



Standard Test Method for Conducting Cyclic Galvanostaircase Polarization¹

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1. Scope

1.1 This test method covers a procedure for conducting cyclic galvanostaircase polarization (GSCP) to determine relative susceptibility to localized corrosion (pitting and crevice corrosion) for aluminum alloy 3003-H14 (UNS A93003) (1).² It may serve as guide for examination of other alloys (2-5). This test method also describes a procedure that can be used as a check for one's experimental technique and instrumentation.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*³

D1193 Specification for Reagent Water

G1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens

G5 Reference Test Method for Making Potentiodynamic Anodic Polarization Measurements

G59 Test Method for Conducting Potentiodynamic Polarization Resistance Measurements

G69 Test Method for Measurement of Corrosion Potentials of Aluminum Alloys

3. Significance and Use

3.1 In this test method, susceptibility to localized corrosion of aluminum is indicated by a protection potential (E_{prot})

determined by cyclic galvanostaircase polarization (1). The more noble this potential, the less susceptible is the alloy to initiation of localized corrosion. The results of this test method are not intended to correlate in a quantitative manner with the rate of propagation of localized corrosion that one might observe in service.

3.2 The breakdown (E_b), and protection potentials (E_{prot}) determined by the cyclic GSCP method correlate with the constant potential corrosion test (immersion-glassware) result for aluminum (1, 6, 7). When the applied potential was more negative than the GSCP E_{prot} , no pit initiation was observed. When the applied potential was more positive than the GSCP E_{prot} , pitting occurred even when the applied potential was less negative than E_b .

3.2.1 Severe crevice corrosion occurred when the separation of E_b and E_{prot} was 500 mV or greater and E_{prot} was less than -400 mV Vs. SCE (in 100 ppm NaCl) (1, 6, 8). For aluminum, E_{prot} determined by cyclic GSCP agrees with the repassivation potential determined by the scratch potentiostatic method (1, 9). Both the scratch potentiostatic method and the constant potential technique for determination of E_{prot} require much longer test times and are more involved techniques than the GSCP method.

3.3 DeBerry and Viebeck (3-5) found that the breakdown potentials (E_b) (galvanodynamic polarization, similar to GSCP but no kinetic information) had a good correlation with the inhibition of localized corrosion of 304L stainless steel by surface active compounds. They attained accuracy and precision by avoiding the strong induction effect which they observed by the potentiodynamic technique.

3.4 If this test method is followed using the specific alloy discussed it will provide (GSCP) measurements that will reproduce data developed at other times in other laboratories.

3.5 E_b and E_{prot} obtained are based on the results from eight different laboratories that followed the standard procedure using aluminum alloy 3003-H14 (UNS A93003). E_b and E_{prot} are included with statistical analysis to indicate the acceptable range.

4. Apparatus

4.1 *Cell*—The cell should be constructed of inert materials such as borosilicate glass and PTFE fluorocarbon. It should have ports for the insertion of a working electrode (1 cm² flat

¹ This test method is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.11 on Electrochemical Measurements in Corrosion Testing.

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² The boldface numbers in parentheses refer to a list of references at the end of this standard.

³ 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.