Designation: C1617 – 15

Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals[1]

This standard is issued under the fixed designation C1617; 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 practice covers procedures for a quantitative accelerated laboratory evaluation of the influence of extraction solutions containing ions leached from thermal insulation on the aqueous corrosion of metals. The primary intent of the practice is for use with thermal insulation and associated materials that contribute to, or alternatively inhibit, the aqueous corrosion of different types and grades of metals due to soluble ions that are leached by water from within the insulation. The quantitative evaluation criteria are Mass Loss Corrosion Rate (MLCR) expressed in mils per year determined from the weight loss due to corrosion of exposed metal coupons after they are cleaned.

1.2 The insulation extraction solutions prepared for use in the test can be altered by the addition of corrosive ions to the solutions to simulate contamination from an external source. Ions expected to provide corrosion inhibition can be added to investigate their inhibitory effect.

1.3 Prepared laboratory standard solutions are used as reference solutions and controls, to provide a means of calibration and comparison. See Fig. 1 and Table 1.

1.4 Other liquids can be tested for their potential corrosiveness including cooling tower water, boiler feed, and chemical stocks. Added chemical inhibitors or protective coatings applied to the metal can also be evaluated using the general guidelines of the practice.

1.5 This practice cannot cover all possible field conditions that contribute to aqueous corrosion. The intent is to provide an accelerated means to obtain a non-subjective numeric value for judging the potential contribution to the corrosion of metals that can come from ions contained in thermal insulation materials or other experimental solutions. The calculated numeric value is the mass loss corrosion rate. This calculation is based on general corrosion spread equally over the test duration and the exposed area of the experimental cells created for the test. Corrosion found in field situations and this accelerated test also involves pitting and edge effects and the rate changes over time.

1.6 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.

1.7 *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:*[2]

A53/A53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A105/A105M Specification for Carbon Steel Forgings for Piping Applications

C168 Terminology Relating to Thermal Insulation

C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

C665 Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

C692 Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel

C739 Specification for Cellulosic Fiber Loose-Fill Thermal Insulation

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

[1] This practice 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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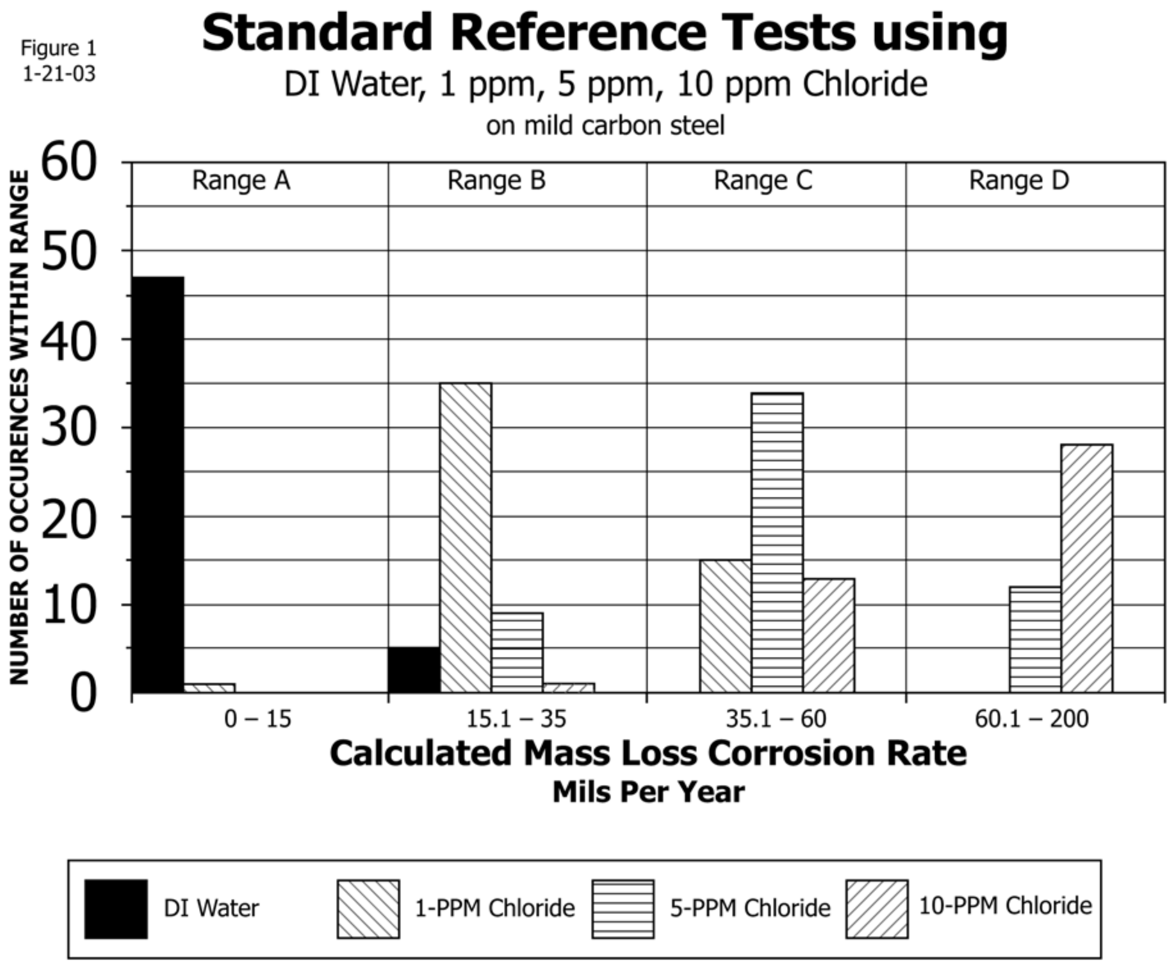
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.



