



Designation: G51 – 18

# Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing<sup>1</sup>

This standard is issued under the fixed designation G51; 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 test method covers a procedure for determining the pH of a soil in corrosion testing. The principle use of the test is to supplement soil resistivity measurements and thereby identify conditions under which the corrosion of metals in soil may be accentuated (see G57 – 78 (2012)).

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *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.*

1.4 *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:*<sup>2</sup>
- D1193 Specification for Reagent Water
  - E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
  - E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
  - G57 Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method
  - NACE/ASTM G193 Terminology and Acronyms Relating to Corrosion
  - G215 Guide for Electrode Potential Measurement

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

Current edition approved Nov. 1, 2018. Published December 2018. Originally approved in 1977. Last previous edition approved in 2012 as G51 – 95(2012). DOI: 10.1520/G0051-18.

<sup>2</sup> 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.

## 3. Terminology

### 3.1 Definitions:

3.1.1 *calibration solution, n*—a commercially available solution with a stable pH used for calibrating a pH measuring system (meter and probe).

3.1.2 *calomel electrode, n*—an electrode that develops a standard electric potential and is used to provide a reference voltage in the circuit for sensing electrodes. It is composed of an amalgam of mercury and mercury (I) chloride.

3.1.2.1 *Discussion*—Due to shipping restrictions on mercury containing materials, calomel electrodes have been replaced by silver/silver chloride electrodes in newer pH meters.

3.1.3 *combination electrode, n*—an electrochemical apparatus that incorporates an ion-selective electrode and a reference electrode in a single assembly thereby avoiding the need for a separate reference electrode.

3.1.4 *pH, n*—the negative logarithm of the hydrogen ion activity written as  $\text{pH} = -\log_{10}(a_{\text{H}^+})$  where  $a_{\text{H}^+}$  = Hydrogen ion activity = the molar concentration of hydrogen ions multiplied by the mean ion-activity coefficient.

3.1.5 *pH meter, n*—an instrument with a display of pH units. For field use, it is portable and battery-powered.

3.1.6 *purified water, n*—water that meets Specification D1193, Type IV requirements.

3.1.7 *silver/silver chloride electrode, n*—an electrode that develops a standard electric potential and is used to provide a reference voltage. The electrode functions as a redox electrode and the equilibrium is between the silver metal (Ag) and its salt – Silver Chloride (AgCl).

3.1.7.1 *Discussion*—Refer to detailed description and discussion in Guide G215.

3.2 The terminology used herein, if not specifically defined otherwise, shall be in accordance with NACE/ASTM G193. Definitions provided herein and not given in NACE/ASTM G193 are limited only to this standard.

## 4. Significance and Use

4.1 Information on pH of soil is used as an aid in evaluating the corrosivity of a soil environment. Some metals are more sensitive to the pH of their environment than others, and

information on the stability of a metal as a function of pH and potential is available in the literature.<sup>3</sup>

## 5. Apparatus

5.1 *pH Meter*—A portable, battery-powered pH meter that reads or attaches the electrodes is necessary for field measurements. An LCD (liquid-crystal display) is preferred for its readability in a bright, outdoor environment.

### 5.2 Electrodes:

5.2.1 *Silver/Silver Chloride Electrode*—A saturated silver/silver chloride reference electrode or its equivalent is used in the pH determination.

NOTE 1—A few crystals of solid potassium chloride should always be present within the chamber surrounding the silver to assure that the solution is saturated under the conditions of use. The design of the electrode must permit the formation of a fresh liquid junction between the solution of potassium chloride and the buffer or test soil for each test and allow traces of soil to be readily removed by washing.

5.2.2 *Glass Electrode*—A glass electrode of rugged construction is required. The performance of the glass electrode is satisfactory if it furnishes the correct pH value ( $\pm 0.1$  pH unit) for standard buffered solutions.

