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Designation: 154/93

Standard Test Method for Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test¹

This standard is issued under the fixed designation D 130; 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. This is also a standard of the Institute of Petroleum issued under the fixed designation IP 154. The final number indicated the year of last revision.

This test method has been approved by the sponsoring committees and accepted by the cooperating societies in accordance with established procedures.

This standard has been approved for use by agencies of the Department of Defense.

^{ε1} NOTE—The warning statements were placed in the text editorially in August 2000.

1. Scope

1.1 This test method covers the detection of the corrosiveness to copper of aviation gasoline, aviation turbine fuel, automotive gasoline, natural gasoline or other hydrocarbons having a Reid vapor pressure no greater than 18 psi (124 kPa), cleaners (Stoddard) solvent, kerosine, diesel fuel, distillate fuel oil, lubricating oil, and certain other petroleum products. (**Warning**—Some products, particularly natural gasoline, may have a much higher vapor pressure than would normally be characteristic of automotive or aviation gasolines. For this reason, extreme caution must be exercised to ensure that the test bomb containing natural gasoline or other products of high vapor pressure are not placed in the 100°C (212°F) bath. Samples having Reid vapor pressures in excess of 18 psi (124 kPa) may develop sufficient pressure at 100°C to cause rupture of the test bomb. For any sample having a Reid vapor pressure above 18 psi (124 kPa), use Test Method D 1838. Also, see Annex A2.)

1.2 *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.* For specific hazard statements, see 1.1, 6.1, and Annex A2.

¹ This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.05.0C on Color and Reactivity.

In the IP, this test method is under the jurisdiction of the Standardization Committee.

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2. Referenced Documents

2.1 ASTM Standards:

D 396 Specification for Fuel Oils²

D 975 Specification for Diesel Fuel Oils²

D 1655 Specification for Aviation Turbine Fuels²

D 1838 Test Method for Copper Strip Corrosion by Liquefied Petroleum (LP) Gases²

2.2 ASTM Adjuncts: ASTM

Copper Strip Corrosion Standard³

3. Summary of Test Method

3.1 A polished copper strip is immersed in a given quantity of sample and heated at a temperature and for a time characteristic of the material being tested. At the end of this period the copper strip is removed, washed, and compared with the ASTM Copper Strip Corrosion Standards.

4. Significance and Use

4.1 Crude petroleum contains sulfur compounds, most of which are removed during refining. However, of the sulfur compounds remaining in the petroleum product, some can have a corroding action on various metals and this corrosivity is not necessarily related directly to the total sulfur content. The effect can vary according to the chemical types of sulfur compounds present. The copper strip corrosion test is designed to assess the relative degree of corrosivity of a petroleum product.

² *Annual Book of ASTM Standards*, Vol 05.01.

³ Available from ASTM Headquarters. Request Adjunct No. ADJD0130.

Names of suppliers in the United Kingdom can be obtained from the Institute of Petroleum. Two master standards are held by the IP for reference.

5. Apparatus

5.1 Test Tubes, 25 by 150-mm.

5.1.1 Provide a bath capable of being maintained at a constant temperature of $50 \pm 1^\circ\text{C}$ ($122 \pm 2^\circ\text{F}$) or $100 \pm 1^\circ\text{C}$ ($212 \pm 2^\circ\text{F}$), or both, and having suitable supports to hold the test tubes in a vertical position and immersed to a depth of about 100 mm (4 in.). Either water, oil, or aluminum block baths are suitable.

5.2 *Copper Strip Corrosion Test Bomb*, constructed of stainless steel according to the dimensions as given in Fig. 1, and capable of withstanding a test pressure of 100 psi (689 kPa). Alternative designs for the bomb cap and synthetic rubber gasket may be used provided that the internal dimensions of the bomb are the same as those shown in Fig. 1. Provide a 25 by 150-mm test tube as a liner for holding the sample.

5.2.1 Provide liquid baths capable of being maintained at $40 \pm 1^\circ\text{C}$ ($104 \pm 2^\circ\text{F}$) or $100 \pm 1^\circ\text{C}$ ($212 \pm 2^\circ\text{F}$), or both, and having suitable supports to hold the test bomb in a vertical position. The bath must be deep enough so that the entire bomb will be submerged during the test. As the bath medium, use water or any other liquid which can be satisfactorily controlled at the specified test temperature.

5.3 *Thermometers*, total immersion, for indicating the required test temperature, with smallest graduations of 1°C (2°F) or less. No more than 25 mm (1 in.) of the mercury thread should extend above the surface of the bath at the test temperature. The ASTM 12C (12F) or IP 64C (64F) thermometer is suitable.

