Designation: B826 – 03

Standard Test Method for
Monitoring Atmospheric Corrosion Tests by Electrical Resistance Probes[1]

This standard is issued under the fixed designation B826; 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 provides a means for monitoring corrosivity of environmental tests that involve exposure to corrosive gases.

1.2 This test method uses a resistance monitor (RM) probe fabricated from a chosen metal conductor, with one conductor segment uncovered to permit exposure of the chosen metal conductor to the corrosive gas mixture and the second conductor segment covered to protect the metal conductor of this segment from direct attack by the corrosive gas mixture. The covered conductor segment provides a reference for evaluating changes in the uncovered segment. The ratio of the resistance of the exposed segment to that of the covered segment provides a measure of the amount of metal conductor that has reacted with the corrosive gas test environment to form poorly conducting corrosion product, thus providing a measure of test corrosivity.

1.3 Resistance monitoring is applicable to a broad range of test conditions by selection of the appropriate metal conductor and initial metal thickness.

1.4 This method is similar in intent to Test Methods B808.

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 become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

B808 Test Method for Monitoring of Atmospheric Corrosion Chambers by Quartz Crystal Microbalances [2]

B810 Test Method for Calibration of Atmospheric Corrosion Test Chambers by Change in Mass of Copper Coupons [2]

B827 Practice for Conducting Mixed Flowing Gas (MFG) Environmental Tests [3]

G96 Guide for Online Monitoring of Corrosion in Plant Equipment (Electrical and Electrochemical Methods)

3. Summary of Test Method

3.1 The corrosivity of an atmospheric corrosion test such as a mixed flowing gas (MFG) type test is measured by monitoring the loss in electrical conductivity of a metal element whose surface corrodes to form poorly conducting corrosion product. This corrosion product consumes metal from a conduction path causing an increase in electrical resistance. The resistance of the degraded conduction path is compared with a similar path whose surface is covered to prevent corrosion. This comparison resistance also provides a temperature correction reference. The ratio of the electrical resistance of the path exposed to the corrosive gases to that of the covered path is monitored during the test and compared to an expected ratio-versus-time curve to establish the relationship of the test corrosivity to expected test corrosivity. Alternatively, the ratio-versus-time curve for a given atmosphere can be compared with the behavior of other corrosive atmospheres to evaluate the relative corrosivity of the various atmospheres.

4. Significance and Use

4.1 Corrosivity monitoring of test environments provides a means to monitor an integrated value of test corrosivity which cannot be evaluated from test parameters themselves, such as temperature, humidity, and gas concentration. As such the monitor value can be used for specification purposes such as

---

[1] This test method is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.11 on Electrical Contact Test Methods.

Current edition approved June 10, 2003. Published July 2003. Originally approved in 1997. Last previous edition approved in 1997 as B826 - 97. DOI: 10.1520/B0826-03.

[2] *Annual Book of ASTM Standards*, Vol 03.04.

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

test validation. Electrical resistance monitoring of conductors exposed to corrosive media is a well-established practice.[4,5,6,7]

4.2 The resistance method assumes uniform corrosion over the entire surface of the exposed metal conductor segment. Local corrosion such as pitting, crevice, or grain boundary corrosion may provide invalid estimates of test corrosivity. Marked changes in slope of the curve of electrical resistance ratio versus time may indicate undesired processes which can be due to deficiencies in the test atmosphere or in the monitor itself.

4.3 Because of limitations of the diffusion process within the corrosion product formed on the metal conductor segment of the RM probe when passivating corrosion films are formed, resistance monitoring may not be useful for test chamber monitoring purposes for very long test exposures. Chamber monitoring is dependent on detecting changes in the rate of corrosion of the RM as an indicator signal that specified gas concentrations must be reverified. However, low corrosion rates limit the absolute value of the rate of change of corrosion rate with change of test conditions; for parabolic film growth processes, the growth rate decreases with time limiting the sensitivity of the RM at extended test times.

