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Standard Test Method for Corrosion Test for Engine Coolants in Glassware[1]

This standard is issued under the fixed designation D1384; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a simple beaker-type procedure for evaluating the effects of engine coolants on metal specimens under controlled laboratory conditions (see Appendix X1).

NOTE 1—For more information on engine coolants, see (Refs **1-8**).[2]

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific ~~hazards~~hazard statements are given in ~~10.1.7.2~~11.1.7.2, ~~10.1.7.3~~11.1.7.3, and ~~10.1.7.4~~11.1.7.4.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

B32 Specification for Solder Metal
B36/B36M Specification for Brass Plate, Sheet, Strip, And Rolled Bar
D1176 Practice for Sampling and Preparing Aqueous Solutions of Engine Coolants or Antirusts for Testing Purposes
D4725 Terminology for Engine Coolants and Related Fluids
E1 Specification for ASTM Liquid-in-Glass Thermometers
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
E178 Practice for Dealing With Outlying Observations
E230 Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
G31 Guide for Laboratory Immersion Corrosion Testing of Metals

[1] This test method is under the jurisdiction of ASTM Committee D15 on Engine Coolants and Related Fluids and is the direct responsibility of Subcommittee D15.06 on Glassware Performance Tests.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this standard.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 *ASTM Adjuncts:*
All-glass apparatus for corrosion test (2 drawings)[4]

3. Terminology

3.1 *Definitions*—For definitions of general terms used in D15 standards, refer to Terminology D4725.

3.2 *Abbreviations:*

3.2.1 *PTFE, n*—Polytetrafluoroethylene

4. Summary of Test Method

4.1 In this test method, specimens of metals typical of those present in engine cooling systems are totally immersed in aerated engine coolant solutions for 336 h at 88 °C (190 °F). The corrosion-inhibitive properties of the test solution are evaluated on the basis of the weight changes incurred by the specimens. Each test is run in triplicate, and the average weight change is determined for each metal. A single test may occasionally be completely out of line (see ~~11.2~~12.2).

5. Significance and Use

5.1 This test method will generally distinguish between coolants that are definitely deleterious from the corrosion standpoint and those that are suitable for further evaluation. However, the results of this test method cannot stand alone as evidence of satisfactory corrosion inhibition. The actual service value of an engine coolant formulation can be determined only by more comprehensive bench, dynamometer, and field tests.

6. Apparatus

6.1 *Container*—A 1000 mL, tall-form, spoutless beaker, made of heat-resistant glass, for containing the engine coolant solution and test specimens. The beaker shall be tightly closed with a No. 15 rubber stopper, having drill holes to accommodate a water condenser, an aerator tube, and a thermometer as shown in Fig. 1. Optionally, an all-glass apparatus may be ~~used.~~used (Fig. 2).

6.2 *Condenser*—A water condenser of the reflux, glass-tube type, having a 400 mm (16 in.) condenser jacket.

6.3 *Aerator Tube*—A gas-dispersion tube, porosity size ~~12-C,~~40 µm to 60 µm to ensure continuous aeration without plugging. Optionally, a capillary tip bleed tube with a 7 mm (0.28 in.) bore and 280 mm (11.2 in.) length may be used when consistent early plugging of gas dispersion tubes occurs.

6.4 *Temperature Measuring Instrument (Environmentally Safe Thermometer or Thermocouple)*—An ASTM Partial Immersion Temperature Measuring Instrument having a range ~~from – 20~~from –20 °C to 150 °C (~~0~~(0 °F to 302 °F) and conforming to the requirements for Thermometer 1C (1F), as prescribed in Specification E1 or Thermocouple as summarized in Specification E230.

