



Designation: G 162 – 99

## Standard Practice for Conducting and Evaluating Laboratory Corrosions Tests in Soils<sup>1</sup>

This standard is issued under the fixed designation G 162; 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 practice covers procedures for conducting laboratory corrosion tests in soils to evaluate the corrosive attack on engineering materials.

1.2 This practice covers specimen selection and preparation, test environments, and evaluation of test results.

1.3 *This practice 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:

- D 1193 Specification for Reagent Water<sup>2</sup>
- D 1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments<sup>3</sup>
- D 2570 Test Method for Simulated Service Corrosion Testing of Engine Coolants<sup>4</sup>
- G 1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens<sup>5</sup>
- G 3 Practice for Conventions Applicable to Electrochemical Measurements in Corrosion Testing<sup>5</sup>
- G 4 Guide for Conducting Corrosion Coupon Tests in Field Applications<sup>5</sup>
- G 16 Practice For Applying Statistics to Analysis of Corrosion Data<sup>5</sup>
- G 31 Practice for Laboratory Immersion Corrosion Testing of Metals<sup>5</sup>
- G 46 Guide for Examination and Evaluation of Pitting Corrosion<sup>5</sup>
- G 51 Test Method for pH of Soil for Use in Corrosion Testing<sup>5</sup>

G 57 Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method<sup>5</sup>

G 71 Guide for Conducting and Evaluating Galvanic Corrosion Tests in Electrolytes<sup>5</sup>

G 102 Practice for Calculation of Corrosion Rates and Related Information from Electrochemical Measurements<sup>5</sup>

### 3. Significance and Use

3.1 This practice provides a controlled corrosive environment that has been utilized to produce relative corrosion information.

3.2 The primary application of the data from this practice is to evaluate metallic materials for use in soil environments.

3.3 This practice may not duplicate all field conditions and variables such as stray currents, microbiologically influenced corrosion, non-homogeneous conditions, and long cell corrosion. The reproducibility of results in the practice is highly dependent on the type of specimen tested and the evaluation criteria selected as well as the control of the operating variables. In any testing program, sufficient replicates should be included to establish the variability of the results.

3.4 Structures and components may be made of several different metals; therefore, the practice may be used to evaluate galvanic corrosion effects in soils (see Guide G 71).

3.5 Structures and components may be coated with sacrificial or noble metal coatings, which may be scratched or otherwise rendered discontinuous (for example, no coating on the edges of metal strips cut from a wide sheet). This test is useful to evaluate the effect of defective metallic coatings.

3.6 Structures and components may be coated or jacketed with organic materials (for example, paints and plastics), and these coatings and jackets may be rendered discontinuous. The test is useful to evaluate the effect of defective or incompletely covering coatings and jackets.

3.7 The corrosivity of soils strongly depends on soluble salt content (related parameters are soil resistivity, see Test Method G 57, and chemistry), acidity or alkalinity (measured by soil pH, see Test Method G 51), and oxygen content (loose, for example, sand, or compact, for example, clay, soils are extreme examples). The manufacturer, supplier, or user, or combination thereof, should establish the nature of the expected soil

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee G-1 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.10 on Corrosion in Soils.

Current edition approved Jan. 10, 1999. Published March 1999.

<sup>2</sup> Annual Book of ASTM Standards, Vol 11.01.

<sup>3</sup> Annual Book of ASTM Standards, Vol 06.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 15.05.

<sup>5</sup> Annual Book of ASTM Standards, Vol 03.02.

environment(s) and select the test environment(s) accordingly. Multiple types of soil can be used to determine the effect of this variable.

#### 4. Test Apparatus and Conditions

4.1 *Container*—The container for the soil shall be made from a material that is not affected by the soil environment and that does not affect the soil. Container materials, such as glass, plastic, or corrosion-resistant metal or alloy, can be used; however, electrically conductive containers must be electrochemically isolated from the specimens. The size of the container is determined by the volume of soil required for the test. A minimum of 40 cm<sup>3</sup> should be used for each 1 cm<sup>2</sup> of exposed metal surface area (see Fig. 1).

4.2 *Soil Environment*—The container is filled with a soil sample of choice. A soil sample from a specific outdoor location may be retrieved for the test, or a soil sample may be prepared with a specific property and chemistry. If necessary, physical and chemical characteristics of the soil may be determined.