4.4 Since corrosion rate can be a complex function of test parameters in MFG tests with any given metal primarily responsive to a subset of the gases in the MFG environment, more than one type metal resistance probe is required in order to assist in maintenance of relative gas concentrations. For such test specifications, values of resistance ratios must be referred to ratios obtained under known test conditions as supplied by the test specifier. Information relating to the sensitivity of various metals to various corrodants has been published.[8,9]

4.5 RM probes can be useful from 1 % of thickness consumed upward to 50 % of thickness consumed by the corrosion film growth. Conductor thicknesses between 25 nm and 0.2 mm are commercially available.[10]

5. Interferences

5.1 Resistance monitor probes are generally constructed from thin film metal coatings on dielectric substrates in the form of a serpentine pattern or loop to provide a long conductor path so as to increase the ease of detection of a resistance change. With such configurations, formation of a corrosion product, which grows out from the edges of the conductor paths, can contact adjacent paths; when such contacting corrosion films are formed from conducting corrosion products such as some copper sulfides, abrupt changes in probe resistance can be observed due to shorting of the current path. Such shorting of the current path can also occur if condensation occurs on the probe, especially in the presence of gases that dissolve in the condensed film to form an electrolyte. Such shorting behavior is seen as an anomalous resistance decrease and indicates that corrosion of the RM is not predictable from its electrical resistance.

5.2 Corrosive gas permeation through the protective covering of the reference conductor can lead to corrosion of the reference conductor, thus reducing the apparent resistance ratio between the exposed conductor and the reference conductor. Excess resistance change of the reference conductor above that expected for any observed temperature change of the RM is an indication of this possible interference. The RM should be examined after the test for discoloration of the reference conductor as a signal of possible corrosion of the reference conductor when such excess resistance change is observed. Presence of corrosion of the reference conductor invalidates the estimate of atmosphere corrosivity based on the observed resistance ratio-versus-time curve.

5.3 Thermal gradients across the RM probe as a result of the presence of local heat sources such as lamps or powered test devices can produce an anomalous resistance ratio change. Such effects can be verified by shutting off the local heat source and remeasuring the resistance ratio.

5.4 Scratches or other localized conductor thickness variations can produce anomalous resistance ratios after reduced corrosion exposures. This behavior can be detected by abrupt increases in apparent rate of corrosion which occur when the thinned region corrodes through to the dielectric substrate. Such abrupt changes indicate the end of useful data from the RM.

5.5 Contaminant films on the surface of the exposed conductor can inhibit corrosion or accelerate corrosion. Care must be taken to assure freedom from fingerprints, spittle, oil, or other surface contamination prior to installation in the test chamber. If a cleaning procedure is used, it should be appropriately evaluated and consistently applied to avoid differing initial conditions on the RM. The exposed metal conductor of the probe should be examined after the test exposure to ensure uniformity of corrosion film growth. Clumps of corrosion product indicate undesirable conditions and potential problems interpreting resistance changes.

5.6 Since in-situ electrical resistance measurements require electrical access to the probe being measured, defects in the electrical access system, for example, cables and sockets, can affect the resistance values being measured. Protection of the electrical access system from the deleterious effects of exposure to corrosive gases is required to ensure a reliable monitoring system.

5.7 Most interferences are detectable when multiple probes are used in a single test by comparison of one probe to another.

---

[4] ASTM G96, Guide for On-Line Monitoring of Corrosion in Plant Equipment (Electrical and Electrochemical Methods).

[5] Allen, R. C. and Trzeciak, M. J., "Measuring Environmental Corrosivity," Institute of Electrical and Electronic Engineers, Components, Hybrids, and Manufacturing Technology Transaction, Vol CHMT-3, 1, March 1980, pp. 67-70.

[6] Murcko, R., Corrosion-Indicating Device, IBM Technical Disclosure Bulletin, Vol 32, No.10A, March 1990, p. 25.

[7] Sproles, E. S., "Electrical Resistance of Wires Used as a Corrosion Rate Monitor," *Corrosion of Electronic and Magnetic Materials, ASTM STP 1148*, P. J. Peterson, Ed., American Society for Testing and Materials, 1992, pp. 11-20.

[8] Rice, D., et. al., "Atmospheric Corrosion of Copper and Silver," *Journal of Electrochemical Society*, Vol 128, No. 2, February 1981, pp. 275-284.

[9] Rice, D., et al., "Indoor Corrosion of Metals," *Journal of Electrochemical Society*, Vol 127, No. 4, April 1980, pp. 891-901.

[10] Resistance monitor system manufactured by Rohrback Cosasco Systems, Inc., 11841 E. Smith Ave., Santa Fe Springs, CA 90670, United States, have been found to be satisfactory for corrosivity monitoring of airborne corrosion agents; see Model CK-3 Corrosometer.