

Standard Test Method

Determining Corrosive Properties of Cargoes in Petroleum Product Pipelines

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Revised 2001-03-10
Approved January 1972
Revised 1976
Reaffirmed March 1986
Reaffirmed September 1993
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ISBN 1-57590-118-8
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Foreword

Interior surfaces of petroleum product pipelines are subject to general surface corrosion caused by traces of moisture condensed from the products. Rusting can be prevented with corrosion inhibitors. Usually, the amount of protection provided to the pipeline is proportional to the inhibitor concentration in the fuels being transported. More protection is required in a static line than in a flowing line.

The purpose of this standard test method is to provide a uniform method of testing the corrosive properties of petroleum product pipeline cargoes. This standard provides guidelines for performing the test method described in ASTM⁽¹⁾ D 665,¹ modified so that it is applicable to gasoline and other petroleum products, and so that it permits analysis within a single working day. This short test is particularly applicable to a batch control procedure because of the need for prompt release of cargoes and because time is limited during the working day. This standard test method is intended to be used by corrosion engineers, corrosion technicians, corrosion consultants, scientists, and others concerned with determining the antirust properties of gasoline and distillate fuels for transport through petroleum product pipelines.

This standard was originally published in 1972 and revised in 1976 by Unit Committee T-3P on Internal Corrosion of Product Pipelines and Tanks. It was reaffirmed with editorial changes in 1986 and 1993 by Unit Committee T-10E on Internal Corrosion of Pipelines, and revised in 2001 by Task Group 042. Task Group 042 is administered by Specific Technology Group (STG) 09 on Measurement and Monitoring Techniques and is sponsored by STG 62 on Testing and Monitoring Procedures. It is issued under the auspices of STG 09 on Measurement and Monitoring Techniques.

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⁽¹⁾ American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

**NACE International
Standard
Test Method**

**Determining Corrosive Properties of Cargoes
in Petroleum Product Pipelines**

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Section 1: General

1.1 This standard provides a procedure for conducting a test to determine the corrosive properties of gasoline and distillate fuels in preparation for transport through a pipeline. Also included is information on test specimen preparation, equipment, and a system for rating the test specimens.

1.2 In this test method, the surface of a cylindrical steel test specimen is prepared and then immersed in a mixture of the test fuel and distilled water. The mixture is stirred and is maintained at a prescribed temperature. The test specimen

is then rated by the proportion of test surface that has corroded. Experience has shown that if enough inhibitor is present to produce B+ or better results as defined in this standard, general corrosion in flowing pipelines may be controlled.

1.3 This test method does not predict corrosiveness in the standing aqueous phase, nor does it predict microbiological attack.

Section 2: Test Specimen Preparation

2.1 The test specimen should be a threaded steel rod 81.0 mm x 12.7 mm (3.19 x 0.500 in.) (see Figure 1), used

with a plastic or polytetrafluoroethylene (PTFE) holder.

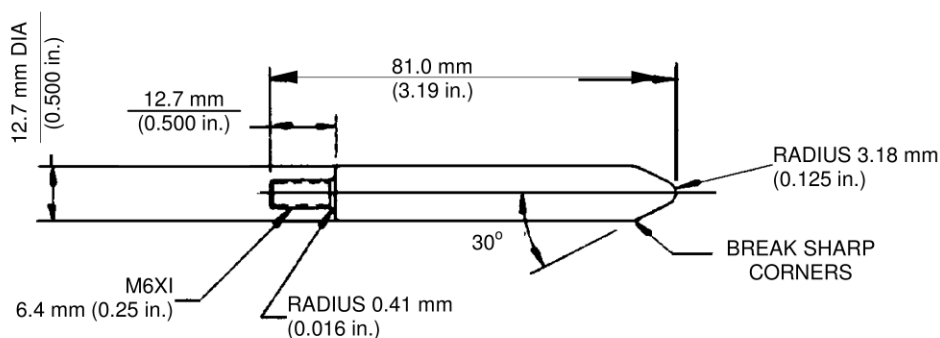


FIGURE 1: Test Specimen

The test specimen should be a threaded steel rod used with a plastic holder (ASTM D 665). Copyright ASTM. Reprinted with permission.

2.1.1 The test specimen should be made of steel conforming to UNS⁽²⁾ G10150 (Grade 1015), UNS G10180 (1018), UNS G10200 (1020), or UNS G10250 (1025) of ASTM A 108.²

2.1.2 If these steels are unavailable, other equivalent steels may be used, provided that they are satisfactory according to comparative tests using this test method.

