Designation: C692 − 13 (Reapproved 2023)

Standard Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel[1]

This standard is issued under the fixed designation C692; 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 covers two procedures for the laboratory evaluation of thermal insulation materials to determine whether they contribute to external stress corrosion cracking (ESCC) of austenitic stainless steel due to soluble chlorides within the insulation. This laboratory procedure is not intended to cover all of the possible field conditions that contribute to ESCC.

1.2 While the 1977 edition of this test method (Dana test) is applicable only to wicking-type insulations, the procedures in this edition are intended to be applicable to all insulating materials, including cements, some of which disintegrate when tested in accordance with the 1977 edition. Wicking insulations are materials that wet through and through when partially (50 % to 75 %) immersed in water for a short period of time (10 min or less).

1.3 These procedures are intended primarily as a preproduction test for qualification of the basic chemical composition of a particular manufacturer's product and are not intended to be routine tests for ongoing quality assurance or production lot compliance. Test Methods C871, on the other hand, is used for confirmation of acceptable chemical properties of subsequent lots of insulation previously found acceptable by this test method.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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 establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *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:*[2]

A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

C168 Terminology Relating to Thermal Insulation

C795 Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel

C871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions

G30 Practice for Making and Using U-Bend Stress-Corrosion Test Specimens

3. Terminology

3.1 *Definitions:* Refer to Terminology C168 for definitions relating to insulation.

4. Summary of Test Method

4.1 The procedures in this test method consist of using a specimen of insulation to conduct distilled (or deionized) water by wicking or dripping to an outside surface, through the insulation, to a hot inner surface of stressed Type 304 stainless steel for a period of 28 days. If leachable chlorides are present, they are carried along with the water and concentrated at the hot surface by evaporation in much the same way as has been experienced in actual industrial process situations.

[1] This test method is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.31 on Chemical and Physical Properties.

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[2] 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.

4.2 Exposed stainless steel coupons are examined visually, and under 10× to 30× magnification, if necessary, to detect ESCC after the prescribed period of exposure.

5. Significance and Use

5.1 An inherent characteristic of some alloys of austenitic stainless steel is their tendency to crack at stress points when exposed to certain corrosive environments. The mechanisms of ESCC are complex and not completely understood but are apparently related to certain metallurgical properties. Chloride and fluoride ions have the potential to induce stress corrosion cracking in the absence of inhibiting ions.[3]

5.2 Chlorides are common to many environments, so great care shall be taken to protect austenitic stainless steel from chloride contamination.

5.3 Most thermal insulations will not, of themselves, cause stress corrosion cracking. Preproduction qualification tests are used to evaluate that under the conditions of the laboratory test that specific thermal insulation materials do not cause cracking of sensitized austenitic stainless steel. Insulation systems have the potential to act as collecting media by means of transmigration and concentration of corrosive ions on heated stainless steel surfaces. Exposure to elevated temperature results in evaporation of water and increased chemical reaction rates. Environments containing corrosive ions, moisture, and oxygen will increase the chance for stress corrosion cracking.

5.4 Insulation materials are available that are specially formulated to inhibit stress corrosion cracking in the presence of chlorides through modifications in basic composition or incorporation of certain chemical additives.

5.5 The ability of the 28-day test to measure the corrosion potential of insulation materials is documented by Karnes,[4] whose data appear to have been used for construction of the acceptability curve used in Specification C795 and other specifications.

5.6 The metal for all of the coupons used in this test method (C692) shall be qualified (see Section 14) to ascertain that under conditions of the test, chloride ions will cause the metal to crack, and deionized water alone will not cause cracks.

6. Applicability (see also 11.2)

6.1 While the original test procedure for the 1977 edition of this test method (Dana Test) was limited to "wicking-type insulations," the "drip test procedure" given in this edition is applicable to all insulations when cut or formed into the required test specimen.

6.2 Heat treatment at some temperature (as recommended by the manufacturer) up to the maximum use temperature is sometimes necessary to make the insulating material "wick," and thus testable by either insulation test procedure (see Sections 12 and 13).

6.3 If the test insulation cannot be made to wick in any way (such as in the case of organic or inorganic closed-cell foams), or when heat treatment of a component of the insulation (such as an attached exterior jacket material) exceeds the manufacturer's recommended maximum temperature for the exterior component, then the 1½ in. (38 mm) wide test specimen is sliced into two ¾ in. (19 mm) thick segments. The two halves are held together with wire, pins, or a rubber band, and are tested by dripping into the crack between the two halves, thus simulating the situation where water penetrates the junction between two sections of insulation. Wetting the mating faces on the two half sections facilitates water wicking down to the coupon surface.

6.4 Adhesives are tested by gluing together a test block of the insulation material to be used with the adhesive. The adhesive joint must come into contact with the stainless steel test coupon.

6.5 Cements with a clay binder are tested by casting a 1½ in. (38 mm) thick slab, drying, and using the drip procedure. Such a sample will disintegrate in the Dana test procedure.

6.6 The drip procedure has the potential to be used for the testing of coatings applied to the coupon prior to test. The corrosive liquids dripped into such a system are limited only by the imagination of the researcher.

7. Apparatus for Dana Test Procedure

7.1 *Enclosure*—In dusty environments, it is permissible for the test apparatus to be located in a cabinet or other closed structure provided with a blower to maintain a positive internal pressure, and equipped with a filter for intake air to minimize dust or other contamination. The test apparatus is normally housed in any suitable clean environment not subject to chloride contamination. The enclosure shall not be so tight as to exclude oxygen from the system, since oxygen is necessary for ESCC to occur.

7.2 *Pyrex Glass Wool.*

7.3 *"Cookie Cutter,"* made from 1¼ in. (32 mm) thin wall electrical conduit (inside diameter 1.38 in. (35 mm)) to cut a 1⅜ in. (35 mm) diameter plug from 2 in. (51 mm) Pyrex Glass Wool.

7.4 *Specimen Holder,* as shown in Fig. 1, or equivalent.

7.5 *Precision Bender,* see Practice G30.

7.6 *Wet-Grinding Belt Grinder,* 80-grit.

7.7 *Copper Lugs,* commercial 2/0–4/0 solderless, or 2 in. by ½ in. by ⅛ in. (51 mm by 13 mm by 3.2 mm) copper tabs.

7.8 *Silver Solder,* and chloride-free flux for use with stainless steel.

7.9 *Torch,* acetylene or propane.

7.10 *Bolt,* stainless steel, 3⁄16 in. (5 mm) in diameter and 2½ in. (65 mm) long with insulating washer and nut for electrically insulating the bolt from the U-bend specimen.

[3] Whorlow, Kenneth M., Woolridge, Edward and Hutto, Francis B., Jr., "Effect of Halogens and Inhibitors on the External Stress Corrosion Cracking of Type 304 Austenitic Stainless Steel"; *STP 1320 Insulation Materials: Testing and Applications*, Third Volume, Ronald S. Graves and Robert R. Zarr, editors , ASTM West Conshohocken, PA, 1997 page 485

[4] Karnes, H. F., "The Corrosion Potential of Wetted Thermal Insulation," AICHE, 57th National Meeting, Minneapolis, MN, September 26 through 29, 1965.