6.5 *Heater*—A constant-temperature bath containing a high-boiling liquid ~~(see~~or ~~Note 2)~~ another suitable heating device that is capable of giving continuous service with the specified temperature control. ~~The size of the bath will be determined by the number of corrosion tests that are to be run concurrently.~~

7. Metal Test Specimens

~~NOTE 2—The specimens prescribed in this test method have been accepted by automobile manufacturers, but their composition may not be the same as that of alloys currently used for engine cooling system components. Therefore, specimens other than those designated in this test method may be used by mutual agreement of the parties involved.~~

7.1 *Type*—~~The~~ Either one or both of the following metal test ~~specimens,~~specimen bundles, representative of cooling system metals, ~~shall be used:~~may be used as agreed between customer and supplier (see Note 2):

[4] Details available from: ASTM International Headquarters. Order Adjunct No. ADJD1384. Original adjunct produced in (1980).

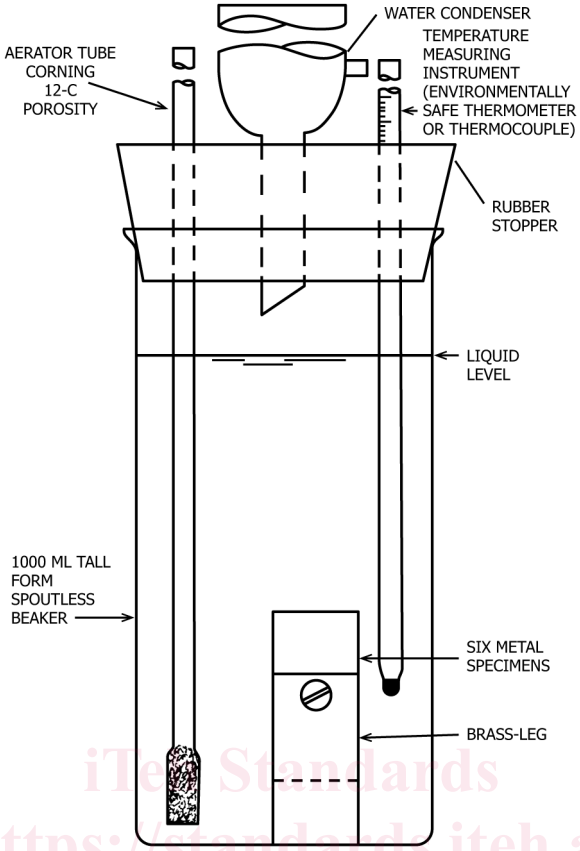

FIG. 1 Metal Specimens and Equipment for the 336 h Corrosion Test

~~6.1.1 *Steel,* UNS G10200 (SAE 1020),[8] cut from 1.59 mm (1/16-in.) cold-rolled sheet stock to size 50.8 by 25.4 mm (2 by 1 in.). Chemical composition of the carbon steel is as follows: carbon, 0.17 to 0.23 %; manganese, 0.30 to 0.60 %; phosphorus, 0.040 % maximum; sulfur, 0.050 % maximum.~~

NOTE 2—The specimens prescribed in this test method have been accepted by automobile manufacturers, but their composition may not be the same as that of alloys currently used for engine cooling system components. Therefore, specimens other than those designated in this test method may be used by mutual agreement of the parties involved.

~~6.1.2 *Copper,* conforming to UNS C11000 (SAE CA110)[8] or UNS C11300 (SAE CA113)[8]. Cold-rolled, cut from 1.59 mm (1/16 in.) sheet stock to size 50.8 by 25.4 mm (2 by 1 in.).~~

NOTE 3—When assembling the test bundle, sizes are stated in SI units, adjustment to these units may be made to accommodate US customary units, that is, 51 mm or 2 in.

