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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Disbonding Characteristics of Pipeline Coatings by Direct Soil Burial[1]

This standard is issued under the fixed designation G 19; 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.

ϵ^1 NOTE—Keywords were added editorially in June 1996.

1. Scope

1.1 This test method describes the determination of the relative disbonding characteristics of damaged coatings on steel pipe by cathodic protection potentials in direct soil burial. This test method is intended to apply to the testing of all types of nonmetallic pipeline coatings and tapes including thermoplastics, thermoset, and bituminous materials.

1.2 Results may vary widely when test sites are in different geographical areas of the country, and even in different localities.

1.3 This test method is limited to nonconducting, or nonmetallic pipe coatings and is not applicable to conducting materials such as zinc coatings on steel pipe.

1.4 *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.*

1.5 The values stated in SI units to three significant decimals are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

G 12 Test Method for Nondestructive Measurement of Film Thickness of Pipeline Coatings on Steel[2]

G 62 Test Methods for Holiday Detection in Pipeline Coatings[2]

3. Summary of Test Method

3.1 Apparatus and materials are described whereby protective coatings on steel pipe are subjected to disbonding by an electrical stress. Specimens with intentionally damaged areas are buried in soil at an outdoor site and electrically connected to a magnesium anode. After test, the disbonded coating is removed, the exposed area measured, and comparisons are made to other specimens similarly exposed.

4. Significance and Use

4.1 Coated pipe is seldom, if ever, buried without some damage to the coating. Hence, an actual soil-burial test can contribute significant data, provided the method of testing is controlled and the test specimen monitored and the relationship between the area disbonded, the current demand, and the mode of failure is fully understood.

4.2 Means are provided for measuring and following the electrical potential and current flow and relating these data to the final measurement of disbonded area.

5. Apparatus

5.1 *Anode*—A standard packaged magnesium anode, minimum 4.082 kg (9 lb), with a factory-sealed, 4107-cmil (14-gage Awg) minimum, insulated copper wire shall be used. A solution potential of not less than − 1.45 V with respect to a copper-copper sulfate reference electrode is required. Use sufficient anodes to maintain required potential.

5.2 *Connectors*—The wiring circuit from anode to test specimen and from specimen to reference electrode should be 4107-cmil (14-gage Awg) minimum insulated copper wire. Attach the wires to the test specimen as shown in Fig. 1 by soldering or brazing at the air-exposed end, and coat the place of attachment with insulating material. A junction box is optional for connecting the resistor in series between the anode and the test specimen.

5.3 The instruments used shall include the following:

5.3.1 *Voltmeter*, a suitable instrument such as a high impedance (>10mΩ) analog multimeter having a sensitivity of 50 000Ω/ V minimum and a multiple range from 0.01 to 2 V for direct current is used for measuring the potential between specimen and the reference electrode,[3] current between specimen and anode, and the resistance of the circuit. The same instrument shall be used for measuring current between specimen and anode. Alligator clips on the leads are permissible.

5.3.2 *Volt-Ohm-Meter* for measuring resistance of the circuit.

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[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.48 on Durability of Pipeline Coatings and Linings.

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[2] *Annual Book of ASTM Standards*, Vol 06.02.

[3] A pipe-to-soil Voltmeter-Ammeter, Agra Engineering Co., Tulsa, Okla., has been found suitable for this test.

