Designation: D 5571 – 94 (Reapproved 2001)ε1

Standard Test Method for Environmental Stress Crack Resistance (ESCR) of Plastic Tighthead Drums Not Exceeding 60 Gal (227 L) in Rated Capacity[1]

This standard is issued under the fixed designation D 5571; 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.

ε1 NOTE—Footnote 4 was updated editorially in October 2001.

1. Scope

1.1 This test method provides an indication of the environmental stress crack resistance of plastic tighthead drums as a summation of the effects of container design, resin, manufacturing conditions, field performance, and other factors.

1.2 This test method may be used to evaluate a plastic drum's resistance to failure by cracking when in the presence of chemical and physical stresses.

1.3 Two procedures are provided as follows:

1.3.1 *Procedure A*—Internal pressure stress crack resistance method to nonyl phenoxypoly (ethyleneoxy) ethanol solution, a stress cracking reagent. The internal pressure is controlled at a constant elevated pressure and temperature.

1.3.2 *Procedure B*—Top-load stress crack resistance method to nonyl phenoxypoly ethanol, a stress cracking reagent. The compressive top load is controlled at a constant weight while maintaining an elevated temperature.

1.4 Although these procedures are not designed to test the ability of the closure or closure gasket material to retain the test reagent, the inclusion of closure failure as a container failure mode is optional. However, leakage through a closure may affect the internal pressure that could affect the test results.

1.5 This test method does not attempt to address all factors that could lead to stress cracking of plastic drums. The user of this standard may use other test parameters, such as top loads, chemical reagents, etc., as agreed upon between the user and supplier in the event of a drum qualification or purchase agreement.

1.6 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

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.* Specific warning statements are given in 6.2.

2. Referenced Documents

2.1 *ASTM Standards:*

D 996 Terminology of Packaging and Distribution Environments[2]

D 4577 Test Method for Compression Resistance of a Container Under Constant Load[2]

E 122 Practice for Choice of Sample Size to Estimate the Average Quality of a Lot or Process[3]

3. Terminology

3.1 *Definitions*—Reference Terminology D 996 for definitions of terms applicable to this test method.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *environmental stress crack*—a crack that develops when a plastic drum is exposed to chemical and physical stresses.

3.2.2 *plastic tighthead drum*—A non-removable head plastic drum, maximum capacity not exceeding 60 gal (227 L), with openings for filling and emptying not exceeding 2.76 in. (70 mm) in diameter.

3.2.3 *stress crack failure*—any environmental stress crack that penetrates through the thickness of the drum resulting in a loss or leakage of the test reagent shall be interpreted as a failure.

4. Summary of Test Method

4.1 *Procedure A*—Exposes a minimum of three partly filled plastic drums to the action of a stress cracking reagent, within the container, at an elevated internal pressure and elevated temperature. The test duration shall be 14 days, or as specified by the user.

4.2 *Procedure B*—Exposes a minimum of three plastic drums to a mechanical top load at elevated temperatures. The drums are filled with a stress cracking reagent and sealed prior to the load being applied. The test duration shall be 14 days, or as specified by the user.

[1] This test method is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.23 on Natural Environment Test Methods.

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[2] *Annual Book of ASTM Standards*, Vol 15.09.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

5. Significance and Use

5.1 These procedures provide an indication of the environmental stress-crack resistance of plastic tighthead drums. This test method may be used for determining the applicability of various plastic resins, mold designs, processing techniques and parameters for plastic tighthead drums.

5.2 Environmental stress cracking is indicative of what results when a container is exposed to chemical agents such as soaps, organics, bleaches, or any surface active solutions while under conditions of stress.

5.3 Environmental stress cracking is a mechanism of chemical attack that is highly dependent upon the test reagent, resin, drum manufacturing or processing history, exposure temperature, and applied stress. The combination of these factors may result in eventual stress crack failure.

5.4 Both procedures minimize the potential for test variability by providing the user with rigidly defined test conditions. This test method may be used as design qualification and auditing tools for plastic tighthead drums.

5.5 This test method is not meant to provide a quantitative value of measurement (that is, number of days to failure). It is intended only as a pass/fail procedure in accordance with user's specifications, or as agreed upon between the user and supplier. It is not intended as a predictor or indicator of field performance regarding time to failure.

6. Apparatus

6.1 *Environmental Chamber*—The environmental chamber should be capable of maintaining a temperature control of ±2.5°F (±1.4°C) of set point. For best circulation and a constant temperature throughout, a forced air system is recommended.

