Designation: D 1998 – 97

Standard Specification for Polyethylene Upright Storage Tanks[1]

This standard is issued under the fixed designation D 1998; 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 specification covers flat-bottom, upright, cylindrical tanks molded in one-piece seamless construction by rotational molding. The tanks are molded from polyethylene for above-ground, vertical installation and are capable of containing aggressive chemicals at atmospheric pressure. Included are requirements for materials, properties, design, construction, dimensions, tolerances, workmanship and appearance. Tank capacities are from 1900 L (500 gal) up.

1.2 This specification does not cover the design of vessels intended for use at pressures other than atmospheric pressure. Furthermore, this specification does not cover the design of portable tanks. It is also not for vessels intended for use with liquids heated above their flash points, or temperatures above 66°C (150°F) for Type I tanks and 60°C (140°F) for Type II tanks for continuous service. *NFPA Standards 30 and 31 should be consulted for installations which may be subject to the requirements of these standards.*

1.3 Special design considerations not covered in this specification should be given to vessels subject to superimposed mechanical forces, such as seismic forces, windload or agitation; to vessels subject to service temperature in excess of 23°C (73.4°F); and vessels subject to superimposed pressure exceeding 25.4 cm (10 in.) of water or 2.5×10^{-3} MPa (0.36 psi).

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

NOTE 1—There is no similar or equivalent ISO standard.

1.5 The following precautionary caveat pertains only to the test methods portion, Section 11, of this specification: *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:*

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]
D 883 Terminology Relating to Plastics[2]
D 1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics[2]
D 2837 Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials[3]
D 3892 Practice for Packaging/Packing of Plastics[4]
D 4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets[5]
E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[6]
F 412 Terminology Relating to Plastic Piping Systems[3]

2.2 *OSHA Standard:*

29 CFR 1910.106 Occupational Safety and Health Administration, Flammable and Combustible Liquids[7]

2.3 *ANSI Standard:*

B-16.5 Pipe Flanges and Flanged Fittings[8]

2.4 *NFPA Standards:*

30 Flammable and Combustible Liquid Code[9]
31 Installation of Oil Burning Equipment[9]

3. Terminology

3.1 *Definitions:* Definitions are in accordance with Terminologies D 883 and F 412 and the Association of Rotational Molders (ARM) Glossary of Terms,[10] unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *impact failure, n*—any crack in the test specimen resulting from the impact and visible in normal room lighting to a person with normal eyesight.

3.2.2 *rotational molding, n*—a three-stage commercial process consisting of loading the mold with powdered resin,

[1] This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.12 on Olefin Plastics.

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[2] *Annual Book of ASTM Standards*, Vol 08.01.
[3] *Annual Book of ASTM Standards*, Vol 08.04.
[4] *Annual Book of ASTM Standards*, Vol 08.02.
[5] *Annual Book of ASTM Standards*, Vol 08.03.
[6] *Annual Book of ASTM Standards*, Vol 14.02.
[7] Available from OSHA, 2900 Newton St., NE, Washington, DC 20018.
[8] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.
[9] Available from National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.
[10] Available from Association of Rotational Molders, 435 North Michigan Ave., Suite 1717, Chicago, IL 60611-4067.

***A Summary of Changes section appears at the end of this standard.**

fusing the resin by heating while rotating the mold about more than one axis, and cooling and removing the molded article.

3.2.3 *service factor, n*—a number less than 1.0 (which takes into consideration all the variables and degrees of safety involved in a polyethylene storage tank installation) which is multiplied by the hydrostatic design basis to give the design hoop stress.

4. Classification

4.1 Tanks meeting this specification are classified according to type as follows, and it is the responsibility of the purchaser to specify Type I or Type II:

4.1.1 Type I—Tanks molded from cross-linkable polyethylene.

4.1.2 Type II—Tanks molded from noncross-linkable polyethylene.

5. Materials

5.1 This specification is based upon the use of 100 % virgin polyethylene intended for the rotational molding process. Any use of regrind, recycled or reprocessed materials, or combinations of such materials, shall not rely upon the performance data of their original constituents, but must meet the requirements of this specification in its own right.