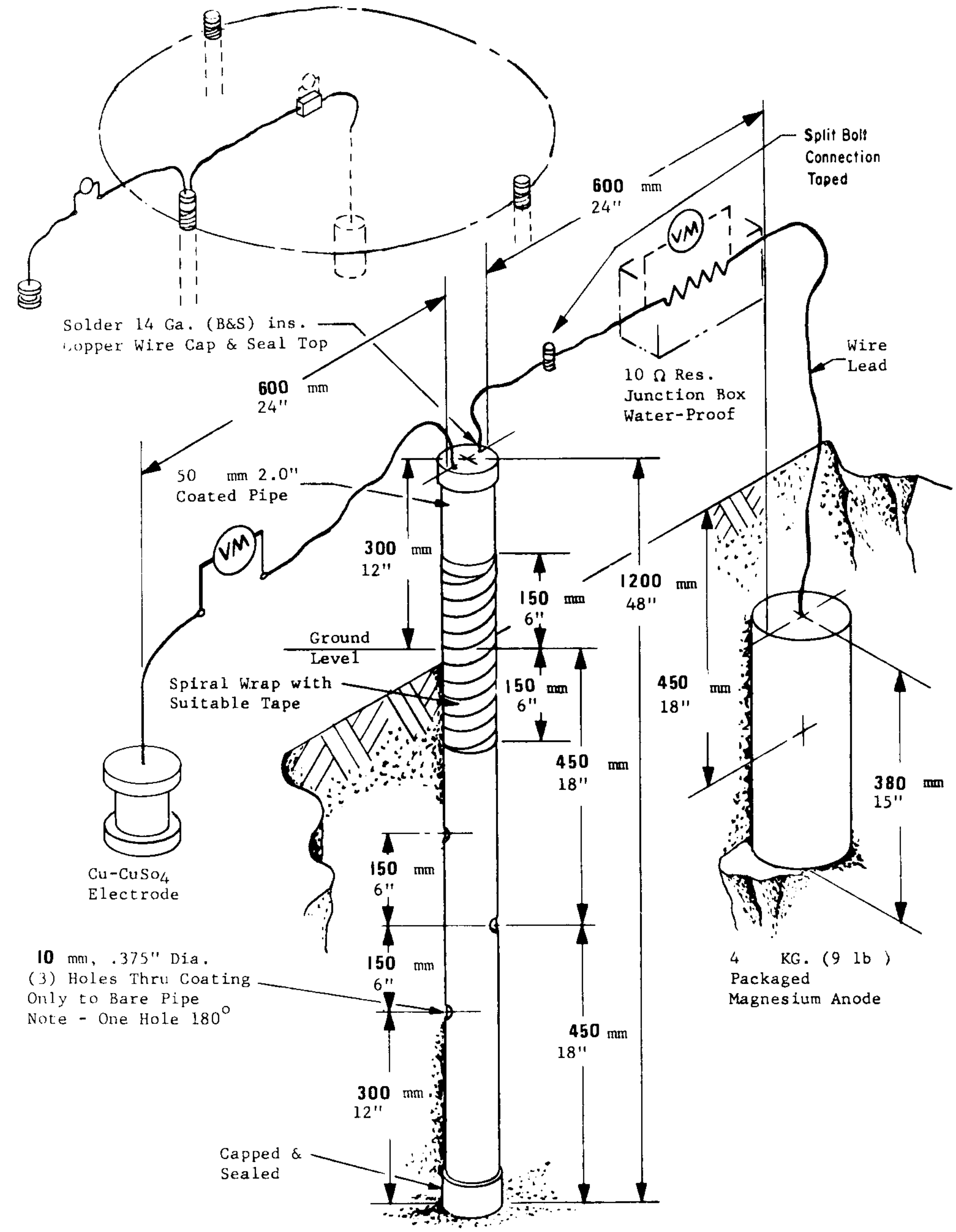

FIG. 1 Three Specimens in a Circle with a Common Anode

5.3.3 *Reference Electrode,* consisting of a copper-copper sulfate half cell in a conventional glass or plastic tube with porous plug construction, but preferably not over 19.05 mm (¾ in.) in diameter, having a potential of − 0.316 V with respect to a standard hydrogen electrode. A calomel electrode may be used, but measurements made with it should be converted to the copper-copper sulfate reference electrode for reporting, by adding − 0.092 V to the observed reading.

5.3.4 A suitable instrument is used to measure the soil resistivity using the four-pin method.[4] Pins should be spaced 762 mm (30 in.) apart.

5.3.5 *Thickness Gages,* to be used in accordance with Test Method G 12.

5.3.6 *Holiday Tools*—Holidays in the specimen are made with conventional drills of the required diameter. A9.525-mm (0.375-in.) drill modified by substantially reducing the cone angle has been found effective in preventing perforation of thin-wall pipe or tubing. A sharp-pointed knife with a safe handle is required for removing disbonded coatings to make physical examinations. A micrometer-type depth gage is used for measuring coating thicknesses at the edge of holidays.

5.3.7 *Holiday Detectors*—Selected in accordance with Test Method G 62.

[4] A Vibroground instrument, Associated Research Inc., 3758 Belmont Ave., Chicago, Ill., has been found suitable for measuring soil resistivity.

6. Test Specimen

6.1 A 1219.2 mm (48-in.) long specimen shall be prepared with its surface preparation and coating procedures equivalent to that of production coated pipe. Only holiday-free specimens may be used in this test and four samples should be prepared.

6.2 Measure the coating thickness of all specimens at four points 90 deg apart and approximately 355.6 mm (14 in.) from each end.

6.3 Cap and seal one end of each specimen. Check the seal for current leakage before and after test by immersion in 1 weight percent sodium chloride solution for ½ h. Test with an ohmmeter sensitive to at least 1 MΩ.