2.1.3 All test specimens must be tested to establish their corrosion activity in comparative tests using this test method.

2.2 The test specimen, either new or from a previous test, shall be prepared as follows:

2.2.1 Preliminary Grinding

2.2.1.1 If the test specimen has been used previously but is free from rust or other irregularities, preliminary grinding may be omitted and the test specimen subjected only to final surface preparation as prescribed in Paragraph 2.2.2.

⁽²⁾ Metals and Alloys in the Unified Numbering System (latest revision), a joint publication of the American Society for Testing and Materials (ASTM) and the Society of Automotive Engineers Inc. (SAE), 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.2.1.2 If the test specimen is new or if any part of its surface shows rust or other irregularities, it should be cleaned with ASTM precipitation naphtha (see ASTM D 91³) or acetone to remove inhibitor, oily residues, and water. The test specimen may be stored in a dry laboratory atmosphere until ready to grind for use. All visible irregularities, pits, and scratches shall be removed from the surface of the test specimen by filing or grinding with abrasive cloths.

2.2.1.3 After cleaning with naphtha or acetone, the test specimen shall not be touched by hand at any stage until the test is complete. Forceps, a clean lint-free cloth, or a dry tissue may be used.

2.2.1.4 The test specimen should be mounted in the chuck of the grinding and polishing apparatus and rotated at a speed of 1,700 to 1,800 rpm while the abrasive cloth is applied (see Paragraph 3.1.7). Old cloth may be used to remove rust or major irregularities, but the grinding shall be completed with a new cloth.

2.2.1.5 The final abrasion should be done immediately, or the test specimen should be removed from the chuck and stored in isooctane or in a desiccator until needed.

2.2.1.6 Reused test specimens should be discarded when the diameter is reduced to 9.53 mm (0.375 in.).

2.2.2 The following procedures shall be used for the final surface preparation of the test specimen. Final surface preparation should be done immediately before the test is to be conducted.

2.2.2.1 If preliminary grinding has just been completed, stop the motor that rotates the test specimen. Otherwise, remove the test specimen from storage, dry it with a clean lint-free cloth, and place it in the chuck.

2.2.2.2 Rub a new piece of abrasive cloth (see Paragraph 3.1.7) longitudinally over the static test

specimen until the entire surface, including the rounded end, shows visible scratches.

2.2.2.3 Rotate the test specimen at a speed of 1,700 to 1,800 rpm and abrade by wrapping the abrasive cloth halfway around the test specimen. Pull the loose ends of the cloth down with firm but gentle pressure for 1 to 2 minutes to produce a uniform, finely scratched surface free from longitudinal scratches.

2.2.2.4 To ensure that the flat shoulder of the threaded coupons (that portion of the test specimen perpendicular to the threaded stem) is free of corrosion products, abrade the area by holding a strip of abrasive cloth between the chuck and the shoulder while rotating the test specimen for a brief period.

2.2.2.5 Complete the final stages of preparation with new abrasive cloth (see Paragraph 3.1.7).

2.2.2.6 Remove the test specimen from the chuck without directly touching it and remove any fine particles by striking the test specimen sharply on a clean surface, wiping lightly with a clean, dry, lint-free cloth or tissue, or by brushing lightly with a camel-hair brush.

2.2.2.7 Attach the test specimen to a plastic holder and then rinse thoroughly with either toluene or xylene followed by acetone. All solvents used should be free of water contamination (technical or better grade). The test specimen should then be rinsed with isooctane and placed immediately in the hot fuel sample to be tested or placed into a clean test tube containing isooctane. The test specimen may later be removed from this tube and allowed to drain briefly before being placed in the hot test fuel.

2.2.2.7.1 Note: The extent of test specimen rinsing after final polishing has been expanded to prevent residual materials from the polishing process from contaminating the test specimen surface or test beaker.

Section 3: Test Equipment and Apparatus

3.1 The apparatus shall consist of the following:

3.1.1 Temperature-measuring device: A temperature-measuring device shall be used.

3.1.2 Bath: A thermostatically controlled bath capable of maintaining a temperature in the test sample of $38 \pm 1^\circ\text{C}$ ($100 \pm 2^\circ\text{F}$) shall be used. The bath shall have a cover with holes to accommodate

the test beakers and the temperature-measuring device (see Figure 2).