5.1.1 The polyethylene shall have a stress-cracking resistance of 500 h minimum F50 in accordance with Test Method D 1693, Condition A, full-strength stress-cracking agent. The test specimens may be compression molded or rotational molded. If compression molded, Procedure C of Annex A1 of Practice D 4703 shall be followed for both types of polyethylene with a minimum platen temperature of 177°C (350°F). If it is a crosslinkable polyethylene the temperature shall be 197°C (390°F) and the platen shall be kept closed under full pressure for 5 min at the specified temperature in order to bring about the crosslinking reaction. If the test specimens are rotational molded, the conditions for rotational molding shall be similar to the conditions used for molding a tank from this polyethylene.

NOTE 2—The stress-cracking test is not used as an indicator of general chemical resistance of a polyethylene. The polyethylene supplier's or molder's chemical-resistance chart should be referred to for information on the resistance of the polyethylene to specific chemicals or products, or testing of specific products or chemicals should be conducted.

5.2 All tanks used for outdoor installation shall contain an ultraviolet stabilizer at a level adequate to give protection for the intended service life of the tanks. This stabilizer shall be compounded in the polyethylene.

5.3 Pigments may be added at the purchaser's request and must be compatible with the polyethylene, but should not exceed 0.5 % dry blended, and 2 % compounded in, of the total weight.

NOTE 3—The use of dry-blended pigments may result in an effect on physical properties, that is, impact strength.

5.4 Each resin used in designing tanks covered by this specification shall have hydrostatic-hoop-stress data available.

6. Design Requirements for Both Type I and Type II Tanks

6.1 *Cylinder Shell (Unsupported Portion of Tanks)*—The minimum required wall thickness of the cylindrical shell at any fluid level shall be determined by the following equation, but shall not be less than 4.7 mm (0.187 in.) thick. The tolerance indicated in 9.1.2 applies to these dimensions.

$$T = P \times OD/2\ SD \quad (1)$$

where:

T = wall thickness, mm (in.),
P = pressure, MPa (0.0098 MPa/m-H_2O × SG × H(m)), or psi (0.433 psi/ft-H_2O × SG × H (ft)),
SG = specific gravity of fluid,
H = fluid head, m (ft),
OD = outside diameter of tank, mm (in.), and
SD = hydrostatic design stress, MPa (psi).

6.1.1 The hydrostatic design stress that is used to determine the minimum wall thickness at any fluid level must be based on hoop stress data for the resin. The hoop stress data, obtained in accordance with the procedures of Test Method D 2837, provide a hydrostatic-design-basis for the resin. The hydrostatic-design-basis must be reduced by a service factor to determine the actual hydrostatic design stress. The maximum service factor shall be 0.5 for wall thicknesses less than 9.5 mm (0.375 in.). For thicknesses equal to or greater than 9.5 mm (0.375 in.), the maximum service factor shall be 0.475. For example, if the hydrostatic-design-basis for the resin is 8.7 MPa (1260 psi), the hydrostatic design stress for a tank with wall thickness greater than 9.5 mm (0.375 in.) is 0.475 × 8.7 = 4.1 MPa (or 0.475 × 1260 = 600 psi).

6.1.2 All tank hoop stress shall be derated for service above 23°C (73.4°F).

6.2 *Cylinder Shell (Externally Supported Tanks)*—The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support, but shall not be less than 4.7 mm (0.187 in.) thick. The tolerance indicated in 9.1.2 applies to these dimensions.

6.3 *Top Head*—Must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall.

6.4 *Bottom Head*—Must be integrally molded with the cylinder shell. The minimum thickness for a full-supported flat-bottom head shall be 4.7 mm (0.187 in.). The radius of the bottom knuckle of a flat-bottom tank shall not be less than 25.4 mm (1 in.) for tanks with a diameter less than 1.8 m (6 ft) and 38.1 mm (1.5 in.) for a diameter greater than 1.8 m (6 ft). The minimum thickness of the radius shall not be less than the maximum thickness of the cylinder wall.

