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Standard
Test Method

Laboratory Test to Evaluate the Vapor-Inhibiting Ability of Volatile Corrosion Inhibitor Materials for Temporary Protection of Ferrous Metal Surfaces

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Foreword

Volatile corrosion inhibitor (VCI) materials are widely used to provide temporary corrosion protection for the surfaces of ferrous and nonferrous metal parts. "Temporary" refers to conditioning the environment enclosing the metal parts for a period, usually months to years, before the parts are put to their ultimate use, or before a "permanent" coating such as paint is applied. VCI materials compete with alternative temporary corrosion protection methods that include oils, greases, and waxes sometimes called rust preventives or corrosion preventive compounds; various aqueous solutions and coatings; and combinations of these coatings with desiccants and "barrier" packaging. Some of these alternatives may incorporate a VCI function, and others claim or imply VCI function in a name, but may function primarily by contact-inhibiting properties. A test of VCI efficacy must reasonably separate VCI effects (the combination of vapor transport and corrosion protection) from other mechanisms.

This standard test method evaluates the vapor-inhibiting ability (VIA) of various forms of VCI materials for temporary corrosion protection of ferrous metal surfaces, which is subsequently herein called the "VIA-Ferrous" test. It can be performed reproducibly with relatively simple and low-cost apparatus. The VIA-Ferrous test provides for standard conditions in a test jar of water-saturated, warm air without the presence of accelerating contaminants. This test method evaluates the combination of (1) vapor transport across a gap containing air, water vapor, and VCI, and (2) corrosion protection. Two options are included to discern the possible desiccating effects of some types of VCI materials, such as VCI paper, as a refinement of this test method. This test method uses one of two standard low-carbon steels as representative of the broad class of ferrous metals. An optional compatibility check that can be performed to determine whether a VCI-treated barrier material (e.g., film, paper) that is intended for temporary protection of ferrous metals causes corrosion of copper is included. The test method is based largely on U.S. MIL-STD-3010, Test Method 4031,[1] with modifications and options from related standards and practices of members of Technology Exchange Group (TEG) 093X.[2–5] These practices included details of preparation of VCI material samples and steel specimens and interpretation of results. Similar VIA test methods are currently in wide use for basic qualification of VCI materials.[6–8]

This standard test method is intended for use by VCI material manufacturers and users. It can be used for basic pass/fail qualification tests by production, quality assurance, user, or corrosion specialist laboratories to determine the VIA of VCI materials to protect ferrous metal surfaces from corrosion (rusting), including the component of ferrous metal protection afforded by multimetal VCI materials.

This VIA-Ferrous test is the first of a planned sequence of three standard test methods to evaluate the VIA of VCI materials. Completion and approval of this standard is a prerequisite for developing a standard test method to evaluate the VIA of VCI materials to protect representative nonferrous metal surfaces from corrosion (VIA-Nonferrous test), and another test method to include the presence of atmospheric contaminants that can accelerate corrosion of the metals.

This standard was originally prepared in 2008 by Task Group (TG) 215, "Volatile Corrosion Inhibitors (VCIs)," which is administered by Specific Technology Group (STG) 61, "Inhibition: Corrosion and Scaling," and sponsored by STG 46, "Building Systems." It was revised by TG 215 in 2012. It is published by NACE International under the auspices of STG 61.

In NACE standards, the terms *shall*, *must*, *should*, and *may* are used in accordance with the definitions of these terms in the *NACE Publications Style Manual*. The terms *shall* and *must* are used to state a requirement, and are considered mandatory. The term *should* is used to state something good and is recommended, but is not considered mandatory. The term *may* is used to state something considered optional.

NACE International
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Contents

Section 1: General

1.1 This standard describes a test method for evaluating the VIA of various forms of VCI materials to reduce corrosion on the surface of ferrous metals. This standard is applicable to VCI materials in the form of thin flexible, rigid, or laminate materials. Examples of thin flexible VCI materials are VCI-treated paper or VCI-impregnated plastic films, sheets, and bags. Examples of more rigid materials include thicker plastic sheeting of 1,000 µm (40 mil) or more in thickness as well as profile board and molded trays, boxes, and other rigid forms. This standard is also applicable to other forms of VCI material such as powders, tablets, plastic pellets, vapor capsules, diffusers, and emitters, as well as liquids that have vapor-inhibiting properties, perhaps in addition to contact inhibitor effects.

1.2 The essence of this standard is a relatively quick, inexpensive, and basic laboratory test in a reusable sealed jar to determine the VIA of various VCI materials to reduce corrosion on the surface of ferrous metals (VIA-Ferrous test). A competent laboratory should be able to achieve reasonable and reproducible results in distinguishing between VCI materials that have VIA-Ferrous properties and those that do not, including the VIA-Ferrous performance component of multimetal VCI materials. Materials that perform well in this test exhibit a combined effect of (1) vapor transport (without contact between the VCI material sample and the test surface of the steel specimen) and (2) corrosion inhibition on the surface of the steel specimen exposed to conditions of water-saturated, warm air followed by condensing water.

1.3 This VIA-Ferrous test method provides a basic qualitative test with limited differentiation among VCI materials. Finer differentiation and comparisons of relative performance among VCI materials is beyond the scope of this test method.

1.4 A numerical rating system has been established for describing and reporting the VIA efficacy of the VCI material sample tested. The user of this VIA-Ferrous test method may specify a pass/fail criterion associated with this numerical rating system. The user must select the pass/fail criterion, as described in Paragraph 6.6, to be used for the VIA-Ferrous test.

1.5 An optional compatibility check may be performed to determine whether a VCI-treated barrier material (e.g., film, paper) that is intended for temporary protection of ferrous metals causes corrosion of copper (see Section 7). The copper compatibility check is not required unless specified by the manufacturer or user of the VCI-treated barrier material. Further tests related to nonferrous metals are beyond the scope of this VCI-Ferrous test standard.

Section 2: Definitions

Sample: Portion of material taken from a larger quantity in a manner intended to be representative of the whole, typically used for test purposes. For the purposes of this test method, this is a volatile corrosion inhibitor (VCI) material prepared for evaluation in this vapor-inhibiting ability (VIA) test.

Specimen: Prepared portion of a metal coupon upon which a test is intended to be performed. For the purposes of this test method, a metal part of the VIA-Ferrous test apparatus whose test surface is prepared and evaluated to indicate VIA performance of a VCI material sample.

Test surface: The specifically prepared surface of the steel specimen that is exposed to the enclosed environment in the VIA-Ferrous test apparatus and evaluated for the presence of corrosion (rust) after the specified exposure period.

Volatile corrosion inhibitor (VCI): A chemical substance that acts to reduce corrosion by a combination of volatilization from a VCI material, vapor transport in the atmosphere of an enclosed environment, and condensation onto surfaces in the space, including adsorption, dissolution, and hydrophobic effects on metal surfaces, where the rate of corrosion of metal surfaces is thereby inhibited; also called vapor corrosion inhibitor, vapor-phase inhibitor, vapor-phase corrosion inhibitor, and vapor-transported corrosion inhibitor.