3.1.3 Beaker: A modified, 400-mL (13.5-oz fluid), Berzelius-type glass beaker that is heat resistant and does not have a pour spout (see Figure 2) shall be used. It should be approximately 127 mm (5.00 in.) high when measured inside the beaker at the center of the base. The inside diameter should be approximately 71 mm (2.8 in.). The modification consists of two

vertical baffles that are 180 degrees from each other and protrude 10 mm (0.40 in.) into the beaker. The baffles should be 102 mm (4.00 in.) in length and begin

about 14 mm (0.55 in.) from the bottom of the beaker. Borosilicate glass is a satisfactory material for the beakers.

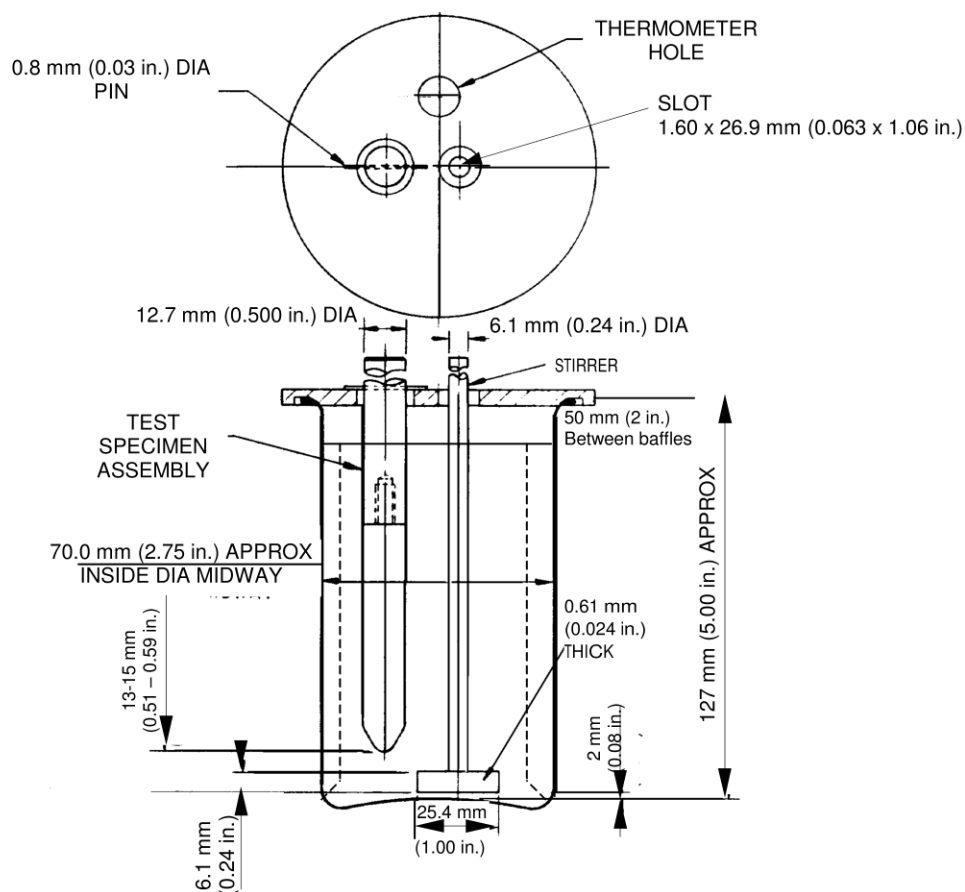


FIGURE 2: Testing Apparatus

Test apparatus showing beaker, solid rod test specimen, temperature-measuring device, stirrer, and beaker cover.

Note: All units are in millimeters unless otherwise specified.

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3.1.4 Cover: A flat beaker cover of glass or polymethyl methacrylate resin shall be used (see Figure 3). It shall be held in place by suitable means (e.g., a rim or groove). An inverted Petri dish makes a suitable cover because its sides hold the dish in a fixed position over the beaker.

3.1.4.1 Two holes should be located on any diameter of the cover. One shall accommodate a stirrer 11.66 to 12.17 mm (0.4590 to 0.4790 in.) in diameter with its center 6.1 to 6.6 mm (0.24 to 0.26 in.) from the cover's center. The other hole should be on the opposite side of the cover's center to accommodate the test specimen

assembly. This assembly should be 17.6 to 18.1 mm (0.693 to 0.713 in.) in diameter with its center 15.62 to 16.13 mm (0.6150 to 0.6350 in.) from the center of the cover.

3.1.4.2 To accommodate a temperature-measuring device, a third hole 11.66 to 12.17 mm (0.4590 to 0.4790 in.) in diameter shall be centered 22.0 to 22.5 mm (0.865 to 0.885 in.) from the center of the cover and on a diameter at right angles to the diameter through the other two holes.

