SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1747 | REV. JUL2007

Issued 1994-12
Revised 2007-07

Superseding J1747 DEC1994

Recommended Methods for Conducting Corrosion Tests in Hydrocarbon Fuels or Their Surrogates and Their Mixtures with Oxygenated Additives

RATIONALE

This revision is made to expand the applicability of this document to include all types of gasoline and diesel fuel types and their blends with various commercially available oxygenated additives primarily those derived from biofuel sources. In addition this document is upgraded to an SAE Recommended Practice.

FOREWORD

In 1989, an Oxygenated Fuels Task Force comprised of Chrysler, Ford, and General Motors automotive engineering personnel, operating in accordance with the 1984 Cooperative Research Act, was formed to address the many issues related to the use of oxygenated fuels in automotive applications. Project Group 2, one of four committees formed by the Task Force to address those issues, was charged with reviewing and developing materials test methods and evaluating materials for use in methanol-gasoline fuel blends. To this end, Project Group 2 developed and published "Gasoline/Methanol mixtures for Materials Testing." Subsequently, the recommended test methods contained in this report were developed.

TABLE OF CONTENTS

1. SCOPE

This SAE Recommended Practice presents standardized test methods developed for use in testing with hydrocarbon fuels or their surrogates and those same fuels when blended with oxygenated fuel additives. Hydrocarbon fuels include Gasoline and Diesel fuel or their surrogates described in SAE J1681. Oxygenated additives include Ethanol, Methanol Methyl Tertiary Butyl Ether (MTBE) and Fatty Acid Methyl Esters (FAME or Biodiesel).

1.1 Corrosion testing of metals has a long and varied history. In spite of the problems inherent in extrapolating results of accelerated tests on standard specimens to actual field durability, engineers have been able, to a large extent, to rely on these results in making materials selection decisions. However, these tests have generally employed aqueous media and not strictly applicable to the use of organic chemical media. Fuel blends with oxygenates tend to exhibit high electrical conductivity relative to straight hydrocarbon fuels, thus the relevance of the historical database for aqueous corrosion is lost. Therefore, to allow rapid build-up of a new database, several corrosion test procedures have been reviewed and amended where appropriate.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1681 Gasoline, Alcohol and Diesel Fuel Surrogates for Materials Testing

"Standard Practice for Laboratory Immersion Corrosion Testing of Metals in Methanol Fuels," an SAE Cooperative Research Report, June 1992

2.1.2 ASTM Publications

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM G 1-72 Standard Practice for Preparing, Cleaning and Evaluating Corrosion Test Specimens

ASTM G 3-89 Standard Practice for Conventions Applicable to Electrochemical Measurements in Corrosion Testing

ASTM G 15-89a Standard Terminology Relating to Corrosion and Corrosion Testing

ASTM G 16-88 Standard Guide for Applying Statistics to Analysis of Corrosion Data

ASTM G 30-79 Standard Practice for Making and Using U-Bend Stress-Corrosion Test Specimens

ASTM G 30-90 Standard Practice for Making and Using U-Bend Stress-Corrosion Test Specimens

ASTM G 31-72 Standard Practice for Laboratory Immersion Corrosion Testing of Materials

ASTM G 32-85 Standard Methods of Vibratory Cavitation Erosion Test

ASTM G 38-73 Standard Practice for Making and Using C-Ring Stress Corrosion Test Specimens

ASTM G 39-79 Standard Practice for Preparation and Use of Bend Beam Stress-Corrosion Test Specimens

ASTM G 39-90 Standard Practice for Preparation and Use of Bent-Beam Stress-Corrosion Test Specimens

ASTM G 46-86 Standard Practice for Examination and Evaluation of Pitting Corrosion

ASTM G 49-85 Standard Practice for Preparation and Use of Direct Tension Stress-Corrosion Test Specimens

ASTM G 58-85 Standard Practice for Stress-Corrosion Test Specimens for Weldments

ASTM G 71-81 Standard Guide for Conducting and Evaluating Galvanic Corrosion Tests in Electrolytes

ASTM G 102-89 Standard Practice for Calculation of Corrosion Rates and Related Information from Electrochemical Measurements

2.1.3 OSHA Publication

Available from Occupational Safety and Health Administration, 200 Constitution Avenue, NW, Washington, DC 20210, www.osha.gov.

