Designation: G 60 – 95

An American National Standard

Standard Test Method for Conducting Cyclic Humidity Tests[1]

This standard is issued under the fixed designation G 60; 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 procedures for conducting cyclic humidity tests with a corrosive dip.[2] It sets forth the conditions required in cyclic humidity testing.

1.2 This test method does not prescribe the type of test specimen or exposure periods nor the interpretation to be given to the results.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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

2. Referenced Documents

2.1 *ASTM Standards:*

D 1193 Specification for Reagent Water[3]

G 1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens[4]

3. Significance and Use

3.1 The procedure described is used to observe the behavior of steels under test conditions that retard the formation of a protective type of rust.

3.2 This test method should not be used to rank steels that form a protective type of rust under atmospheric exposure conditions.

4. Apparatus

4.1 The apparatus required for cyclic humidity testing consists of a test chamber, provisions for heating the chamber, a humidifying tower, a drying train, a dip mechanism, provisions for introducing and draining the solution, a supply of compressed air, specimen supports, and necessary means of control (see Annex A1).

4.2 A schematic diagram of the apparatus is shown in Fig. 1.

4.3 The apparatus should be capable of providing an 8-h humidity cycle three times per day, as shown in Fig. 2, and a dip cycle once a day.

4.3.1 The cyclic variation of humidity can be obtained by variation of the temperature of the water in the humidifying tower. The temperature of the water is cycled thermostatically such that the relative humidity of air bubbling through the water at a minimum rate of 1 L/min (.04 ft^3/min) will vary between 100 and 50 % when the temperature of the air in the test chamber is brought to 52 ± 1°C (125 ± 2°F).

4.3.2 The range of relative humidity can be extended by adding a drying period to the humidity cycle described above. The control circuit (see Annex A1 and Fig. 3) is arranged such that the air is switched to the drying train when the relative humidity has descended to 50 %. The drying train can be a desiccating tower containing anhydrous calcium sulfate. The minimum relative humidity shall be 20 % or less and the maximum relative humidity shall be 95 % or more for each cycle.

NOTE 1—Instruments to continuously record temperature and humidity are not mandatory, but these provide the most reliable and economical way of recording such information. In the absence of such instrumentation, temperature and humidity measurement shall be made, at least twice a day, at the maximum and minimum humidity in a cycle.

4.4 *Materials of Construction*:

4.4.1 The test chamber should be made of inert materials such as plastics, glass or metals lined with impervious plastics, rubber or epoxy-type materials, or materials exhibiting equivalent corrosion resistance.

4.4.2 The dip solution container should not be affected by or cause contamination of the dip solution.

4.4.3 *Specimen Supports*:

4.4.3.1 The specimen-supporting device should not be affected by or cause contamination of the dip solution.

4.4.3.2 The method of supporting specimens will vary with the apparatus used for conducting the tests, but should be designed to insulate the specimens from each other physically and electrically and to insulate the specimens from any metallic container or supporting device used within the apparatus.

4.4.3.3 Shape and form of the specimen support should assure free contact of the specimen with the corrosive solution, the liquid line, or the vapor phase. In a stacked rack, the first and last specimens should be dummy specimens so that the outermost test specimens are shielded by their neighbors in the

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[1] This test method is under the jurisdiction of ASTM Committee G-1 on Corrosion of Metals, and is the direct responsibility of Subcommittee G01.05 on Laboratory Corrosion Tests.

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[2] Opinsky, A. J., Thomson, R. F., and Boegehold, A. L., "A Cyclic Humidity Accelerated Corrosion Test for Sheet Steel", *ASTM Bulletin*, January 1953.

[3] *Annual Book of ASTM Standards*, Vol 11.01.

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

TABLE 1 Summary of Mass Loss from Replicate Tests of Low Carbon Steels in the Cyclic Humidity Test

Steel	Mass Loss (g/m^2)								
	Test 8			Test 9			Test 18		
	No.	Mean	Stnd. Dev.	No.	Mean	Stnd. Dev.	No.	Mean	Stnd. Dev.
A	10	9.22	0.16	...	...	...			
B	9	10.77	0.18	...	...	...			
C	10	9.60	0.13	...	...	...			
D	...	...	...	...	...	...	6	8.90	0.17
E	...	...	...	6	10.02	0.52	6	9.80	0.31
F	...	...	...	6	9.21	0.21	6	9.35	0.48
G	...	...	...	6	11.30	0.48	6	11.00	0.21

No. = Number of test specimens.
Stnd. Dev. = Standard deviation.