6.4 Provide the unsealed end of the pipe with two lengths of insulated 4107-cmil (14-gage Awg) copper wire as in 5.2.

6.5 Make 3 holidays 304.8 mm (12 in.), 457.2 mm (18 in.), and 609.6 mm (24 in.), respectively, from the sealed end of the pipe by drilling holes through the coating so that the drill will fully enter the steel. The center holiday is to face the anode with the remaining two holidays facing 180 deg away from the anode. The drill diameter may not be less than two times the coating thickness, and never smaller than 9.525 mm (0.375 in.) in diameter. Do not perforate the steel wall of the pipe. With thin-wall steel pipe where there is danger of perforating the pipe, start the holiday with a standard 60-deg cone-point drill and finish with a substantially reduced cone-angle drill.

6.6 To prevent mechanical damage, apply a spiral wrap of suitable tape from approximately 152.4 mm (6 in.) from the top of the pipe specimen to 457.2 mm (18 in.) from the top. When the test specimens are buried, the taped area will extend 152.4 mm above and 152.4 mm below ground.

6.7 The specimen test area will consist of the area between the edge of the bottom end seal and the ground level. The bottom end-seal area is not considered part of the area tested. Any suitable diameter and length of pipe may be used, but the buried area should not be less than 23 227.2 mm^2 (36 in.^{2}). An area of 93 000 mm^2 (1 ft^2) has been found preferable.

7. Test Site

7.1 Any level location may be used, provided the site will not be disturbed for the duration of the test.

8. Procedure

8.1 Lay out the test site with stakes so that the anode location will be the center of a circle as shown in Fig. 1. Locate the pipe specimens 20° apart around the circumference so that the surface of the anode when placed in the center will be 609.6 mm (24 in.) from the nearest holiday of each specimen equally. Three specimens can thus be protected by one anode.

8.2 *Installation of Test Specimens*:

8.2.1 Dig suitable holes with an auger or posthole digger to accommodate the anode and test specimens at the test site.

8.2.2 Insert the anode at the center of the circle. The center of the anode should be 457.2 mm (18 in.) below ground. Pipe specimens should be inserted so that 304.8 mm (12 in.) are above the ground level, and oriented so that the single intentional holiday faces the anode and the remaining two holidays are 180° away from the anode. Maintain a distance of 609.6 mm (24 in.) between the surface of the anode and the nearest specimen and holiday.

8.2.3 Refill all holes with soil or a soil and water slurry. Firmly tamp the soil so that it is in intimate contact with the specimen and anode. No wood or other foreign material should contact the pipe coating or the anode.

8.3 *Electrical Measurements*:

8.3.1 Determine in several areas the soil resistance in ohm-centimetres by the four-pin method.

8.3.2 Measure the initial pipe to soil potential with reference to a copper-copper sulfate half cell with the electrode 609.6 mm (24 in.) from the pipe as shown in Fig. 1. Record the closed-circuit potentials.

8.3.3 Connect the anode lead to one test specimen lead at the junction box with a 10 Ω ± 1 % wire-wound resistor connected in series between the anode and test specimen.

8.3.4 Measure the voltage. E, across the 10-Ω resistor, R, and convert to current, I as follows:

$$I = E/R = E/10 \quad (1)$$

8.3.5 Measure the polarized potential, in volts with the analog multimeter described in 5.3.8 connected between the test specimen and the reference electrode as follows:

8.3.5.1 Disconnect the anode from the test specimen while closely observing the analog multimeter. As the instrument pointer falls, it will dwell significantly at the polarized value before receding further. The dwell point is the polarized potential.

8.3.6 Determine electrical measurements at 30-day intervals for a test period of 18 months or longer depending on soil conditions.

9. Report

9.1 The report shall include the following information:

9.1.1 Complete identification of the test specimens, including name and code number of coating, size of the pipe, source, production date, production run number, and any other information that may be pertinent to identification.

9.1.2 Date of starting and of terminating the test.

9.1.3 Coating thickness of the test specimen before testing.

9.1.4 After subtracting the initial holiday areas, report the total disbonded area, average disbonded area, and disbonded area at each holiday in square millimetres (square inches) after testing.

9.1.5 Condition of the pipe surface under the disbonded coating.

9.1.6 Pipe-to-soil potentials, initial readings and at 30-day intervals.

9.1.7 Current readings between anode and pipe specimens, initial readings and 30-day intervals.

9.1.8 Soil resistivity readings in ohm-centimetres.

9.1.9 Polarized potentials, initial readings and 30-day intervals.

10. Precision

10.1 Precision data are limited to two adjacent specimens taken from the same production-coated pipe, assuming that the production process was uniform with respect to pipe surface condition and coating material. Specimens that were not adjacent in the as-produced condition, or were taken from different lengths of pipe may represent differing process conditions.

11. Keywords

11.1 cathodic disbonding; pipeline coatings; soil burial