3.1.4.3 Figure 3 shows an optional feature that consists of a slot 1.60 x 26.9 mm (0.063 x 1.06 in.) through the stirrer hole that is centered on a diameter of the stirrer hole at right angles to the cover diameter. This feature allows the stirrer to be removed while the beaker cover is in place.

3.1.5 Stirrer: A stirrer constructed entirely of stainless steel in the form of an inverted T shall be used.

3.1.5.1 A flat blade 25 x 6.1 x 0.61 mm (1.0 x 0.24 x 0.024 in.) shall be attached to a 6.1-mm (0.24-in.) rod at the balance point of the blade to form a T-shaped stirrer.

3.1.5.2 A suitable material is 18% chromium, 8% nickel stainless steel conforming to UNS S30400 of ASTM A 240.⁴

3.1.6 Stirring apparatus: Any convenient form of stirring apparatus capable of maintaining a speed of $1,000 \pm 50$ rpm may be used.

3.1.7 Grinding and polishing equipment: A 100-grit, metalworking, J-weight silicon carbide abrasive cloth, a suitable chuck for holding the test specimen, and a means for rotating the test specimen at a speed of 1,700 to 1,800 rpm shall be used.

3.1.7.1 Note: A consistent polishing procedure is crucial to minimizing variation in test results between laboratories. Paper-backed abrasives have been found to give results different from cloth-backed abrasives and should not be used. Additionally, use of an "x-weight" cloth-backed abrasive is not recommended because it is not flexible enough to be used for hand polishing.

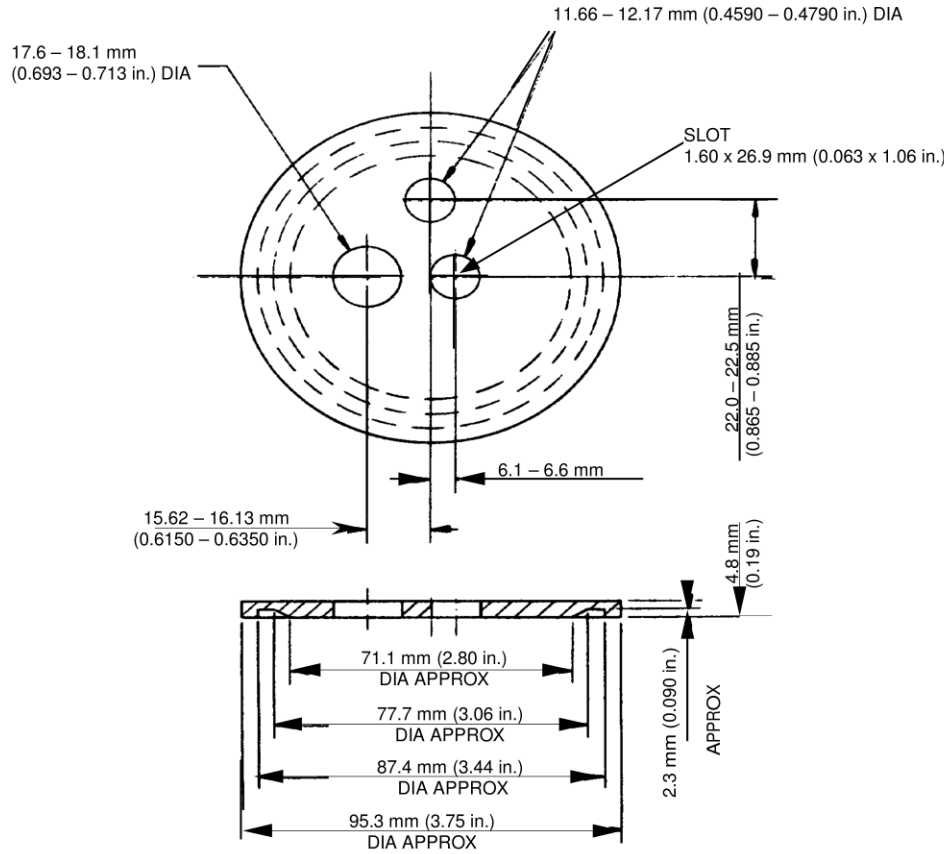


FIGURE 3: Test Beaker Cover

Dimensions for cover to be used on test beaker.

Note: All units are in millimeters unless otherwise specified.
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Section 4: Testing Procedures

4.1 The following procedures shall be used to conduct the test:

4.1.1 Clean the beaker and glass beaker cover with an approved cleaning solution, wash thoroughly with distilled water to remove the cleaning solution completely, and then dry in an oven.