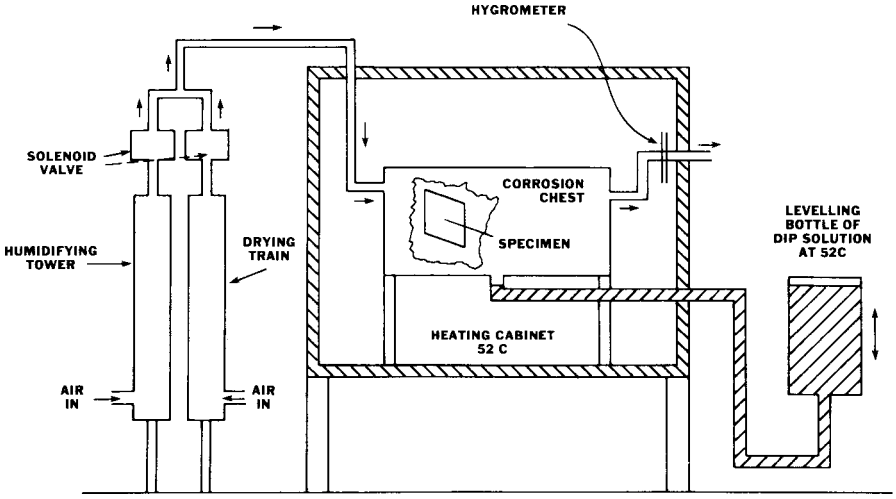

FIG. 1 Main Parts of the Corrosion Testing Apparatus (Schematic)

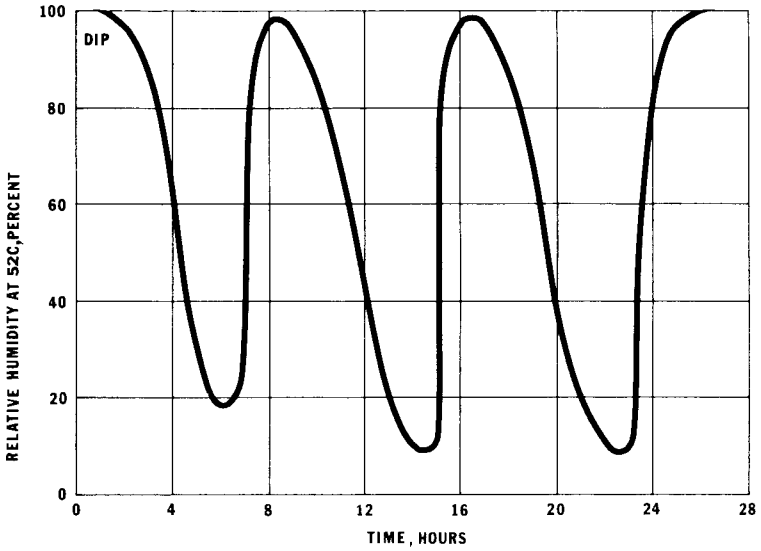

FIG. 2 Humidity Cycle (Schematic)

same manner as specimens in the middle of the stack.

5. Reagents and Materials

5.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society,

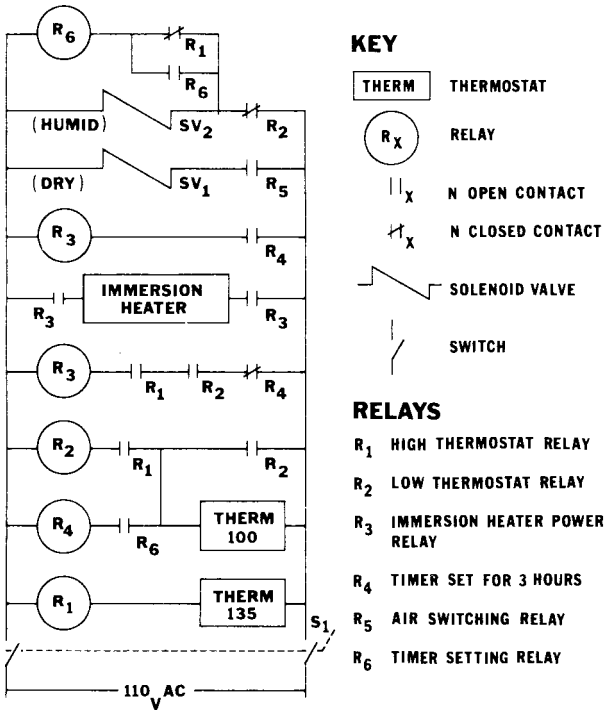

FIG. 3 Schematic of Cycling Control Mechanism

where such specifications are available.[5]