6.2 *Top Load*—Requires free weights (dead load) be placed on top of the specimens in amounts necessary to equal the specified top load. The deadload base should be of sufficient dimensions to completely cover the top perimeter of the drum. A calibrated pneumatic or hydraulic cylinder may be substituted for the free weights provided that a floating-head platen is used. (**Warning**—The potential exists for catastrophic stress-crack failure causing an instability of the applied top-load. Precautionary steps should be taken (that is, allow drum failure but restrain the top load) to reduce the chance of injury to the operator or damage to the chamber and surrounding test drums.)

6.3 *For Procedure A Only*:

6.3.1 The essential parts of this apparatus are shown in Fig. 1. The necessary equipment is as follows:

6.3.1.1 *Clean (Compressed) Air Supply*, of sufficient pressure to operate regulator and maintain regulated pressure to drums.

6.3.1.2 *Pressure Regulator*, to reduce line pressure to 2.0± 0.1 psi (13.8 ± 0.7 kPa).

6.3.1.3 *Pressure Gages*, calibrated to indicate a pressure of 2.0 ± 0.05 psi (13.8 ± 0.34 kPa).

6.3.1.4 *Ball Valve*—see Fig. 2.

6.3.1.5 *Pressure Relief Valve*, to prevent over pressurizing (ruptured disc-type recommended).

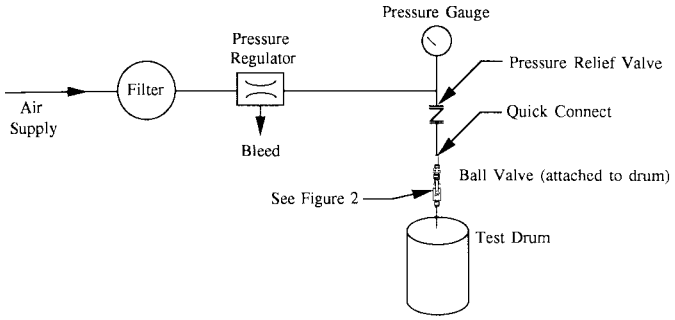

FIG. 1 Apparatus for Procedure A

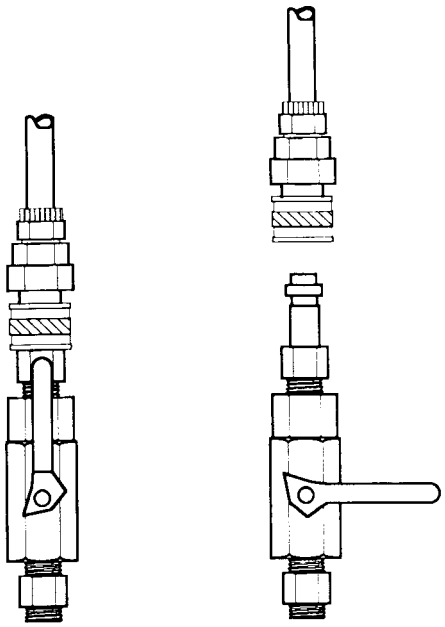

FIG. 2 Quick Connect With Ball Valve

7. Reagent

7.1 *Nonyl Phenoxypoly Ethanol Solution*—Prepare a 10 % solution, by volume, of the stress cracking agent[4] and water in sufficient volume to fill the specified number of drums to 10 % rated capacity for Procedure A, and to rated capacity for Procedure B. (It may be helpful to add an indicator dye to the solution to aid in the detection of micro-leaks).

NOTE 1—Due to the viscosity of the stress cracking agent, it may be helpful to prepare the solution at an elevated temperature. A maximum temperature of 122°F (50°C) is an acceptable level provided caution is used to avoid prolonged heating and eventual volume losses.

8. Sampling

8.1 A minimum of three drums is required for this test. When possible, for direct comparison, the test drums should be produced by the same process under identical conditions from the same production lot. It is suggested that the test drum resin, machine, mold (if applicable) and process conditions be

[4] Nonyl phenoxypoly (ethyleneoxy) ethanol solution is available from Rhodia, Inc. Home, Personal Care and Industrial Ingredients, CN 7500, 259 Prospect Plains Road, Cranbury, NJ 08512–7500 (1888–776–7337) as Igepal CO-630 (Antanox CO-630).

thoroughly documented to improve statistical reliability of the test data (see Practice E 122).

