Designation: G8 – 24

Standard Test Methods for Cathodic Disbonding of Coated Steel[1]

This standard is issued under the fixed designation G8; 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 These test methods apply to procedures for determining the degree of disbondment of a coating from a steel substrate when placed in contact with an electrolyte and a potential is applied to the steel. Specimens may include coated steel pipe or coated flat or curved steel plate. The coating applied to the steel substrate shall be non-metallic and shall not show flow characteristics at the test temperature.

1.2 These test methods apply to specimens that are immersed in an electrolyte bath or specimens with an attached electrolyte cell at ambient room temperature, 21 °C to 25 °C (70 °F to 77 °F), conditions. If higher temperatures are required, use Test Method G42.

1.3 These test methods apply to methods of polarization including sacrificial anodes or impressed current applied to the steel by a rectifier.

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

1.5 *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.*

1.6 *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:*[2]

A36 Specification for Carbon Structural Steel

D1141 Practice for Preparation of Substitute Ocean Water

D5162 Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates

D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

G42 Test Method for Cathodic Disbonding of Pipeline Coatings Subjected to Elevated Temperatures

G95 Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)

3. Summary of Test Method

3.1 Three test methods are described in this standard. In each method, an artificial holiday or defect is applied to the specimen's coating film through to the steel substrate. The specimen is immersed in a defined electrolyte with the steel polarized to a defined voltage.

3.1.1 *Method A*—The specimens are immersed in an electrolyte immersion bath. A specified metallic anode is used to polarize the specimen with no electrical monitoring during the test period.

3.1.2 *Method B*—The specimens are immersed in an electrolyte immersion bath. Polarization of the specimen is conducted using an impressed current potentiostat at a specified DC voltage with electrical monitoring during the test period.

3.1.3 *Method C*—The specimens shall have a cell containing the electrolyte attached to the surface of the specimen. Polarization of the specimen is conducted using an impressed current potentiostat at a specified DC voltage with electrical monitoring during the test period.

3.2 Upon completion of immersion exposure, a physical examination is conducted by comparing the extent of loosened

[1] These test methods are under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and are the direct responsibility of Subcommittee D01.48 on Durability of Pipeline Coating and Linings.

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[2] 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.

or disbonded coating at the holiday in the immersed area with extent of loosened or disbonded coating at a new holiday in the coating made in an area that was not immersed. Test specimens are also examined for any other visible defect.

4. Significance and Use

4.1 Breaks or holidays in a coating applied over steel exposes the substrate to a potential corrosion cell. When the steel is subjected to cathodic protection by the polarization of the steel via sacrificial anodes or impressed current, the exposed steel at the holiday becomes the cathode in the corrosion cell. When the electrolyte is neutral or slightly alkaline, hydroxyl ions form from the reduction of oxygen and, when paired with a suitable cation from the electrolyte, form an alkaline solution. Depending on the strength of this alkaline solution and the concentration of the alkaline compound, this alkalinity may disrupt the adhesion between the coating and the steel, disbonding the coating from the steel.

4.2 Current density of the cathodic cell also can affect the degree of cathodic disbondment. The greater the current density generated by the concentration of electrons at the anode, the greater the number of hydroxyl ions formed, thus increasing the alkalinity available for disrupting the adhesion between the coating and the steel substrate. Likewise, the concentration of oxygen in the electrolyte will affect the concentration of hydroxyl ions formed at the cathode.

4.3 For these reasons it is often useful to measure pH, oxygen, and current density when conducting a cathodic disbondment test.

5. Apparatus

5.1 *Apparatus for All Three Methods—Method A, Method B, and Method C:*

5.1.1 *Connectors*—Wiring from anode to test specimen shall be 4107 cmil (14 gauge AWG), minimum, insulated copper. Attachment to the test specimen shall be by soldering, brazing, or bolting to the non-immersed end, and the place of attachment shall be coated with an insulating material. A junction in the connecting wire is permitted, provided that it is made by means of a bolted pair of terminal lugs soldered or mechanically crimped to clean wire ends.