5.4 *Polishing Vise*, for holding the copper strip firmly without marring the edges while polishing. Any convenient type of holder (see Appendix) may be used provided that the strip is held tightly and that the surface of the strip being polished is supported above the surface of the holder.

5.5 *Viewing Test Tubes*, flat glass test tubes, are convenient for protecting corroded strip for close inspection or storage (see Appendix).

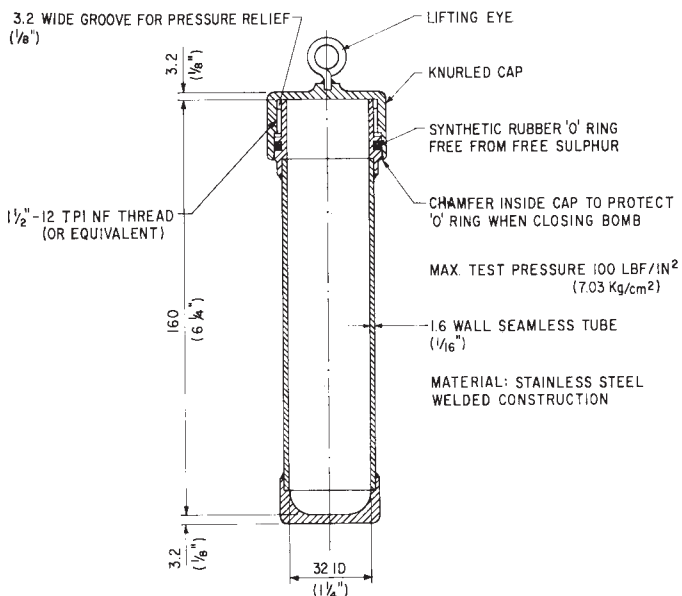


FIG. 1 Copper Strip Corrosion Test Bomb

6. Materials

6.1 *Wash Solvent*—Any volatile, sulfur-free hydrocarbon solvent may be used provided that it shows no tarnish at all when tested at 50°C (122°F). Knock test grade *isooctane* is a suitable solvent and should be used in case of dispute. (**Warning**—Extremely flammable, see A2.1.)

6.2 *Polishing Materials*—Silicon carbide grit paper of varying degrees of fineness including 65- μm (240-grit) paper or cloth; also a supply of 105- μm (150-mesh) silicon carbide grain and pharmaceutical grade absorbent cotton (cotton wool).

6.3 Copper Strips:

6.3.1 *Specification*—Use strips 12.5 mm (1/2 in.) wide, 1.5 to 3.0 mm (1/16 to 1/8 in.) thick, cut 75 mm (3 in.) long from smooth-surfaced, hard-temper, cold-finished copper of 99.9 + % purity; electrical bus bar stock is generally suitable (see Appendix). The strips may be used repeatedly but should be discarded when the surfaces become deformed on handling.

6.3.2 *Surface Preparation*—Remove all surface blemishes from all six sides of the strip with silicon carbide paper of such degrees of fineness as are needed to accomplish the desired results efficiently. Finish with 65- μm (240-grit) silicon carbide paper or cloth, removing all marks that may have been made by other grades of paper used previously. Immerse the strip in wash solvent from which it can be withdrawn immediately for final preparation (polishing) or in which it can be stored for future use.

6.3.2.1 As a practical manual procedure for surface preparation, place a sheet of the paper on a flat surface, moisten it with kerosene or wash solvent, and rub the strip against the paper with a rotary motion, protecting the strip from contact with the fingers with an ashless filter paper. Alternatively, the surface of the strip can be prepared by use of motor-driven machines using appropriate grades of dry paper or cloth.

6.3.3 *Final Preparation*—Remove a strip from the wash solvent. Holding it in the fingers protected with ashless filter paper, polish first the ends and then the sides with the 105- μm (150-mesh) silicon carbide grains picked up from a clean glass plate with a pad of cotton (cotton wool) moistened with a drop of wash solvent. Wipe vigorously with fresh pads of cotton (cotton wool) and subsequently handle only with stainless steel forceps; *do not touch with the fingers*. Clamp in a vise and polish the main surfaces with silicon-carbide grains on absorbent cotton. Do not polish in a circular motion. Rub in the direction of the long axis of the strip, carrying the stroke beyond the end of the strip before reversing the direction. Clean all metal dust from the strip by rubbing vigorously with clean pads of absorbent cotton until a fresh pad remains unsoiled. When the strip is clean, immediately immerse it in the prepared sample.