9. Conditioning

9.1 Condition empty test drums at ambient conditions for 48 h prior to testing.

10. Procedure

10.1 *Procedure A—Internal Pressure Stress Crack Resistance Method*:

10.1.1 Place the chamber set point at 122°F (50.0°C) and allow it to reach equilibrium. Precondition test reagent to 122 ± 2.5°F (50.0 ± 1.4°C) and fill each test specimen to 10 % of rated capacity with the preconditioned test reagent. Apply the closures and torque according to the drum manufacturer's recommendations. Invert the drum and then place on its side and roll the drum a distance equal to twice the circumference in order to thoroughly coat the inside surfaces of the drum with the reagent. Place test specimens upright in the chamber on an even horizontal surface.

10.1.2 Affix air pressure apparatus to top head of drum and apply 2.0 ± 0.1 psi (13.8 ± 1.4 kPa) pressure. Check drum for leaks around fittings and closures at start of test, and again after 8 h. Any leaks should be noted and sealed.

10.1.3 Visually inspect the test specimens every 24 h for any evidence of stress crack failure. Recoat the inside surfaces of the drum with test reagent every 48 h. Recoating is performed by closing the ball valve (to maintain internal pressure), detaching the air supply, and inverting the drum and rolling it a distance equal to twice its circumference. If no stress cracks are evident (which would be indicated by bubbling or leaking of the reagent through the failure) immediately put the drum back on test with the applied air pressure. If stress cracks are evident, record the location of the failure. If test drums have not failed after a predetermined duration, the test is terminated with the drums successfully meeting established criteria.

10.2 *Procedure B—Top Load Stress Crack Resistance Method*:

10.2.1 Place the oven set point control at 122°F (50°C) and allow it to reach equilibrium. Precondition test reagent to 122 ± 2.5°F (50.0 ± 1.4°C). Fill each specimen to its rated capacity with the preconditioned test reagent. Apply non-vented closures to the drum and torque according to the drum manufacturer's recommendations. Place the test specimens upright in the oven on an even horizontal surface.

NOTE 2—If the drum is normally shipped with vented closures then the test may be performed using vented closures, however the results might differ from drums tested with non-vented closures.

10.2.2 The top load test shall conform to Test Method D 4577. Place the top load (as recommended in Table 1, or as agreed upon between user and supplier) on the drum.

TABLE 1 Recommended Top Loads

Drum Rated Capacity, gal (L)	Top Load Weight, lbs (kg)
5 thru 7 (18.9 thru 26.5)	200 (90.6)
15 (56.8)	300 (136.0)
30 (113.6)	600 (272.2)
55 (208.2)	1100 (499.0)

NOTE 3—The potential exists for catastrophic drum failure. Care should be taken to prevent reagent spillage and ensure top load stability (see Note). For drums with rated capacities other than those in Table 1, with capacities exceeding 7 gal (26.5 L), the top load values may be determined by multiplying the rated capacity by 20 lbs (9.0 kg).

10.2.3 Inspect the test drums every 24 h for any evidence of stress crack failure. Inspection is performed without removing the top load from the test drum. Stress cracks may be more easily detected by placing the drum on a moisture indicating medium, such as paper. The moisture indicating medium will allow the detection of small leaks which otherwise may evaporate. Record the location of any failure that occurs. If the test drums have not failed after a predetermined duration, the test is terminated with the drum successfully meeting the established performance criteria.

11. Report

11.1 Report the following information:

11.1.1 Procedure used (Procedure A or B),

11.1.2 Complete description of the drums tested, including style, resin properties, processing conditions, pigment loading levels, percent of regrind resin, closures (vented or non-vented), and any other pertinent information,

11.1.3 Number of drums tested,

11.1.4 Reagent or product description,

11.1.5 Temperature conditioning levels,

11.1.6 Applied air pressure or top load value,

11.1.7 Method and frequency of evaluation for stress-crack failure,

11.1.8 Method and frequency of inspection and recoating,

11.1.9 Detailed description of pass/fail criteria and how the test specimen performed to the criteria, and

11.1.10 Location and types of failures.

12. Precision and Bias

12.1 *Precision and Bias*—No statement is made about either the precision or bias of this test method for measuring environmental stress crack resistance since the results merely state whether there is conformance to the performance criteria specified in the procedure.

13. Keywords

13.1 drum; environmental stress crack; internal pressure; plastic; stacking; stress crack; tighthead