



# Standard Test Method for Corrosiveness of Lubricating Fluid to Bimetallic Couple<sup>1</sup>

This standard is issued under the fixed designation D 6547; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the corrosiveness of hydraulic and lubricating fluids to a bimetallic galvanic couple.

NOTE 1—This test method replicates Fed-Std No. 791, Method 5322.2. It utilizes the same apparatus, test conditions, and evaluation criteria, but it describes test procedures more explicitly.

1.2 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

A 322 Specification for Steel Bars, Alloy, Standard Grades<sup>2</sup>

### 2.2 Federal Standards:

Fed-Std No. 791, Method 5322.2 Corrosiveness of Oil on a Bimetallic Couple<sup>3</sup>

## 3. Summary of Test Method

3.1 This test method consists of fitting a brass clip to the fluid-coated surface of a steel disk, storing the assembly at approximately 50 % relative humidity for ten days, and visually inspecting the assembly for evidence of galvanic corrosion.

## 4. Significance and Use

4.1 Corrosiveness of a fluid to a bimetallic couple is one of the properties used to evaluate hydraulic or lubricating fluids. It is an indicator of the compatibility of a fluid with a brass on steel galvanic couple at ambient temperature and 50 % relative humidity.

## 5. Apparatus

5.1 *Desiccating Jars*, two.

5.2 *Magnifier*, 10 x power.

5.3 *Glass Stirring Rod*.

5.4 *Abrasive Papers*, silicon-carbide or aluminum oxide (150, 240, 400, 600 grit, one sheet per disk).

5.5 *Cloth*, lint-free, clean, dry.

5.6 *Chromium Alloy Steel Disks*, three for each test sample.<sup>4</sup>

5.7 *Brass Clips*, three for each test sample.<sup>4</sup>

## 6. Reagents and Materials

6.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the Committee on Analytical Reagents of the American Chemical Society where such specifications are available.<sup>5</sup>

6.2 *Etching Solution*, consisting of distilled water, 450 mL; nitric acid, concentrated, 225 mL; sulfuric acid, concentrated, 300 mL; and hydrochloric acid, concentrated, 8 mL.

6.2.1 To avoid hazardous reactions when preparing the etching solution, place the distilled water (450 mL) in a 1.5-L, or larger, glass beaker set in a container of ice and water. Stir with a glass mechanical stirrer or plastic coated magnetic spin bar while slowly adding concentrated sulfuric acid (300 mL). Add more ice to the cooling bath as needed. When acid addition is complete, continue stirring until the solution has cooled to room temperature, and then start slow addition of the concentrated nitric acid (225 mL). Continue stirring after acid addition until the solution has cooled to room temperature, and then add concentrated hydrochloric acid (8 mL). Allow the mixture to equilibrate to room temperature before use. (**Warning**—Nitric, hydrochloric, and sulfuric acids are very corrosive. Nitric acid and sulfuric acid are also oxidizing acids. The analyst should prepare the etching solution in a well-ventilated hood and wear appropriate gloves, apron, and face shield.)

6.3 *Acetone*, technical grade. (**Warning**—Flammable. Health hazard.)

6.4 *Distilled Water*.

NOTE 2—Both distilled and deionized water were used in the round robin with no apparent impact on test outcome.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.N0.02 on Industrial Applications.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 05.01.

<sup>3</sup> Available from Standardization Documents Order Desk, Building 4 Section D, 700 Robbins Avenue, Philadelphia, PA 19111-5904, Attn: NPODS.

<sup>4</sup> Available from Metaspac, 790 W. Mayfield Rd., San Antonio, TX 78211.

<sup>5</sup> *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

6.5 *Saturated Aqueous Solution*, in contact with excess calcium nitrate tetrahydrate.

NOTE 3—A saturated aqueous solution in contact with an excess of  $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$  will produce 51 % relative humidity within a closed space at 25°C. To prepare the saturated solution, dissolve 660 g of  $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$  in 100 cc of water at 30°C.<sup>6</sup>

6.6 *Low-Erucic Rapeseed Oil*, commercial grade.<sup>7</sup>

## 7. Test Specimen

7.1 Gather reagents and materials before beginning specimen preparation. The specimens must be prepared and assembled for testing on the same day to reduce formation of passivating oxide films on the surface of the bimetallic couple. For each test fluid, prepare three steel disks. These steel disks may either be new or from a previous test.

7.1.1 The steel disks shall consist of a chromium alloy steel in accordance with Specification A 322 (E52100 or G52986), heat treated to Rockwell C-62. When new, the steel disks shall be 25.4 mm (1.00 in.) in diameter by 13 to 25 mm (0.5 to 1.0 in.) thick. Prior to initial use, the steel disk shall be ground on one side to a 0.51  $\mu\text{m}$  (20  $\mu\text{in.}$ ) rms. This treatment need not be repeated prior to reuse.