6.5 *Open-Top Tanks*—The top edge of open tanks shall be reinforced by design to maintain its shape after installation.

7. Fittings

7.1 Fabricated nozzles, gaskets, and other fitting accessories must be chemically compatible with the materials to be handled in the tanks.

7.2 Openings that are cut in tanks to install fittings must not have sharp corners. Holes should have minimum clearance to insure best performance of fittings.

7.3 The size, location, and specification, etc., for manways and fittings shall be agreed upon between the purchaser and the manufacturer.

7.4 The vents must comply with OSHA 1910.106 (F) (iii) (2) (IV) (9) normal venting for atmospheric tanks, or other accepted standard, or shall be at least as large as the filling or withdrawal connection, whichever is larger but in no case less than 25.4 mm (1 in.) nominal inside diameter.

7.5 Fittings installed in tanks shall be of appropriate strength to meet manufacturer and purchaser specifications.

7.6 Bolts securing mechanical fittings must be manufactured of materials compatible with tank contents.

7.7 Provisions shall be made to attach hold-down devices to the tanks for outdoor service.

7.8 For all flanged connectors, the flange drilling and bolting shall be in accordance with ANSI/ASME B-16.5 for 150 psi (1 MPa) pressure class straddling the principal centerline of the vessel.

8. Performance Requirements

8.1 The following performance requirements shall be met by Type I and Type II tanks:

8.1.1 *Low-Temperature Impact*—Low-temperature impact shall be determined using the test method described in 11.3. The requirements for Type I and Type II tanks are as follows:

Wall thickness, mm (in.)	Impact energy, min. J (ft-lb)
4.7 mm (0.187 in.) to and including 6.4 mm (0.25 in.)	122.0 (90)
6.6 mm (0.26 in.) to and including 12.9 mm (0.50 in.)	135.5 (100)
12.9 mm (0.51 in.) to and including 19.3 mm (0.75 in.)	203.2 (150)
19.3 mm (0.76 in.) to and including 25.4 mm (1.00 in.)	271.0 (200)
greater than 25.4 mm (1.00 in.)	271.0 (200)

8.1.2 *Percent Gel, for Type I Tanks Only*—The percent gel level shall be determined using the test method described in 11.4. The percent gel level for Type I tanks on the inside 3.2 mm (0.125 in.) of the wall shall be a minimum of 60 %.

9. Dimensions and Tolerances

9.1 *General*—All dimensions will be taken with the tank in the vertical position, unfilled. Tank dimensions will represent the exterior measurements.

9.1.1 *Outside Diameter*—The tolerance for the outside diameter, including out of roundness, shall be ±3 %.

9.1.2 *Shell Wall and Head Thickness*—The tolerance for average thickness at each elevation shall be − 10 % of the design thickness on the low side and shall be unlimited on the high side. The tolerance for individual audit readings shall be limited to − 20 % of the design thickness. The total amount of surface area on the low side of the tolerance shall not exceed 10 % of the total surface area.

9.1.3 *Placement of Fittings*—The tolerance for fitting placements shall be 12.7 mm (±0.5 in.) in elevation and 2° radial at ambient temperature.

10. Workmanship

10.1 Type I finished tank walls shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking and delaminations that will impair the serviceability of the vessel. Fine bubbles are acceptable with Type II tanks to the degree to which they do not interfere with proper fusion of the resin melt.

10.2 Because of the differences in various resins used in this application and the molding conditions used, the interior surface characteristics may vary. The acceptable finish shall be predetermined by agreement between the molder and the buyer.

11. Test Methods

11.1 *Test Specimens*—Test specimens shall be taken from an area that is representative of the bottom side wall. If no representative sample cut-out area in the tank is available, test specimens may be molded in a test mold. In either case, prior testing shall verify that the tank wall and the test specimen have equal impact resistance.