4.1.2 Clean the stainless steel stirrer and polymethyl methacrylate cover using ASTM precipitation naphtha or isooctane. Wash thoroughly with hot water and finally with distilled water, and then dry at a temperature not exceeding 65°C (150°F), such as in an oven.

4.1.3 Pour 300 mL (10.1 oz fluid) of the fuel to be tested into the beaker and place the beaker in the oil bath, which should be maintained at a temperature that keeps the fuel sample at $38 \pm 1^\circ\text{C}$ ($100 \pm 2^\circ\text{F}$).

4.1.3.1 The oil level in the bath shall not be below the fuel level in the test beaker.

4.1.4 Cover the beaker with the beaker cover after placing the stirrer in the proper opening; then rotate the beaker so that the baffles are 90 degrees from the test specimen hole (as described in Paragraph 3.1.3).

4.1.5 Adjust the stirrer so that the shaft is 6.1 mm (0.24 in.) off center in the beaker containing the fuel sample and the blade is within 2 mm (0.09 in.) of the bottom of the beaker.

4.1.6 Suspend the temperature-measuring device through the hole intended for that purpose so that it is immersed to a depth of 56 mm (2.2 in.).

4.1.7 Start the stirrer, and when the temperature of the fuel sample reaches $38 \pm 1^\circ\text{C}$ ($100 \pm 2^\circ\text{F}$), insert the steel test specimen prepared in accordance with Section 2.

4.1.8 Insert the test specimen assembly through the test specimen hole in the beaker cover and suspend it such that its lower end is 13 to 15 mm (0.51 to 0.59 in.) from the bottom of the beaker.

4.1.9 Stir at $1,000 \pm 50$ rpm for 30 minutes to ensure complete wetting of the steel test specimen.

4.1.10 With the stirrer in motion, remove the temperature-measuring device temporarily and add 30 mL (1.0 oz fluid) of distilled water through this hole, discharging the water onto the bottom of the beaker. This can be accomplished by injecting the water with a syringe through a needle or by pouring through a long-necked funnel. Then replace the temperature-measuring device or, alternatively, stopper the hole.

4.1.11 Continue stirring at a speed of $1,000 \pm 50$ rpm for 3.5 hours from the time the water was added, maintaining the temperature of the fuel-water mixture at $38 \pm 1^\circ\text{C}$ ($100 \pm 2^\circ\text{F}$).

4.1.12 Stop the stirring at the end of the 3.5-hour period. Remove the test specimen, allow it to drain, and then wash it with toluene or xylene followed by acetone.

4.1.12.1 If desired, the test specimen may be preserved by lacquering.

Section 5: Rating of Test Specimen

5.1 Rating shall be based exclusively on the portion of the test specimen exposed within the test fluid. Corrosion products formed during the test have had limited opportunity to darken, and all deposition of solids not removed by washing with toluene and acetone shall be considered corrosion products. Circumferential etching can occur during polishing and should not be interpreted as corrosion.

5.2 Final inspection shall be made with a lighted glass of 2X magnification.

5.3 Rating shall be based on that portion of the test specimen that has changed, and shall be expressed according to the scale in Table 1.

5.4 Data records and time logs shall meet the requirements of the quality control procedures of the particular locality and laboratory, which can vary.

TABLE 1
Rating of the Test Specimen

Rating	Percent of Test Surface Corroded
A	0
B++	Less than 0.1 (2 or 3 spots of no more than 1-mm [0.04-in.] diameter)
B+	Less than 5
B	5 to 25
C	25 to 50
D	50 to 75
E	75 to 100

Section 6: Safety Precautions

6.1 Personnel conducting tests shall at all times be aware of potential hazards and avoid accidents when handling gasoline and other highly volatile products.

6.2 Hazardous vapors are formed when this test is run on gasoline. Therefore, this test shall not be conducted in a

small, closed space. Tests shall be run in large, well-ventilated laboratories or in a vented hood.

6.3 Procedures used while conducting this test should meet safety requirements of the particular locality and laboratory, which can vary.

References

1. ASTM D 665 (latest revision), "Standard Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water" (West Conshohocken, PA: ASTM).

2. ASTM A 108 (latest revision), "Standard Specification for Carbon Steel Forgings for Piping Applications" (West Conshohocken, PA: ASTM).

3. ASTM D 91 (latest revision), "Standard Test Method for Precipitation Number of Lubricating Oils" (West Conshohocken, PA: ASTM).

4. ASTM A 240 (latest revision), "Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels" (West Conshohocken, PA: ASTM).