5.1.2 *Holiday Tools*—Holidays shall be made with conventional drills of the required diameter. For use in preparing small-diameter pipe specimens, the use of a flat end mill has been found effective in preventing perforation of the metal wall of the pipe.

5.1.3 *Disbondment Evaluation Tools*—A sharp-pointed thin blade knife with a safe handle is required for use in removing disbonded coating from the specimen.

5.1.4 *Reference Electrode*—A reference electrode Ag/AgCl in saturated KCl with double junction, or a saturated Cu/$CuSO_4$ reference electrode shall be used. The accuracy of the Ag/AgCl reference electrode shall be checked before starting the test. The Ag/AgCl reference electrode can be checked against another Ag/AgCl reference electrode which is only used for accuracy checkup only without routine usage. The two Ag/AgCl reference electrodes can be inserted into the same electrolyte solution (for example, 3 % NaCl solution). The voltage differential shall be within 5 mV. If over 5 mV, the subject Ag/AgCl reference electrode shall be discarded.

5.1.5 *Thickness Gauge,* for measuring coating thickness in accordance with Practice D7091.

5.1.6 *Holiday Detector,* for locating holidays in the coating of the test specimen in accordance with Practice D5162, Test Method A – Low Voltage Wet Sponge Testing.

5.1.7 *Thermometer,* for measuring electrolyte temperature, general lab type, 1° subdivisions, 76.2 mm (3 in.) immersion.

5.1.8 *High-Resistance Voltmeter,* for direct current, having an internal resistance of not less than 10 MΩ and capable of measuring as low as 10 μV potential drop across a shunt in the test cell circuit.

5.2 *Additional Apparatus for Methods, Method A and Method B:*

5.2.1 *Test Vessel*—A nonconducting material shall be used for the vessel or as a lining in a metallic vessel. Dimensions of the vessel shall permit the following requirements:

5.2.1.1 Test specimens shall be suspended vertically in the vessel with at least 25.4 mm (1.0 in.) clearance from the bottom.

5.2.1.2 Each test specimen shall be separated from the other specimens, from the anodes and from the walls of the test vessel by at least 38.1 mm (1.5 in.).

5.2.1.3 The depth of electrolyte shall permit the test length of the specimen to be immersed such that a minimum of 23 227 mm^2 (36 $in.^2$) shall be immersed in the electrolyte.

5.2.1.4 Plywood or plastic material has been found suitable for the construction of test vessel covers and for the support through apertures of test specimens and electrodes. Wood dowels introduced through holes in the top ends of test specimens have been found suitable for suspending test specimens from the vessel cover.

5.3 *Additional Apparatus for Method A:*

5.3.1 *Sacrificial Anodes*—Anodes shall be made as specified in Table 1. It shall have a surface area not less than one third that of the total specimen area exposed to electrolyte (for flat panels, the area containing the artificial holiday only and for pipe outside area exposed only). The anode shall be provided with a factory-sealed, 4107 cmil (14 gauge AWG), minimum, insulated copper wire for connecting to the test specimen. Anodes without a factory seal may be used if the alloy extends above the cover or if the connection of the wire to the anode is coated with an insulating material. Anodes, alternatively, may be directly bolted to the test specimen ensuring that there is positive electrical contact between the anode and the test specimen. If pre-used anodes are to be used, the anodes shall be cleaned by wire brushing or by immersion in dilute acid to remove corrosion products to ensure they are active.

TABLE 1

Metal Alloy	Potential (Ag/AgCl reference electrode)	Potential (Cu/$CuSO_4$ reference electrode)
Magnesium	–1.33 to –1.43 V	–1.45 to –1.55 V
Zinc	–0.88 to –0.98 V	–1.00 to –1.10 V
User specified alloy	User specified	User specified