~~6.1.3 *Brass,* conforming to Alloy UNS C26000 (SAE CA 260).[9] Half-hard, cut from 1.59 mm (1/16 in.) sheet stock to size 50.8 by 25.4 mm (2 by 1 in.).~~

7.1.1 ~~*Solder*—A brass specimen as described in~~ Test Specimen bundle ~~6.1.3, coated with solder conforming to Alloy Grade 30A (SAE 3A) of Specification~~ with copper and copper alloy (“conventional bundle”).~~B32. Solder-coated specimens may be prepared, or used specimens recoated for reuse, by the procedure given in Annex A1. A solid solder specimen cut from 1.59 mm (1/16 in.) sheet stock of Alloy Grade 30A (SAE 3A) to size 50.8 by 25.4 mm (2 by 1 in.) may be used subject to mutual agreement of the parties involved. The use of a solid solder specimen must be reported along with the metal specimen weight loss results.~~

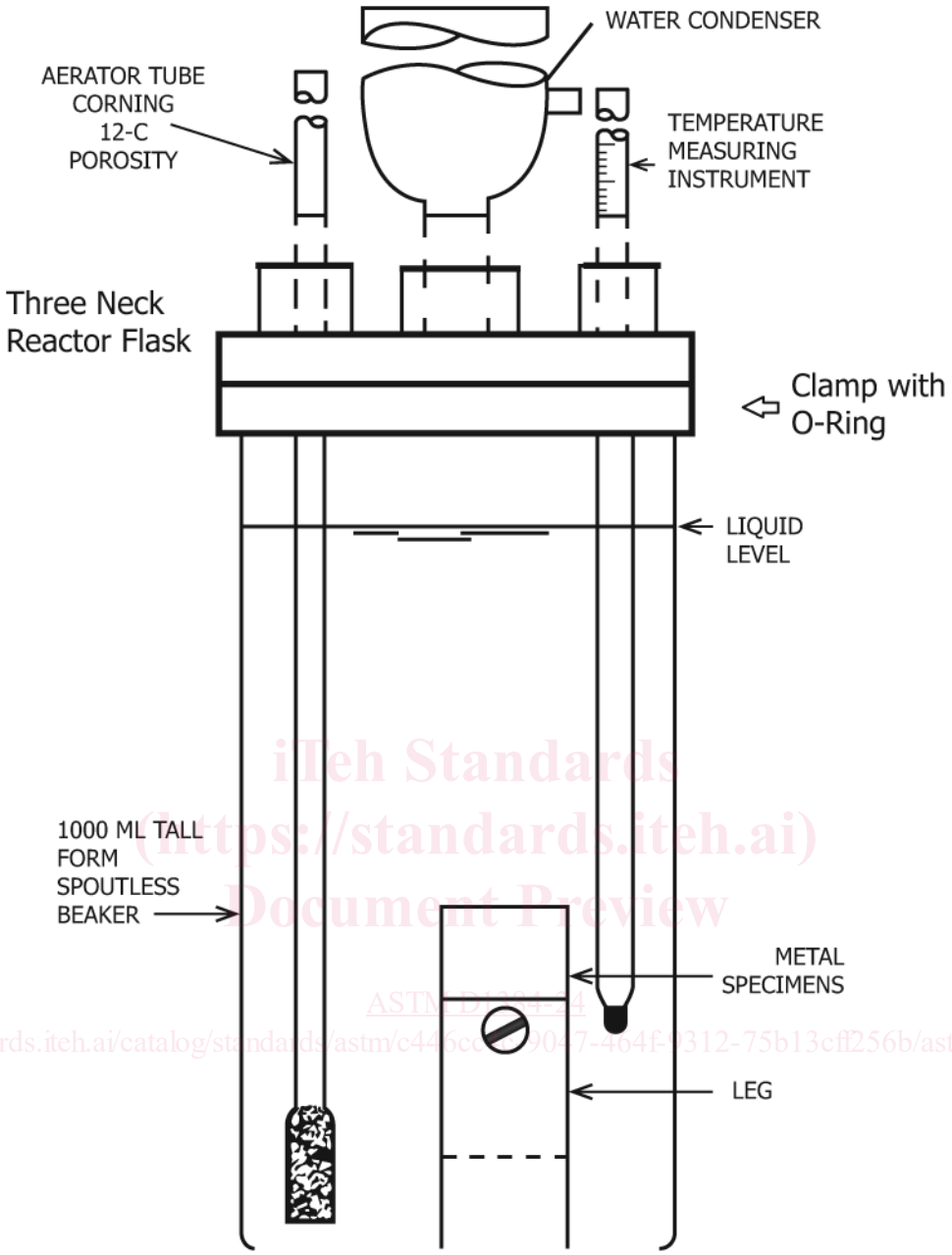

FIG. 2 Metal ~~Specimen Arrangement~~Specimens and All Glass Equipment for the 336 h Corrosion Test

