GM Aeration Test Monitoring System

Introduction

The GM aeration test procedure measures an oil's tendency to entrain free air during operation in a naturally aspirated engine. The GM aeration test is a part of GM's dexos™ 1 and dexos™ 2 engine oil specifications.

Definitions

Configuration – an engine installed on a test stand.

Day – Monday through Friday, excluding federal holidays, company holidays, or scheduled facility shutdown periods.

LCL – lower control limit

Qualification – the process whereby an engine installed on a test stand demonstrates the capability to discriminate between reference oils of differing performance levels.

TMC – ASTM Test Monitoring Center

UCL – upper control limit

Reference Oils

A. Two reference oils will be provided by GM and stored at TMC. TMC will dispense reference oil to the laboratory as needed. In addition to TMC's quality monitoring process, GM will measure oil properties and will report the results to TMC.

B. Test methods used by GM for oil analysis will be the following:
   1. Additive profile (GM proprietary method)
   2. Differential scanning calorimetry (DSC): ASTM D6186
   3. Elemental analysis by ICP: ASTM D5185
   4. Kinematic viscosity at 40°C (KV40): ASTM D7279
   5. Kinematic viscosity at 100°C (KV100): ASTM D7279
   6. High temperature high shear viscosity at 150°C (HTHS150): ASTM D5481
   7. Oxidation: DIN 51 453
   8. Thermogravimetric analysis (TGA): ASTM E1131
   9. Water content: ASTM E2412

C. Initial reference oil batches will be measured by GM for the following properties:
   1. Additive profile
   2. DSC
   3. HTHS150
   4. ICP (B, Ba, Ca, Fe, K, Mg, Mo, Na, P, S, Si, Zn)
   5. KV40
   6. KV100
   7. Oxidation
   8. TGA
   9. Water content

D. Reference oil batches will be measured by GM every 6 months for the following:
   1. DSC
   2. Oxidation
   3. Water content

E. In addition, reference oil batches will be measured by GM every 12 months for the following:
   1. Additive profile
   2. ICP
   3. KV40
   4. KV100

Test Measurement Parameters

The critical test measurement parameter percent aeration at 28 – 29 hours

Test Stand Qualification Criteria

A single test stand at one laboratory has been approved to run the GM aeration test. Every time a new test stand or a new engine on an existing test stand is installed, the laboratory will need to prove that the configuration can distinguish between 2 oils differing performance.

A. Qualifying a New Configuration

   1. The laboratory must consult GM before installing a new test stand or replacing an engine on an existing test stand. GM must approve the resulting new configuration before testing can begin.

2. The laboratory is permitted to replace an engine at its discretion if the following condition are met:

   (a) The engine has experienced a mechanical failure that cannot be repaired by replacing external parts or

   (b) GM personnel cannot be reached within 2 days (excluding weekends or holidays no more than 2 days in length).

   In the event the laboratory replaces an engine at its discretion, GM thereafter will approve the configuration as soon as possible.

3. Once a new engine has been installed and is ready for testing, the laboratory must provide written notification to TMC of the new engine. TMC will provide a reference oil testing sequence within 2 days of receipt of the notification.

4. The laboratory will run one operationally valid test on reference oil GMAER1 and GMAER2. The laboratory must report each individual reference oil result along with operational parameters within 2 days of test completion to the TMC, who will perform all calculations necessary for the qualification process.

5. A test is operationally valid if:

   (a) The test is run in accordance with the test procedure and is not terminated before its designed conclusion.

   (b) No engine shutdown can occur after the 23rd running hour (23-30 hours) during the normal 30-hour steady-state operation and aeration data acquisition.

   (c) Every controlled engine operating parameter meets its respective Quality Index.

6. TMC will determine pass/fail for reference oils GMAER1 and GMAER2 as follows:

   (a) If the GMAER1 and GMAER2 results are between the X chart UCL and LCL, the configuration passes qualification.

   (b) If the GMAER1 and/or GMAER2 results are on or beyond the UCL or LCL, the configuration fails qualification.

7. If a failing result is obtained, the laboratory must rerun the reference oil. The average of the 2 results will be used to determine conformance.

8. If the average still fails, the laboratory, TMC and GM will investigate the cause and develop an action plan. Once the laboratory submits an attestation to TMC that the action plan has been implemented, TMC will provide a reference oil testing sequence within 2 days of receipt of the notification. The laboratory must resume qualification starting at A.4.

9. After receipt of all reference oil results, TMC will provide written confirmation to the laboratory within 2 days whether the configuration is qualified. The laboratory is permitted to start candidate oil testing immediately upon receipt of an affirmative confirmation.