6.3.3.1 It is important to polish the whole surface of the strip uniformly to obtain a uniformly stained strip. If the edges show wear (surface elliptical) they will likely show more corrosion than the center. The use of a vise (see Appendix) will facilitate uniform polishing.

6.3.3.2 It is important to follow the order of preparation with the correctly sized silicon carbide material as described in 6.3.2 and 6.3.3. The final preparation is with 105- μm silicon carbide grains. This is a larger grain size than the 65 micron

paper used in the surface preparation stage. The reason for this use of larger silicon carbide grains in the final preparation is to produce asperities (controlled roughness) on the surface of the copper which acts as sites for the initiation of corrosion reactions.

7. Corrosion Standards

7.1 *ASTM Copper Strip Corrosion Standards*⁴ consist of reproductions in color of typical test strips representing increasing degrees of tarnish and corrosion, the reproductions being encased in plastic in the form of a plaque.

7.1.1 Keep the plastic-encased printed ASTM Copper Strip Corrosion Standards protected from light to avoid the possibility of fading. Inspect for fading by comparing two different plaques, one of which has been carefully protected from light (new). Observe both sets in diffused daylight (or equivalent) first from a point directly above and then from an angle of 45°. When any evidence of fading is observed, particularly at the left-hand end of the plaque, it is suggested that the one that is the more faded with respect to the other be discarded.

7.1.1.1 Alternatively, place a 20-mm (3/4-in.) opaque strip (masking tape) across the top of the colored portion of the plaque when initially purchased. At intervals remove the opaque strip and observe. When there is any evidence of fading of the exposed portion, it is suggested that the standards be replaced.

7.1.1.2 These plaques are full-color reproductions of typical strips. They have been printed on aluminum sheets by a 4-color process and are encased in plastic for protection. Directions for their use are given on the reverse side of each plaque.

7.1.2 If the surface of the plastic cover shows excessive scratching it is suggested that the plaque be replaced.

8. Samples

8.1 It is particularly important that all types of fuel samples, which pass a low-tarnish strip classification, be collected in clean, dark glass bottles, plastic bottles, or other suitable containers that will not affect the corrosive properties of the fuel. Avoid the use of tin plate containers for collection of samples, since experience has shown that they may contribute to the corrosiveness of the sample.

8.2 Fill the containers as completely as possible and close them immediately after taking the sample. Take care during sampling to protect the samples from exposure to direct sunlight or even diffused daylight. Make the test as soon as possible after receipt in the laboratory and immediately after opening the container.

8.3 When suspended water (haze) is observed in the sample, dry by filtering a sufficient volume of sample through a medium rapid qualitative filter, into the prescribed clean, dry test tube. Carry out this operation in a darkened room or under a light-protected shield.

8.3.1 Contact of the copper strip with water before, during, or after the completion of the test run, will cause staining, making it difficult to evaluate the strips.

9. Procedure

9.1 Those product classes, to which given procedural variations are intended to be applied, are listed below. Some product classes, being quite broad, may be tested by more than one set of conditions; in such cases the copper strip quality requirement for a given product should be limited to a single set of conditions. The conditions of time and temperature given below are those most commonly used and are quoted in the ASTM specifications for these products where such specifications exist. However, other conditions can also be used as and when required by specifications or by agreement between parties.

9.1.1 *For aviation gasoline, and aviation turbine fuel*—Place 30 mL of sample, completely clear and free of any suspended or entrained water (see 8.3) into a chemically clean, dry 25 by 150-mm test tube, and within 1 min after completing the final preparation (polishing), slide the copper strip into the sample tube. Carefully slide the sample tube into the test bomb (Fig. 1) and screw the lid on tight. Completely immerse the bomb in a boiling water bath at $100 \pm 1^\circ\text{C}$ ($212 \pm 2^\circ\text{F}$). After $2 \text{ h} \pm 5 \text{ min}$ in the bath, withdraw the bomb and immerse for a few minutes in tap water. Open the bomb, withdraw the test tube and examine the strip as described in 9.2.

9.1.2 *For natural gasoline*—Carry out the test exactly as described in 9.1.1 but at 40°C (104°F) and for $3 \text{ h} \pm 5 \text{ min}$.

9.1.3 *For diesel fuel, fuel oil, automotive gasoline*—Place 30 mL of sample, completely clear and free of any suspended or entrained water (see 8.3), into a chemically clean, dry 25 by 150-mm test tube and, within 1 min after completing the final preparation (polishing), slide the copper strip into the sample tube. Stopper with a vented cork and place in a bath maintained at $50 \pm 1^\circ\text{C}$ ($122 \pm 2^\circ\text{F}$) (see 5.1.1). Protect the contents of the test tube from strong light during the test. After $3 \text{ h} \pm 5 \text{ min}$ in the bath, examine the strip as described in 9.2. For tests on fuel oil and diesel fuel, to specifications other than Specifications D 396 and D 975, a temperature of 100°C (212°F) for 3 h is often used as an alternative set of conditions.