5.2 *Purity of Water*—Unless otherwise indicated, reference to water shall be understood to mean distilled or deionized water conforming to Type IV reagent water described in Specification D 1193 except that for this test method the limits for chlorides and sodium may be ignored.

5.3 *Dip Solution*—The dip solution should be prepared by dissolving 1 % sodium chloride (NaCl), 1 % calcium chloride ($CaCl_2$), and 0.1 % sulfuric acid (H_2SO_4) by solution weight in water. The solution volume to specimen surface area ratio should be a minimum of 250 mL/cm^2.

6. Test Specimen

6.1 Strip coupons 75 by 38 by 2 mm (3 by 1½ by 1⁄16 in.) may be preferred as corrosion specimens.

6.2 Six to eight identical specimens should be tested.

6.3 Specimens should be prepared, cleaned, and evaluated in accordance with Practice G 1.

7. Procedure

7.1 Place specimens in the test chamber when the humidity is 100 %.

7.2 Keep the chest shut for the remainder of the test. Start the first dip cycle immediately after placing the specimens in the chamber.

7.2.1 One dip cycle shall consist of three 5-min immersion periods. Drain the dip solution from the test chamber for a 1-min period between each immersion period.

7.2.2 Maintain the dip solution at 52 ± 1°C (125 ± 2°F).

7.3 Cycle the humidity as shown in Fig. 2 during the test period.

7.3.1 Maintain the temperature in the test chamber at 52 ± 1°C (125± 2°F).

7.3.2 Operate the dip cycle once a day at a point in the humidity cycle when the relative humidity is close to 100 %.

7.4 The duration of the test should be a minimum of 20 days. Longer test times may be used depending upon the purpose of the test. Use fresh dip solution for each test, and change the dip solution at least every 90 days during extended exposure periods.

8. Report

8.1 Data for the exposed specimens should include physical dimensions, chemical composition, metallurgical history, surface preparation, and after-exposure cleaning methods.

8.2 The report should include the exposure period and the method of supporting the specimens in the test chamber.

8.3 The results of the tests should be expressed as corrosion rate (Practice G 1) such as penetration per unit time (for example, millimetre per year), loss in thickness over the exposure period, or plotted as mass loss per unit area versus time.

8.4 Any disturbances that significantly alter the prescribed test conditions invalidate the test. Do not report results from such tests.

9. Precision and Bias [6]

9.1 The precision and bias for this test method are being reviewed and revised by Task Group G01.05.01.05.

10. Keywords

10.1 cyclic testing; humidity; test cycles; test equipment; steels

[5] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

[6] Supporting data available from ASTM Headquarters. Request RR: G01-1005.

ANNEX

(Mandatory Information)

A1. ELECTRICAL CIRCUIT FOR CONTROLLING THE TEST

A1.1 A suitable electrical control circuit is shown in Fig. 3. The relays can be divided into two groups as follows: humidifying (R_1, R_2, R_3) and drying (R_4, R_5, R_6)

A1.1.1 Two thermostats located on the humidifying tower control the cycling between the desired temperatures. Their action is transmitted to R_1 and R_2. If R_4 is open, then R_1 and R_2 will control R_3, applying power to the immersion heater when both are closed. This is the basis of the humidity cycle.

A1.1.2 The remaining relays permit the drying period to be inserted into the cycle. If R_4 is open, R_5 is open; R_6 will close when R_1 opens at 57°C (135°F), and will be held in until R_5 is closed.

A1.1.3 When the low-temperature thermostat closes again, both R_2 and R_4 will close. R_2 will now be prevented from closing by R_4; no power is applied to the immersion heater while the timer is operating. R_4 closes R_5, which switches the air from the humidifying tower to the drying train by means of the two solenoid valves. R_5 also opens R_6: R_4 cannot be re-energized at the end of the 3-h period; instead R_2 closes and the heating period is begun.