7.1.1.1 *Steel,* UNS G10200 (SAE 1020),[5] cut from 1.59 mm (1⁄16 in.) cold-rolled sheet stock to size 50.8 mm by 25.4 mm (2 in. by 1 in.). Chemical composition of the carbon steel is as follows: carbon, 0.17 % to 0.23 %; manganese, 0.30 % to 0.60 %; phosphorus, 0.040 % maximum; sulfur, 0.050 % maximum.

7.1.1.2 *Copper,* conforming to UNS C11000 (SAE CA110)[5] or UNS C11300 (SAE CA113).[5] Cold-rolled, cut from 1.59 mm (1⁄16 in.) sheet stock to size 50.8 mm by 25.4 mm (2 in. by 1 in.).

7.1.1.3 *Brass,* conforming to Alloy UNS C26000 (SAE CA 260).[6] Half-hard, cut from 1.59 mm (1⁄16 in.) sheet stock to size 50.8 mm by 25.4 mm (2 in. by 1 in.).

[5] UNIFIED numbering system for metals and alloys, SAE-ASTM, July 1995.
[6] Round-robin evaluation of coated solder report is available from ASTM Headquarters. Request RR:D15-0132.

7.1.1.4 *Solder*—~~When agreed upon between the supplier~~A brass specimen as described in 7.1.1.3~~and the purchaser of engine~~, coated with solder conforming to Alloy Grade 30A (SAE 3A) of Specification B32~~coolants,~~.[6] ~~the standard solder specimen may be replaced with one having a different~~Solder-coated specimens may be prepared by the procedure given in Annex A1~~alloy composition than standard~~. A solid solder specimen cut from 1.59 mm (1⁄16 in.) sheet stock of Alloy Grade 30A ~~or 30B. Use of specimens other than standard Alloy Grade 30A or 30B shall be noted in the test report.~~(SAE 3A) to size 50.8 mm by 25.4 mm (2 by 1 in.) may be used subject to mutual agreement of the parties involved. The use of a solid solder specimen must be reported along with the metal specimen weight loss results.

(1) When agreed upon between the supplier and the purchaser of engine coolants, the standard solder specimen may be replaced with one having a different alloy composition than standard Alloy Grade 30A or 30B. Use of specimens other than standard Alloy Grade 30A or 30B shall be noted in the test report.

NOTE 4—Where non-standard alloy is used, the standard flux shown in A1.1.5 may not be satisfactory. A low corrosive flux may be required.

7.1.1.5 *Cast Aluminum,* conforming to Alloy UNS A23190 (SAE 329).[5] Specimen size, 50.8 mm by 25.4 mm by 3.18 mm (2 in. by 1 in. by 1⁄8 in.).

7.1.1.6 *Cast Iron,* conforming to Alloy UNS F10007 (SAE G3500).[5] Specimen size, 50.8 mm by 25.4 mm by 3.18 mm (2 in. by 1 in. by 1⁄8 in.).

~~6.1.5 *Cast Aluminum,* conforming to Alloy UNS A23190 (SAE 329).[8] Specimen size, 50.8 by 25.4 by 3.18 mm (2 by 1 by 1⁄8 in.).~~

7.1.2 ~~*Cast Iron,* conforming to Alloy UNS F10007 (SAE G3500).~~Test Specimen ~~size, 50.8 by 25.4 by 3.18 mm (2 by 1 by~~bundle with no copper, copper alloy, or steel test specimen (“aluminum ~~1⁄8 in.).~~bundle”).