NOTE 1—The Fig. 1 bar graph was created using the MLCR data shown in Table 1. Standard reference tests using de-ionized water, 1 ppm, 5 ppm, and 10 ppm chloride solutions were performed on mild carbon steel coupons. The calculated MLCR test results for mild carbon steel coupons were separated into four ranges. The rating criteria ranges were developed to accommodate the results obtained using this practice on the reference standards and experimental insulation samples. The ranges used are: MLCR = 0 to 15 mils = range A; MLCR = 15.1 to 35 mils = range B; MLCR = 35.1 to 60 mils = range C, MLCR = 60.1 and higher = range D. The bars on the graph represent the total number of occurrences within the range for each of the reference solutions.

NOTE 2—It is necessary for each laboratory to develop their own data, with their own individual plate or plates, metal, operators, cleaning procedures, and environmental conditions to establish the ranges of MLCR calculated for the reference standards. The insulation or other test solutions are only evaluated against the reference solution results run at the same time.

FIG. 1 Uncertainty Test

C871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products
G1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens
G16 Guide for Applying Statistics to Analysis of Corrosion Data
G31 Guide for Laboratory Immersion Corrosion Testing of Metals
G46 Guide for Examination and Evaluation of Pitting Corrosion

3. Terminology

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

4. Summary of Practice

4.1 The practice uses controlled amounts of test solutions delivered drip wise onto a defined area of small flat coupons of selected test metals for the purpose of producing, comparing, and measuring the corrosion that occurs on the metals due to the exposure.

4.2 The test is conducted at elevated temperatures, greatly accelerating the corrosion in comparison with corrosion at room temperature. The heat makes the solution evaporate quickly, allowing an air (oxygen) interface and making thousands of wet-dry-wet cycles possible in a short time.

4.3 Quantitative measurements of corrosion are determined from the weight change (loss) due to the corrosion of the tested coupons. Reference tests prepared with known concentrations of solutions that are conducive to the corrosion of the tested metal are compared with water solutions containing ions extracted from insulation samples. Calculations of MLCR in

TABLE 1 Mass Loss Corrosion Rate (MLCR) Calculated Using Practice G1 (see Section 12)

NOTE 1—MLCR expressed in mils per year.