9.1.4 *For cleaners (Stoddard) solvent and kerosine*—Carry out the test exactly as described in 9.1.3 but at $100 \pm 1^\circ\text{C}$ ($212 \pm 2^\circ\text{F}$).

9.1.5 *For lubricating oil*—Tests can be carried out for varying times and at elevated temperatures other than 100°C (212°F). For the sake of uniformity, it is suggested that even increments of 50°F beginning with 250°F (or Celsius equivalents to the nearest whole degree) be used.

9.2 Strip Examination:

9.2.1 Empty the contents of the test tube into a 150-mL tall-form beaker, letting the strip slide in gently so as to avoid breaking the beaker. Immediately withdraw the strip with stainless steel forceps and immerse in wash solvent. Withdraw the strip at once, dry with quantitative filter paper (by blotting and not by wiping), and inspect for evidences of tarnishing or corrosion by comparison with the Copper Strip Corrosion Standards. Hold both the test strip and the standard strip plaque in such a manner that light reflected from them at an angle of approximately 45° will be observed.

9.2.2 In handling the test strip during the inspection and comparison, the danger of marking or staining can be avoided

⁴ Conforming to Copper Development Assn. (CDA), United States of America No. 110, or to British Standard (BS) 1036: 1952, which have proper quality.

if it is inserted in a flat glass tube (see Appendix X1) which can be stoppered with absorbent cotton.

10. Interpretation

10.1 Interpret the corrosiveness of the sample accordingly as the appearance of the test strip agrees with one of the strips of the ASTM Copper Strip Corrosion Standards.

10.1.1 When a strip is in the obvious transition state between that indicated by any two adjacent standard strips, judge the sample by the more tarnished Standard Strip. Should a strip appear to have a darker orange color than Standard Strip 1*b*, consider the observed strip as still belonging in Classification 1; however, if any evidence of red color is observed, the observed strip belongs in Classification 2.

10.1.2 A claret red strip in Classification 2 can be mistaken for a magenta overcast on brassy strip in Classification 3 if the brassy underlay of the latter is completely masked by a magenta overtone. To distinguish, immerse the strip in wash solvent; the former will appear as a dark orange strip while the latter will not change.

10.1.3 To distinguish multicolored strips in Classifications 2 and 3, place a test strip in a 20 by 150-mm test tube and bring to a temperature of 315 to 370°C (600 to 700°F) in 4 to 6 min with the tube lying on a hot plate. Adjust to temperature by observing a high distillation thermometer inserted into a

second test tube. If the strip belongs in Classification 2, it will assume the color of a silver and then a gold strip, if in Classification 3 it will take on the appearance of a transparent black, etc., as described in Classification 4.

10.1.4 Repeat the test if blemishes due to finger prints are observed, or due to spots from any particles of water droplets that may have touched the test strip during the digestion period.

10.1.5 Repeat the test also if the sharp edges along the flat faces of the strip appear to be in a classification higher than the greater portion of the strip; in this case it is likely that the edges were burnished during preparation (polishing).

11. Report

11.1 Report the corrosiveness in accordance with one of the classifications listed in Table 1. State the duration of the test and the test temperature.

12. Precision and Bias

12.1 In the case of pass/fail data no generally accepted method for determining precision or bias is currently available.

13. Keywords

13.1 automotive gasoline; aviation gasoline; aviation turbine fuel; copper corrosion; copper strip finish; corrosiveness to copper; natural gasoline

TABLE 1 Copper Strip Classifications

Classification	Designation	Description ^A
Freshly polished strip	...	^B
1	slight tarnish	a. Light orange, almost the same as freshly polished strip b. Dark orange
2	moderate tarnish	a. Claret red b. Lavender c. Multicolored with lavender blue or silver, or both, overlaid on claret red d. Silvery e. Brassy or gold
3	dark tarnish	a. Magenta overcast on brassy strip b. Multicolored with red and green showing (peacock), but no gray
4	corrosion	a. Transparent black, dark gray or brown with peacock green barely showing b. Graphite or lusterless black c. Glossy or jet black

^A The ASTM Copper Strip Corrosion Standard is a colored reproduction of strips characteristic of these descriptions.

^B The freshly polished strip is included in the series only as an indication of the appearance of a properly polished strip before a test run; it is not possible to duplicate this appearance after a test even with a completely noncorrosive sample.