7.1.2.1 *Aluminum 3003,* conforming to Alloy UNS A93003 (SAE 3003).[5] Specimen size, 50.8 mm by 25.4 mm by 1.59 mm (2 in. by 1 in. by 1⁄16 in.).

7.1.2.2 *Aluminum 319,* conforming to Alloy UNS A23190 (SAE 329).[5] Specimen size, 50.8 mm by 25.4 mm by 3.18 mm (2 in. by 1 in. by 1⁄8 in.).

7.1.2.3 *Aluminum 380.1,* conforming to Alloy UNS A13801 (SAE 306).[5] Specimen size, 50.8 mm by 25.4 mm by 3.18 mm (2 in. by 1 in. by 1⁄8 in.).

7.1.2.4 *Aluminum 7075,* conforming to Alloy UNS A97075 (SAE 7075).[5] Specimen size, 50.8 mm by 25.4 mm by 1.59 mm (2 in. by 1 in. by 1⁄16 in.).

7.1.2.5 *Aluminum 7075 Clad,* conforming to Alloy UNS A87075.[5] Specimen size, 50.8 mm by 25.4 mm by 1.59 mm (2 in. by 1 in. by 1⁄16 in.).

7.1.2.6 *Cast Iron,* conforming to Alloy UNS F10007 (SAE G3500).[5] Specimen size, 50.8 mm by 25.4 mm by 3.18 mm (2 in. by 1 in. by 1⁄8 in.).

7.2 ~~*Arrangement (See* *Arrangement:* Fig. 2*).*~~

7.2.1 *Conventional Bundle (See* Fig. 3*): Metal Specimen Arrangement*—None of the hardware used in metal specimen arrangement (metal specimen, screws, washers, metal spacers, insulating sleeves, insulating spacers and nuts) can be reused for a test. The metal test specimens shall be drilled through the center with a 6.75 mm (17⁄64 in.) drill to accommodate a ~~50.8 mm (2 in.)~~ 50.8 mm (2 in.) 10–24 brass machine screw covered with a thin-walled insulating sleeve. ~~Tetrafluoroethylene~~ Polytetrafluoroethylene (PTFE) tubing with a 6.35 mm (1⁄4 in.) outside diameter 1.59 mm (1⁄16 ~~in.)~~ in.) wide and a wall thickness of 0.4 mm (1⁄64 in.) is satisfactory. Two half-hard brass legs shall be cut from 1.59 mm (1⁄16 in.) sheet stock to size ~~50.8~~50.8 mm by 25.4 mm ~~(2 by 1 in.).~~ (2 in. by 1 in.). A 6.35 mm (1⁄4 in.) diameter hole shall be drilled in each leg with the center 6.35 mm (1⁄4 in.) from the top and 12.7 mm (1⁄2 in.) from each side. The test “bundle” shall be made up on the insulated screw with the specimens in the following order: brass leg, copper, solder, brass, steel, cast iron, cast aluminum, and brass leg. The specimens shall be separated by 4.76 mm (3⁄16 ~~in.)~~ in.) thick solid metal spacers having a 6.75 mm (17⁄64 in.) inside diameter and a 11.11 mm (7⁄16 in.) outside diameter. Insulating spacers made from ~~tetrafluoroethylene~~polytetrafluoroethylene shall be used between the brass legs and the specimen “bundle,” and between the brass and steel specimens. Brass spacers shall be used between the brass, solder, and copper

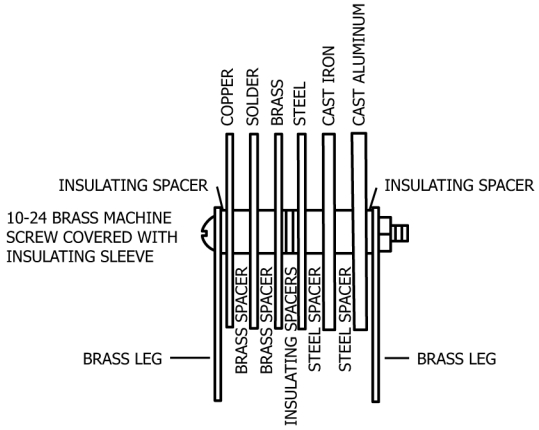

FIG. 3 Metal Specimen Arrangement

specimens, and steel spacers between the cast iron, steel, and cast aluminum specimens. The nut shall be tightened firmly to ensure good electrical contact between the test specimens in each section of the "bundle."