4.2.1 A field soil sample may be utilized for purposes of conducting a soil corrosion test in a specific environment.

4.2.2 Laboratory soil samples may be prepared by using washed sand, (that is, No. 2 silica sand) clean clay (that is, bentonite) or other uniform known media.

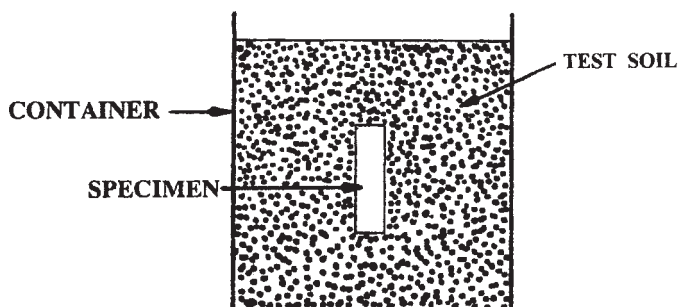
4.2.3 *Soil Chemistry*—The field soil sample and the laboratory soil sample are saturated with a known electrolyte chosen for the test. Typically, the electrolyte is added to the soil of choice in the container. A typical electrolyte for use with washed sand is ASTM corrosive water (see Test Method D 2570). With field soil samples, deionized or distilled water (see Test Method D2570) is commonly used. Periodically, deionized or distilled water (see Specification D 1193) is added to maintain the soil in a saturated condition. A non-saturated condition can be maintained if desired.

4.2.4 *Temperature*—The test is conducted under laboratory ambient temperature unless the effect of temperature is being evaluated.

4.2.5 *Test Specimen*—The test specimen is buried in the soil within the container and is prepared as discussed in Section 5.

#### 5. Test Specimen

5.1 *Material*—Prepare the test specimens from the same material as that used in the structures or components being studied. Alternatively, use test specimens from the actual products.



**FIG. 1** Apparatus for Conducting Laboratory Corrosion Tests in Soils

#### 5.2 Size and Shape:

5.2.1 The size and shape of test specimens are dependent on several factors and cannot be rigidly defined. When determining corrosion behavior of metals in the laboratory, it is advisable to use the largest specimens permissible within the constraints of the test equipment. In general, the ratio of surface area to metal volume should be large in order to obtain maximum corrosion loss per specimen weight. However, sufficient thickness should be employed to minimize the possibility of perforation of the specimen during the test exposure unless an evaluation of perforation susceptibility is of interest. When modeling large structures or components, the size of the specimens should be as large as practical. When modeling small components, the specimen size should be as close as possible to that of the component modeled. When the structure or component is made of two or more metals, the surface area ratio of the test specimen should be similar to the structure or component being modeled.

5.2.2 When modeling service applications, the shapes of the specimens should approximate the shapes in the application. Complex shapes are frequently simplified for testing purposes. For some tests, the specimen may be taken from the manufacturing line or cut from manufactured pieces (for example, short sections of pipes, wires, cables).

#### 5.3 Specimen Preparation:

5.3.1 Prepare the edges of the test specimens so as to eliminate all sheared or cold worked metal, except for cold working introduced by stamping for identification. Shearing can, in some cases, introduce residual stress that may cause considerable attack. Therefore, do not use specimens with sheared edges unless this effect is being evaluated. Finish the edges by machining or polishing. The slight amount of cold work resulting from the machining process should not introduce serious error.

5.3.2 The specimen metallurgical and surface condition should be similar to the application being modeled. In all cases, remove surface contamination, such as dirt, grease, oil and thick oxides, prior to weighing and exposure to the test environment (see Practice G 1).

5.3.3 The effect of damage areas on coated specimens may be of interest. In this circumstance, artificially introduce uniform damages, similar in size to the expected field damage. Some methods of applying standardized mechanical damage to coated specimens are presented in Test Method D 1654.

5.3.4 Introduce a specimen identification system that will endure throughout the test period. Edged notches, drilled holes, stamped numbers, and tags are some of the methods used for identification. The identification system must not induce corrosion attack in any way.

#### 5.4 Number of Specimens:

5.4.1 The number of scheduled periodic specimen removals during the test should include duplicate and, preferably, triplicate specimens for any given test period to determine the variability in the corrosion behavior. The effect of the number of replications on the evaluation of the results is set forth in Practice G 16.

5.4.2 If the test specimens are made of galvanically coupled dissimilar metals, control specimens should also be tested to