Designation: G 59 – 97

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Conducting Potentiodynamic Polarization Resistance Measurements[1]

This standard is issued under the fixed designation G 59; 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 This test method describes an experimental procedure for polarization resistance measurements which can be used for the calibration of equipment and verification of experimental technique. The test method can provide reproducible corrosion potentials and potentiodynamic polarization resistance measurements.

1.2 *This test method 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:*

G 3 Practice for Conventions Applicable to Electrochemical Measurements in Corrosion Testing[2]

G 5 Test Method for Making Potentiostatic and Potentiodynamic Anodic Polarization Measurements[2]

G 102 Practice for Calculation of Corrosion Rates and Related Information from Electrochemical Measurements[2]

2.2 *Adjunct:*

Samples of the Standard AISI Type 430 Stainless Steel (UNS S43000)[3]

3. Significance and Use

3.1 This test method can be utilized to verify the performance of polarization resistance measurement equipment including reference electrodes, electrochemical cells, potentiostats, scan generators, measuring and recording devices. The test method is also useful for training operators in sample preparation and experimental techniques for polarization resistance measurements.

3.2 Polarization resistance can be related to the rate of general corrosion for metals at or near their corrosion potential, E_{corr}. Polarization resistance measurements are an accurate and rapid way to measure the general corrosion rate. Real time corrosion monitoring is a common application. The technique can also be used as a way to rank alloys, inhibitors, and so forth in order of resistance to general corrosion.

3.3 In this test method, a small potential scan, $\Delta E(t)$, defined with respect to the corrosion potential ($\Delta E = E - E_{corr}$), is applied to a metal sample. The resultant currents are recorded. The polarization resistance, R_P, of a corroding electrode is defined from Eq 1 as the slope of a potential versus current density plot at $i = 0$ **(1-4)**:[4]

$$R_p = \left(\frac{\partial\, \Delta E}{\partial\, i}\right)_{i=0,\, dE/dt \to 0} \tag{1}$$

The current density is given by *i*. The corrosion current density, i_{corr}, is related to the polarization resistance by the Stern-Geary coefficient, *B*. **(3)**,

$$i_{corr} = 10^6\, \frac{B}{R_p} \tag{2}$$

The dimension of R_p is ohm-cm^2, i_{corr} is muA/cm^2, and *B* is in V. The Stern-Geary coefficient is related to the anodic, b_a, and cathodic, b_c, Tafel slopes as per Eq 3.

$$B = \frac{b_a\, b_c}{2.303(b_a + b_c)} \tag{3}$$

The units of the Tafel slopes are V. The corrosion rate, *CR*, in mm per year can be determined from Eq 4 in which *EW* is the equivalent weight of the corroding species in grams and ρ is the density of the corroding material in g/cm^3.

$$CR = 3.27 \times 10^{-3}\, \frac{i_{corr}\, EW}{\rho} \tag{4}$$

Refer to Practice G 102 for derivations of the above equations and methods for estimating Tafel slopes.

3.4 The test method may not be appropriate to measure polarization resistance on all materials or in all environments. See 8.2 for a discussion of method biases arising from solution resistance and electrode capacitance.

4. Apparatus

4.1 The apparatus is described in Test Method G 5. It includes a 1 L round bottom flask modified to permit the addition of inert gas, thermometer, and electrodes. This standard cell or an equivalent cell can be used. An equivalent

[1] This practice is under the jurisdiction of ASTM Committee G–1 on Corrosion of Metals, and is the direct responsibility of Subcommittee G 01.11 on Electrochemical Measurements in Corrosion Testing.

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[2] *Annual Book of ASTM Standards*, Vol 03.02.

[3] Available from ASTM Headquarters. Order PCN 12-700050-00.

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.