7.2.2 *Alternate Metal Specimen Arrangement*—When agreed upon between the supplier and the purchaser, an alternate metal specimen arrangement may be used to evaluate multiple solder alloys, such as high lead Alloy Grade L50113[6] consisting of 97 % lead, 2.5 % tin, 0.3 % silver, concurrently with Standard Alloy Grade 30A or 30B. It is recommended that the metal specimen arrangement be modified by replacing the copper specimen with the high lead solder specimen and arranging specimens in the bundle as follows:

High Lead Solder	Brass	Alloy Grade 30A or 30B	Steel	Cast Iron	Cast Aluminum

Use of alternate specimens and metal specimens arrangements shall be noted in the test report.

7.2.3 *Aluminum Bundle Metal Specimen Arrangement (See* Fig. 4*)*—When agreed upon between the supplier and the purchaser, an aluminum metal specimen arrangement may be used to evaluate multiple aluminum alloys as specified in 7.1.2. The metal specimen arrangement shall be arranged as follows:

7.2.3.1 All the hardware used in metal specimen arrangement (metal specimen, screws, washers, metal spacers, insulating sleeves, insulating spacers, and nuts) shall be new and unused. The metal test specimens shall be drilled through the center with a 6.75 mm (17⁄64 in.) drill to accommodate a 50.8 mm (2 in.) 10–24 brass machine screw covered with a thin-walled insulating sleeve. PTFE tubing with a 6.35 mm (¼ in.) outside diameter 1.59 mm (1⁄16 in.) wide and a wall thickness of 0.4 mm (1⁄64 in.) is satisfactory. Two PTFE legs shall be cut from 1.59 mm (1⁄16 in.) sheet stock to size 50.8 mm by 25.4 mm (2 in. by 1 in.). A 6.35 mm (¼ in.) diameter hole shall be drilled in each leg with the center 6.35 mm (¼ in.) from the top and 12.7 mm (½ in.) from each side. The test "bundle" shall be made up on the insulated screw with the specimens in the following order: PTFE leg, AL3003, AL319, AL380.1, AL7075, AL7075 Clad, cast iron, and PTFE leg. The specimens shall be separated by 4.76 mm (3⁄16 in.) thick solid PTFE spacers having a 6.75 mm (17⁄64 in.) inside diameter and a 11.11 mm (7⁄16 in.) outside diameter. Insulating spacers made from PTFE shall be used between the PTFE legs and the specimen "bundle," and between the specimens. The nut shall be tightened firmly."

7.2.3.2 The use of alternate specimens and their arrangements shall be noted in the test report.

8. Preparation of Test Specimens

8.1 Sand the cast iron and cast aluminum specimens on the ~~25.4 by 50.8 mm (1 by 2 in.)~~ 25.4 mm by 50.8 mm (1 in. by 2 in.) cut surfaces with "coarse" grade (No. 1) emery cloth. Remove any burrs from coupon edges and hole. Scrub all specimens vigorously, using a moistened bristle brush and ground pumice powder or fine silicon carbide grit until the entire metal area is bright, shiny, and free from any visible oxide film or tarnish.

8.2 Rinse the specimens thoroughly with tap water; then rinse with acetone, dry, and weigh to the nearest ~~1 mg.~~ 1 mg. Cast aluminum specimens should be dried in a 100 °C oven for ~~1 h,~~ 1 h, to a constant weight, prior to recording the weight.