Designation: D 1975 – 95

Standard Test Method for Environmental Stress Crack Resistance of Plastic Injection Molded Open Head Pails[1]

This standard is issued under the fixed designation D 1975; 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 provides procedures for an indication of the environmental stress crack resistance of plastic injection molded open head pails, covers, and components 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 container's resistance to mechanical 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, Specified Stress-Crack Resistance Test Method*—This procedure is particularly useful for quality control since the conditions of the test are specified.

1.3.2 *Procedure B, User Selected Stress-Crack Resistance Test Method*—This procedure allows individual selection of test levels and is particularly useful as a design and development tool.

1.4 These procedures are not designed to test the ability of the cover gasketing material or closure to retain the test reagent. Loss or leakage of the reagent through these openings does not constitute container failure. However, this may indicate an internal pressure loss that might affect test results.

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

1.6 *This standard does not purport to address all of the safety problems, 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 caution statements are given in Note 1, Note 4, Note 6, Note 10, and Note 12.

2. Referenced Documents

2.1 *ASTM Standards:*

D 996 Terminology of Packaging and Distribution Environments[2]

D 4332 Practice for Conditioning Containers, Packages, or Package Components for Testing[2]

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

3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *environmental stress crack*—an external or internal crack that develops when a container is exposed to chemical or physical stresses, or both.

3.2.2 *stress crack failure*—any environmental stress crack that causes a loss or leakage of the test reagent shall be interpreted as container failure.

4. Summary of Test Method

4.1 The environmental stress-crack resistance is determined by subjecting an injection molded open head pail and cover that is filled and sealed with a stress-crack reagent to a mechanical top load at elevated temperatures. The time to stress-crack failure is observed.

4.1.1 Procedure A exposes a minimum of three containers to specified levels of chemical and physical stresses.

4.1.2 Procedure B exposes containers to varying chemical and physical stresses based on the user's knowledge and objectives.

5. Significance and Use

5.1 These procedures provide an indication of the environmental stress-crack resistance of injection molded open head pails, covers, and components from a selected group or lot. Provided the thermal history of each container is constant, this test method may be used for determining the applicability of various plastic resins and mold designs for injection molding of open head pails and covers.

5.2 The environmental stress-crack that occurs is indicative of what results when a container is exposed to agents such as soaps, organics, or any surface active solutions while under environmental conditions of stress.

5.3 Environmental stress-cracking is the mechanism of chemical attack that is highly dependent upon the test reagent, resin, container molding history, exposure temperature, applied

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

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

stress, and other factors. The combination of these factors may result in eventual stress-crack failure.

5.4 Procedure A minimizes the potential for test variability by providing the user with rigidly defined test conditions. This test method may be used for production quality control of injection molded open head containers.

5.5 Procedure B allows the user to select and evaluate extreme individual elements or the interaction of several test levels on container performance. These conditions are established based on laboratory experience and available knowledge of the distribution environment. This test method may be used for identifying critical stresses which could aid in container design or help in minimizing the occurrence of these stresses during distribution.

5.6 This test method is intended only as a pass/fail procedure in accordance with the user's specification, or as agreed upon between the user and the supplier. It is not intended as a predictor or indicator of field performance regarding time to failure.

6. Apparatus

6.1 *Oven*—The oven 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 a pail identical to the test pail be filled to rated capacity or weight and then nested above the test pail. Free weights are then placed above in amounts necessary to equal the specified top load. A calibrated pneumatic or hydraulic cylinder may be substituted for the additional free weights.

NOTE 1—**Caution:** The potential exists for catastrophic stress-crack failure causing an instability of the applied top load. Precautionary steps should be taken (that is, through restraining or guiding of the top load) to reduce the chance for injury to the operators or damage to the oven and surrounding test containers.

7. Reagents

7.1 *Procedure A; Nonyl Phenoxypoly (Ethyleneoxy) Ethanol Solution*—Prepare a 10 % solution, by volume, of the stress-cracking agent[4] and water.

NOTE 2—Due to the viscosity of the stress-cracking agent, it is 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.

7.2 *Procedure B*—Any reagent or proprietary product (liquid, solid, etc.) that is potentially a stress-cracking agent.

8. Sampling

8.1 A minimum of three containers are required for this test method. When possible for direct comparison, the test containers should be produced in the same mold and molding conditions. It is suggested that test container resin, machine, mold, and molding conditions be thoroughly documented to improve statistical reliability of the test data. (Practice E 122.)

9. Conditioning

9.1 Condition empty test containers at 73 ± 2°F (23 ± 1.3°C) 50± 3 % relative humidity for 48 h prior to testing (see Practice D 4332).

10. Procedure

10.1 *Procedure A—Specified Stress-Crack Resistance Method*:

10.1.1 Place the oven set point control at 122 ± 2°F (50 ± 1.3°C) and allow it to reach equilibrium. Fill each test specimen to 98 % of the container's total volumetric capacity with the test reagent. Apply the cover to the pail firmly and evenly using a method similar to the assembly technique used during actual production.

10.1.2 Place test specimens in the oven on an even horizontal surface. Place an identical pail filled to rated capacity with sand or water on top of each test specimen. Apply additional weight to the top of the pail filled with sand or water to bring the total top load weight (sand or water pail plus weight) up to the values specified in Table 1. Record the time and date the test was started.

10.1.3 Inspect the test pails and covers daily for any evidence of stress-crack failure. Inspection is performed without removing the top load from the test container. Stress crack may be more easily detected by placing the pail on top of a moisture indicating medium, such as paper. The moisture indicating medium will allow the detection of small leaks that otherwise may evaporate. Record the time, date, and location of any failure that occurs.

10.2 *Procedure B—User Selected Stress-Crack Resistance Method*:

10.2.1 The following are individual elements that may attribute to the weakening of a polymer and eventual stress-crack failure. Use these guidelines in establishing and selecting test intensity levels.

10.2.2 *Container Production Techniques*—The processing methods involved with injection molding of a container may have an effect on environmental stress-crack resistance. Document all factors significant to the production of the test containers.

NOTE 3—Molded in stress resulting in warpage or dimensional changes can alter the chemical resistance of some polymers.

10.2.3 *Reagent*—Select a stress-crack agent or suspect product and fill each test container to 98 % of the container's total volume capacity.

NOTE 4—**Caution:** If the containers are only partially filled, the potential exists for the development of excessive internal pressures that may affect test results and create unstable test conditions.

TABLE 1 Top Load Weight Requirements

Top Loads	
Pail Rated Capacity, gal (L)[A]	Top Load Weight, lb (kg)
3 (11.36)	120 (54.43)
4 (15.14)	160 (72.58)
5 (18.93)	200 (90.72)
6 (22.71)	240 (108.86)

[A] For pails having a capacity other than those shown in Table 1, the top load is calculated using the following equation: capacity in gallons (litres) × 40 lb (4.792 kg) = top load in pounds (kilograms).

[4] Nonyl phenoxypoly (ethyleneoxy) ethanol solution is available from Rhone-Poulenc Corp., P.O. Box 2643, Spartansburg, SC 29304-2643 as Igepal CO-630 (Antanox CO-630).