OHSA Laboratory Standards

3. APPROACH

Changes in test media have required some modifications in both the equipment and the methods for carrying out the tests. In some test procedures, compromises had to be accepted, e.g., open or closed containers or in test temperature. These compromises most often involved the trade-offs among higher temperature (for greater acceleration of results), oxygen concentration (faster reaction, but less soluble at high temperature), media volatility (e.g., methanol b.p. 64 °C), and the possibility of phase separation in the fuel, which produces an oxygenate-water rich layer. It is expected that results obtained using the modified procedures that follow can be used to produce valid comparative rankings of materials.

4. TECHNICAL REQUIREMENTS

Each of the main paragraphs in Section 4 addresses a single corrosion test or practice. For brevity's sake, only those parts of the original procedure which are affected by the change in exposure medium are given. The individual sections cannot stand alone but must be used in conjunction with the referenced documents. For example, the changes made in ASTM G 31-72 are to be included when ASTM G 31-72 is referenced.

4.1 Standard Practice for Laboratory Immersion Corrosion Testing of Metals in Test Fluid Blends

4.1.1 This section describes the specific test conditions and requirements for immersion corrosion testing of metals, inorganic coated metals, and plated metals in hydrocarbon fuels and their blends with oxygenated additives within the general procedure described in ASTM G 31-72.[1]

4.1.2 Interferences

4.1.2.1 Paragraph 4.1.3 of ASTM G 31-72, concerning the aeration of the solution, is to be excluded for testing in oxygenated fuels. Aeration or deaeration is not to be used as part of this procedure.

4.1.2.2 The oxygenated fuel test solution is to be changed once each week of the test in order to minimize bulk solution composition changes, minimize oxygen depletion of the fuel, and to replenish ionic contaminants (paragraph 4.1.4, ASTM G 31-72).

[1] This Standard involves hazardous materials. For example Methanol is a flammable liquid that burns with a low visible flame. It is toxic by ingestion or skin contact. Explosion-proof heaters and other equipment should be used. It is the responsibility of the user of this standard to comply with all Federal and State Safety Regulations and to establish the appropriate safety and health practices.

4.1.3 Apparatus

4.1.3.1 A closed, airtight, 1 L high-density polyethylene container with a minimum burst strength of 202.7 kPa is required. The vessel is not to be filled to more than 80% of its volume. No metallic vessels are permitted.

4.1.3.2 Typically, the container is to be heated by air, or placed in a water or sand bath. Heating mantles or hot plates are not permitted. The vessel is to be heated uniformly with no localized application of heat. Aeration or stirring of the solution is not allowed. Close and seal the container after the test temperature is reached to minimize internal pressure buildup. Observe safety precautions applicable to the handling of flammable mixtures (refer to OSHA Laboratory Standards).

4.1.3.3 The temperature must be maintained at 45 °C ± 2 °C for the duration of the test.

4.1.4 Test Specimen

4.1.4.1 The test specimens can consist of flat panels or strip coupons with a large surface to mass ratio. For inorganic coated or plated specimens, it is best to coat the panels after the panels are cut to size in order to avoid exposed edges.

4.1.4.2 The test vessel can be used to immerse up to three test coupons that are 25.4 x 101.6 mm in size so as not to exceed 0.2 cm^2/mL of metal surface area to fuel volume (maintain at least 5 mL/cm^2). Multiple samples must not contact each other.

4.1.5 Test Conditions

4.1.5.1 Composition of Solution

4.1.5.2 The test solutions are to be prepared as described in SAE J1681 paragraph 7.2.4. The test solution must be changed each week of the test. In the case where fuels containing hydroperoxides are used, the fuel shall be made up fresh each week during the test period.