7.1.2 Polish the surface of the ground side using 150, 240, 400, and 600-grit silicon carbide or aluminum oxide paper in succession. Use one sheet of each per disk. Perform each polishing operation at right angles to the previous one, and continue until all the cross scratches from the previous operation are removed.

NOTE 4—Hand polishing techniques were used exclusively in the round robin evaluation of this test method. Mechanical polishing was not evaluated and may not yield equivalent results.

7.1.3 Clean the disks by wiping with a clean, dry, lint-free cloth, being careful not to touch the polished surfaces with bare hands.

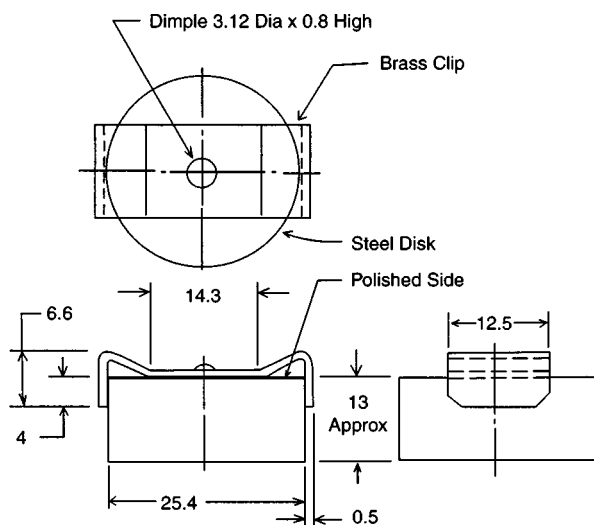
7.1.4 Examine with a 10 x power magnifier for discoloration, etching, pitting, or other signs of corrosion. Discard disks with any signs of corrosion.

7.1.5 Store the disks in a desiccator containing desiccant until time of use.

7.2 For each test fluid, prepare three brass clips. These brass clips may either be new or from a previous test.

7.2.1 The clips shall consist of a QQ-B-613, composition 2 brass, spring temper, fabricated to the dimensions shown in Fig. 1.

7.2.2 Place 150 mL of etching solution in a 250-mL beaker. Immerse the brass clips in etching solution for 20 s. Remove the clip from the etching solution and immediately wash successively in cold running water, distilled water, and acetone. If a visible stain remains on the clip in the area that will be in contact with the disk, repeat the etching process for an additional 20 s with fresh etching solution. Change etching solution and acetone every six clips. Allow the clip to air dry and store it in the desiccator until ready for use. Be careful not



NOTE 1—Dimensions in millimetres.

NOTE 2—Tolerance  $\pm 0.8$  mm.

FIG. 1 Brass Clip Dimensions

to touch the surface that will be in contact with the steel disks with bare hands.

## 8. Procedure

8.1 Remove the disks from the desiccator, being careful not to touch the finished surface.

8.2 Using the stirring rod, place two drops of the test fluid along a diameter in a line on the polished surface of each of three disks.

8.3 Remove the brass clips from the desiccator, being careful not to touch the area to be in contact with the steel disks.

8.4 Place the clips on the disks as indicated in Fig. 1 so that the center of the clip is in full contact with the wetted area of the disk.

8.5 Place the assemblies in a covered desiccating jar containing the saturated aqueous  $\text{Ca}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$  solution for ten days (relative humidity approximately 50 %).

8.6 Remove the assemblies from the desiccating jar after ten days. Absorb excess fluid from the assemblies with a lint-free cloth. Using a sharp pencil, mark an outline of the clips where they are in contact with the polished surface of the disks. Remove the clips and wipe the disks clean with a lint-free cloth.

8.7 Using the 10 x power magnifier, examine the marked-off area for discoloration, etching, pitting, or other signs of corrosion. Fig. 2 depicts galvanic corrosion stains typical of tests using low-erucic rapeseed oil as the failing reference fluid.



FIG. 2 Appearance of Disks After Performing Test with Low-erucic Rapeseed Oil

<sup>6</sup> CRC Handbook of Chemistry and Physics, CRC Press, Inc., Boca Raton, FL, 1993.

<sup>7</sup> Low-erucic rapeseed oil may be used at the operator's discretion as a failing reference fluid to monitor test severity.

## 9. Report

9.1 Report the following information:

9.1.1 Report the fluid as failing the test if the test areas of more than one disk show signs of corrosion, pitting, or other attack. Also report the fluid as failing if two disks are free of corrosion, but the third shows more than three affected spots.

9.1.1.1 Wipe the dish with a lint-free cloth. Rate the specimen as passing if no discoloration or pitting is visible.

9.1.2 Report the fluid as passing if the condition of the disks is other than these.

## 10. Precision and Bias

10.1 *Precision*—It is not practical to specify the precision of

the procedure in this test method because the results of this test method are only intended to give a pass/fail rating to the fluid being tested.

10.2 *Bias*—The procedure in this test method has no bias because the value of corrosion-preventing characteristics is defined only in terms of this test method.

## 11. Keywords

11.1 corrosion; copper corrosion; galvanic corrosion; hydraulic fluids

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