0-ppm De-ionized Water	1-ppm Chloride Solution	5-ppm Chloride Solution	10-ppm Chloride Solution
19.02	35.17	57.31	62.61
11.68	29.87	40.91	56.48
14.04	33.00	66.76	110.54
12.13	37.91	52.46	131.35
12.45	29.80	16.53	52.27
14.42	22.72	42.51	35.42
6.13	35.42	76.33	67.01
13.27	31.78	111.82	57.48
21.25	17.04	42.19	98.92
7.59	37.78	44.42	132.35
12.83	32.55	53.61	61.52
6.70	36.12	54.25	36.42
16.08	25.66	41.87	90.44
19.02	14.93	54.50	95.48
11.42	31.08	65.67	63.44
14.81	34.21	70.46	99.63
9.38	34.46	42.57	69.63
18.38	36.06	63.44	107.28
8.62	27.38	50.10	58.84
8.49	24.19	48.63	65.10
12.13	15.25	55.40	64.27
5.36	33.70	69.12	71.29
4.66	32.10	39.06	78.37
5.55	35.04	43.21	88.52
6.57	22.98	41.93	30.57
5.87	39.44	36.76	39.25
7.21	35.04	25.66	50.93
6.45	34.66	30.06	128.41
3.45	41.48	41.68	97.52
2.30	41.55	29.61	98.03
11.93	42.70	38.74	82.84
9.19	33.32	38.10	105.31
13.15	28.98	33.00	96.50
14.10	21.38	58.27	84.50
12.25	16.08	39.31	59.55
12.25	17.17	40.78	45.57
9.96	32.42	48.25	56.80
4.60	34.72	23.10	63.63
3.70	34.02	27.19	67.01
2.43	33.38	35.61	48.82
3.32	25.66	77.16	75.76
1.21	33.12	30.76	48.95
1.28	44.04	42.57	
5.87	37.46	42.63	
7.15	23.36	41.61	
3.96	28.15	61.27	
11.23	25.02	27.76	
10.02	36.83	49.27	
10.28	21.64	67.65	
9.38	27.63	68.54	
12.25	18.51	42.44	
9.38		40.14	
		36.76	
		54.12	
		67.40	
Average and (Standard Deviation)			
9.5 (4.8)	30.5 (7.4)	48.0 (16.4)	74.6 (26.0)

mils-per-year (MPY) made using the methods of Practice G1 are reported as the quantitative measurement.

5. Significance and Use

5.1 Corrosion associated with insulation is an important concern for insulation manufacturers, specification writers, designers, contractors, users and operators of the equipment. Some material specifications contain test methods (or reference test methods contained in other material specifications), for use in evaluating the insulation with regard to the corrosion of steel, copper, and aluminum. In some cases these tests are not applicable or effective and have not been evaluated for precision and bias.

5.2 A properly selected, installed, and maintained insulation system will reduce the corrosion that often occurs on an un-insulated structure. However, when the protective weather-resistant covering of an insulation system fails, the conditions for the aqueous environment necessary for corrosion under insulation (CUI) often develop. It is possible the insulation contains, collects, or concentrates corrosive agents, or a combination thereof, often found in industrial and coastal environments. If water is not present, these electrolytes cannot migrate to the metal surface. The electrochemical reaction resulting in the aqueous corrosion of metal surfaces cannot take place in the absence of water and electrolytes. Additional environmental factors contributing to increased corrosion rates are oxygen, and elevated-temperature (near boiling point).

5.3 Chlorides and other corrosive ions are common to many environments. The primary corrosion preventative is to protect insulation and metal from contamination and moisture. Insulation covers, jackets, and metal coating of various kinds are often used to prevent water infiltration and contact with the metal.

5.4 This procedure can be used to evaluate all types of thermal insulation and fireproofing materials (industrial, commercial, residential, cryogenic, fire-resistive, insulating cement) manufactured using inorganic or organic materials, faced or unfaced, for which a filtered extraction solution can be obtained.

5.5 This procedure can be used with all metal types for which a coupon can be prepared such as mild steel, stainless steel, copper, or aluminum.

5.6 This procedure can also be applicable to insulation accessories including jacketing, covers, adhesives, cements, and binders associated with insulation and insulation products.

5.7 Heat treatment of the insulation (as recommended by the manufacturer up to the maximum potential exposure temperature) can be used to simulate possible conditions of use.

5.8 Adhesives can be tested by first drying followed by water extraction or by applying a known quantity of the test adhesive to a test piece of insulation and then extracting.

5.9 Insulating cements can be tested by casting a slab, drying, and extracting or by using the uncured insulating cement powder for extraction.

5.10 Reference tests prepared with various concentrations of solutions that are conducive to the corrosion of the tested metal serve as comparative standards. Solutions containing chloride, sodium hydroxide, various acids (sulfuric, hydrochloric, nitric, and citric acid), as well as "blank" tests using only de-ionized water and tap water are used.

5.11 Research can be done on insulation that has been specially formulated to inhibit corrosion in the presence of corrosive ions through modifications in basic composition or