5.2.3 *Combination Electrode*—A combination electrode consisting of a reference electrode and a glass electrode (5.2.1 and 5.2.2) combined as a single electrode is acceptable. However, the requirements outlined above are equally applicable to the electrodes used in this combination unit.

5.3 *Subsurface Probe*—When pH measurements below the surface of the soil are required, it is necessary to use a probe of suitable length which will allow measurements to be made at the depth of interest. This probe consists of a glass electrode or a combination electrode in a rubber housing at the end of a plastic tube. One type of probe is illustrated in Fig. 1.

5.4 *Soil Thermometer*—Some pH electrodes have temperature compensation built in as part of the pH electrode, but most do not (see manufacturer's specifications). A thermometer of rugged construction is required for soil use, and a stainless steel sheathed thermometer is preferred. Metal sheathed ther-

mometers come in different lengths, and a length appropriate for the depth of interest should be chosen.

5.5 *Miscellaneous*—Depending on how and where the soil will be analyzed, one or more of the following may be needed: hand auger, post-hole diggers, sample bags, glass container, etc.

## 6. Reagents and Materials

6.1 During the calibration procedure for the pH meter, standard buffered solutions of known pH are necessary. These solutions, or tablets to make up these solutions, can be purchased from chemical supply companies or pH equipment manufacturers. From practical experience, standard solutions of pH 4, 7, and 10 are recommended. Reagent grade water such as those described in Specification D1193 may be required to make solutions.

## 7. Sampling, Test Specimens, and Test Units

7.1 By the nature of the measurement, pH is determined for a small volume of soil at each reading, and it is important that at least three measurements at different locations be made and a simple average calculated.

7.2 *In-situ Soil Sampling*—Ideally the pH measurement should be made in the field with the glass electrode contacting the soil at the specific depth of interest. If the surface soil pH is desired, then the soil can be broken up if compacted so as to accept the electrodes. If a subsurface pH is desired, then a boring or an excavation must be done so that the electrode can be placed in the soil at the desired depth. The subsurface probe (Fig. 1) is ideal for use with a boring tool such as hand auger. After boring through the soil to the depth of interest, carefully lower the probe into the cavity without further preparation of the soil.

7.3 *Disturbed Soil Sampling*—Soil samples can be brought to the surface with a boring tool or a post-hole digger, and the measurement made in the field on the soil specimen thus obtained. This technique is less desirable than the probe method described in 7.2.

7.4 *Laboratory Testing*—The least desirable pH measurement of soil is that which is based on a soil sample transported to a laboratory for evaluation. However, if this must be done,

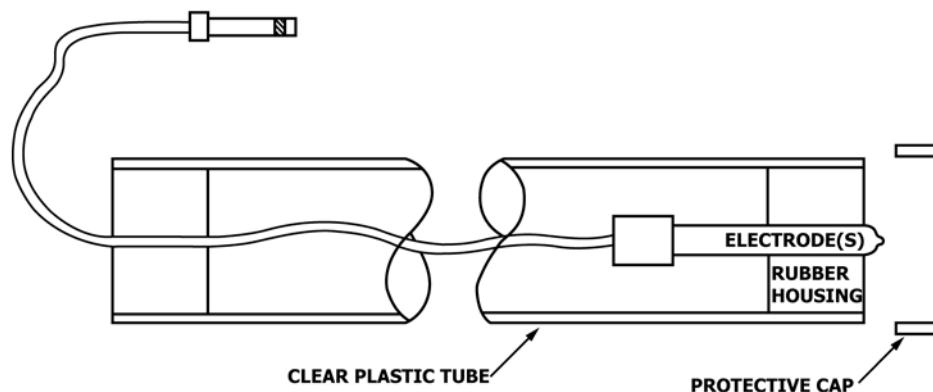


FIG. 1 Subsurface Probe

<sup>3</sup> Pourbaix, M., *Atlas of Electrochemical Equilibria in Aqueous Solutions*, Pergamon Press, 1966.