4.1.5.3 The temperature of the corroding solutions are to be maintained at 45 °C ± 2 °C.

4.1.5.4 Paragraphs 9.7.2, 9.7.3, 9.7.4, 9.8.2, 9.8.4, and 9.9.3 of ASTM G 31-72 referring to aeration, stirring and heating to boiling do not apply to materials testing in methanol fuels.

4.1.5.5 Continue the test for at least 2000 h with evaluations at one week, three week, six week, and 12 week intervals.

4.1.6 Interpretation of Results

4.1.6.1 The measurement of corrosion is as described in ASTM G 31-72, paragraph 10.

4.2 Standard Practice for Vibratory Cavitation Erosion-Corrosion Testing in Test Fluid Blends

4.2.1 This section describes the specific test conditions and requirements for vibratory cavitation erosion-corrosion testing of metals in oxygenated fuels or their surrogates within the general procedure described in ASTM G-32-85.[2]

4.2.2 Test Conditions

4.2.2.1 The test solutions will be those described in SAE J1681 paragraph 7.

[2] This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

4.2.2.2 The temperature of the test solution will be maintained at 40 °C ± 2 °C. Note that this test temperature is different from that used in immersion corrosion testing in an attempt to balance the effects of erosion and corrosion. The test solution will be replenished in the test container at a frequency required to maintain the recommended minimum solution volume indicated in ASTM G 32-85.

4.2.2.3 The test should be continued on each specimen at least until the rate of erosion-corrosion has reached a maximum and begins to diminish.

4.3 Standard Practice for Preparation and Use of Stress-Corrosion Test Specimens in Oxygenated Fuels or Their Surrogates

4.3.1 This section describes the specific test conditions and requirements for total immersion stress-corrosion testing of metals in fuels within the general procedures described in ASTM G 30-79, ASTM G 38- 73, ASTM G 39-79, and ASTM G 49-85.2

4.3.2 Specimen Design and Stressing Method

4.3.2.1 Test specimens will be prepared as direct tension, U-bend, C-ring, or bent-beam specimens and will be stressed in accordance with the applicable ASTM procedure corresponding to the specimen geometry. The material and form in which the material is supplied will determine the appropriate specimen geometry, and hence, the method of stressing the specimens.

4.3.2.2 The test specimen surface area to fuel volume ratio will not exceed 0.2 cm^2/mL of solution (5 mL/cm^2).

4.3.3 Exposure of the Test Specimens

4.3.3.1 The test solution will be prepared as indicated in SAE J1681 paragraph 7.

4.3.3.2 The test solution should be changed once each week of the test. In the cases where solutions containing hydroperoxides are used, the test solution should be mixed fresh each week during the test.

4.3.3.3 The temperature of the test solution will be maintained at 45 °C ± 2 °C. Typically, the test container solution will be heated by air, or placed in a water or sand bath. Heating mantles or hot plates are not permitted. The vessel should be heated uniformly with no localized application of heat. Safety precautions applicable to the handling of flammable mixtures should be observed (refer to OSHA laboratory standards).

4.3.3.4 The test specimens will be totally immersed in the test solution as soon as possible after stressing. The testing will be conducted in a closed, airtight container which will not result in galvanic corrosion with the test specimens. The vessel should not be filled to more than 80% of its volume. Close and seal the container after the test temperature is reached to minimize internal pressure buildup.

4.3.3.5 The test should be carried out for at least 2000 hours or until material failure by stress corrosion cracking has occurred, whichever is shorter. Regular inspections are required. Inspections at 500, 1000, 1500, and 2000 hours are recommended as a minimum.

4.4 Standard Practice for Conducting and Evaluating Galvanic Corrosion Tests in Oxygenated Fuels or Their Surrogates

4.4.1 This section outlines test requirements for testing metals for galvanic corrosion in alcohol fuels within the general procedure described in ASTM G 71-81.