10. A laboratory must notify TMC of an invalid test within 2 days of occurrence. An operationally invalid test requires the laboratory to submit an action plan to TMC within 5 days after notification, identifying the problem, indicating the action to be taken, and providing a time line for implementation.

11. TMC will provide a written reply approving/disapproving the action plan to be taken within 5 days of receipt of the report.

    (a) TMC may consult GM regarding approving/disapproving the action plan.

    (b) If TMC approves the action plan, the laboratory must submit an attestation to TMC once the action plan has been implemented. Upon receipt of the attestation, TMC will provide a reference oil testing sequence within 2 days of receipt of the attestation. The laboratory must resume qualification starting at A.4.

    (c) If TMC disapproves the action plan, the laboratory must submit a second plan to TMC specifying the new action to be taken. This iterative process will continue until the action plan is satisfactory. If TMC approves the action plan, the laboratory must submit an attestation to TMC once the action plan has been implemented. Upon receipt of the attestation, TMC will provide a reference oil testing sequence within 2 days of receipt of the notification. The laboratory must resume qualification starting at A.4.

12. If a configuration experiences 2 operationally invalid tests during the course of engine qualification that in the opinion of the laboratory or TMC represents a systemic problem or have no readily identifiable root cause, the laboratory, TMC, and GM will together develop an action plan. Once the laboratory submits an attestation to TMC that the action plan has been implemented, TMC will provide a reference oil testing sequence within 2 days of receipt of the notification. The laboratory must resume qualification starting at A.4.

B. Monitoring of an Existing Configuration

1. An existing configuration will be monitored by TMC through periodic reference oil testing.

2. A reference test consists of one operationally valid test on reference oil GMAER2.

3. A newly qualified or existing configuration must begin a reference test:

   (a) after no more than 15 candidate test starts or

   (b) no later than 90 days from receiving qualification confirmation from TMC or

   (c) no later than 90 days from the last reference test,

   whichever occurs first.

4. All reference test results must be reported to TMC within 2 days of completion of test. TMC will plot the results on control charts.

5. An individuals chart will be used to monitor configuration performance.

   (a) R chart for the moving range

      i. A value for the mean of the moving range, R_bar, will be provided for the low and high aeration oils. The mean will be recalculated every 15 tests, incorporating each new set of data.

      ii. The upper control limit is defined as: 3.267*(R_bar)

      iii. The lower control limit is 0.

(b) X chart for the mean

i. A value for the mean, X_bar, will be provided for the high and low aeration oils. The mean will be recalculated every 10 tests, incorporating each new set of data.

ii. The upper control limit is defined as: (X_bar) + 2.66*(R_bar).

iii. The lower control limit is defined as: (X_bar) - 2.66*(R_bar).

6. An assignable cause exists if any of the following occur:

(a) A point on the R chart is on or beyond the UCL.

(b) A point on the X chart is on or beyond the UCL.

(c) A point on the X chart is on or beyond the LCL.

(d) Eight consecutive points on the X chart fall on one side of the mean.

7. If a control chart indicates an assignable cause exists, the laboratory cannot continue with candidate oil testing. The laboratory and TMC will together investigate the assignable cause and develop an action plan. The laboratory or TMC may request the assistance of GM in the investigation and development of an action plan. Once the laboratory submits an attestation to TMC that the action plan has been implemented, TMC will assign a reference oil testing sequence. The laboratory must resume reference tests with 2 days of receipt of the assignment.

8. A test is operationally valid if it meets the criteria listed in A.5. A laboratory must notify TMC of an invalid test within 2 days of occurrence. An operationally invalid test requires the laboratory to submit an action plan to TMC within 5 days after notification, identifying the problem, indicating the action to be taken, and providing a time line for implementation.

9. TMC will provide a written reply approving/disapproving the action to be taken within 5 days of receipt of the report.

(a) TMC may consult GM regarding approving/disapproving the action plan.

(b) If TMC disapproves the action plan, the laboratory must submit a second plan to TMC specifying the new action to be taken. This iterative process will continue until the action plan is satisfactory. If TMC approves the action plan, the laboratory must submit an attestation to TMC once the action plan has been implemented. Upon receipt of the attestation, TMC will randomly assign one SPI reference oil to the configuration. The laboratory must resume reference tests within 2 days of receipt of the assignment.

10. The TMC, in consultation with General Motors, will review all invalid test declarations to determine if a reason for an invalid test represents a systemic pattern within a stand. Re-occurring evidence and the frequency of invalid tests by a laboratory will be a strong factor in determining the need to suspend the stand from candidate oil testing. A laboratory will be required to provide detailed explanations for the cause of an invalid test and the action taken to prevent the re-occurrence.

Release and revision history

Initial release, August 2015