or equivalent. The installation position and orientation of the exhaust system shall be representative. The exhaust system shall be equipped with sensors according to 4.1.1.

4.2 Conditions.

4.2.1 Environmental Conditions. Test cell ambient temperature shall be +25 °C ± 5 °C, consistent with 70/220/EEC.

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4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions. Consecutive driving cycles according to 3.5.1.2 shall be run. It is expected that during the first phase of the test, condensate is accumulating in the tuning element(s). While the test is being continued, the exhaust system is heating up and condensate will be evaporated or discharged through the tailpipe. The test shall be continued until 25 minutes have elapsed.

4.3.1 The material surface temperature and speed of the test vehicle shall be recorded.

4.3.2 Test cell ambient temperature, humidity and atmospheric pressure shall also be recorded.

4.3.3 The tuning element assembly shall be weighed directly after completion of the test. It shall be ensured that the measuring equipment attached to the test sample is the same as during the initial measurement according to 4.1.2. The measuring equipment (e.g., sensors, electrical connections) shall be attached properly to the test sample to ensure a correct measurement. The tuning element system shall be removed from the test vehicle carefully, in order to keep the condensate inside of the test sample. The purpose of this measurement is to identify condensate that may have accumulated in E-glass (glass fiber) fillings of the investigated tuning element.

4.3.4 Alternative methods to identify condensate in the tuning element require the approval of the GM DRE and GM Validation Engineer.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. The test sample must not contain any condensate at the end of the test. The test is being considered as passed if all humidity sensors indicate **dry** and if no remaining condensate can be identified by weighing the test sample.

5.3 Test Documentation.

5.3.1 Summary of Test Results and Rating. Overall rating of test results (OK, Not OK (NOK)) shall be shown on the first page. The test specification as well as any deviation from this procedure shall be described.

5.3.2 Test Sample Description. The test sample description shall include part name and number, development status, date of manufacture, drawing number, drawing revision and drawing date. A drawing, indicating sensor location, as well as a photograph of the test sample with sensors shall be added.

5.3.3 Test Description. A description of test facility and test setup as well as calibration of test equipment shall be provided.

5.3.4 Individual Results. The drying times for the individual humidity measurement points shall be indicated in the driving cycle chart from the start of the test cycle to the end. The material surface temperature and exhaust gas temperatures shall also be shown in the chart. Reference measurement chart Appendix A, Figure A1.The test sample mass before the test, after conditioning and, after the test shall be documented and compared to each other according to the CTS.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary.

E-glass: Glass fibers used in fiberglass and made up of alumino-borosilicate glass with less than 1% mass/mass alkali oxides, mainly used for glass-reinforced plastics.

7.2 Acronyms, Abbreviations, and Symbols.

3-D Three-Dimensional

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