11.1.1 The test mold shall be constructed of the same type material and have the same wall thickness as the tank mold. The thickness of the specimen from a test mold shall be the same as the thickness of the bottom side wall within the tolerances as defined in 9.1.2. The test mold shall be molded with each tank.

11.2 *Conditioning*—If requested, test specimens may be conditioned at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity for not less than 40 h prior to testing in accordance with Procedure A of Practice D 618.

11.3 *Low-Temperature Impact Test*:

11.3.1 *Scope*—This test method is for the determination of the impact property of rotational-molded polyethylene tanks at low temperature. The test method is used on tanks molded from both crosslinked and non-crosslinked polyethylenes.

11.3.2 *Summary of Test Method*—Test specimens are cut from available areas on the tank and conditioned at − 29°C (−20°F) for a specified period of time. A suitable type of test apparatus is shown in Fig. 1 and Fig. 2. The specimens are placed, inside-surface down, in the sample holder and immediately impacted with a dart of specified weight, from a prescribed height with a specified radius on the tip. The specimen is observed for failure on both surfaces. The test prescribes a minimum impact value which the specimen must pass.

11.3.3 *Significance and Use*:

11.3.3.1 The dart impact test at −29°C (−20°F) produces a value that is used as an indication of the quality of the tank. If the molding conditions were inadequate and a homogenous melt was not obtained, the impact will likely be low. Higher impact values are obtained with ideal molding conditions indicating that a quality part with good impact resistance has been molded.

11.3.3.2 The impact test gives a true indication of how well the tank was molded.

11.3.4 *Procedure*:

11.3.4.1 Cut specimens to loosely fit the 127 mm by 127 mm (5 in. by 5 in.) sample holder (see Fig. 2). Specimens shall be approximately 127 mm by 127 mm (5 in. by 5 in.), or the maximum size available. In those tanks where specimens of the above size are not available, the supplier must show correlation data between the smaller size and the recommended size.

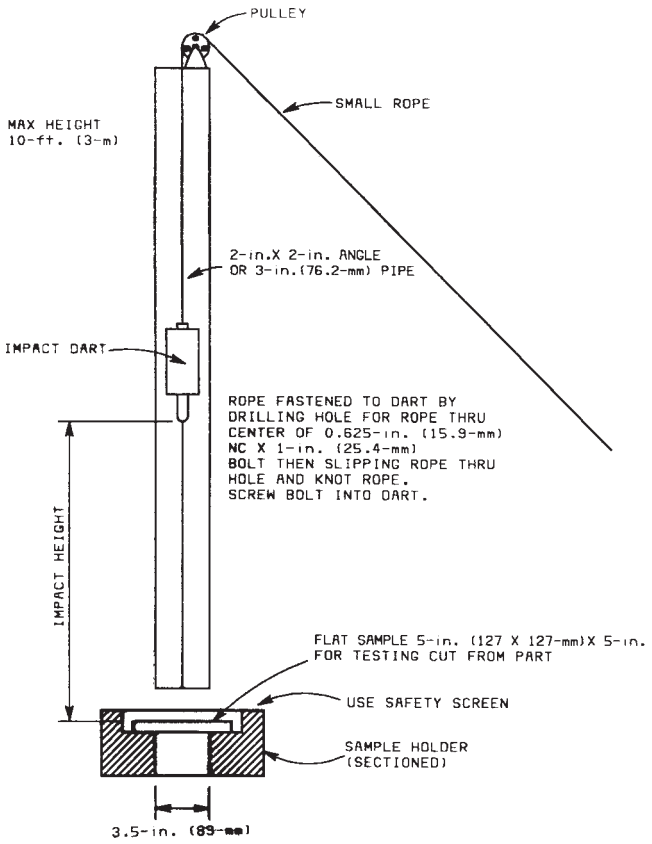

FIG. 1 Dart Drop Impact Test Apparatus

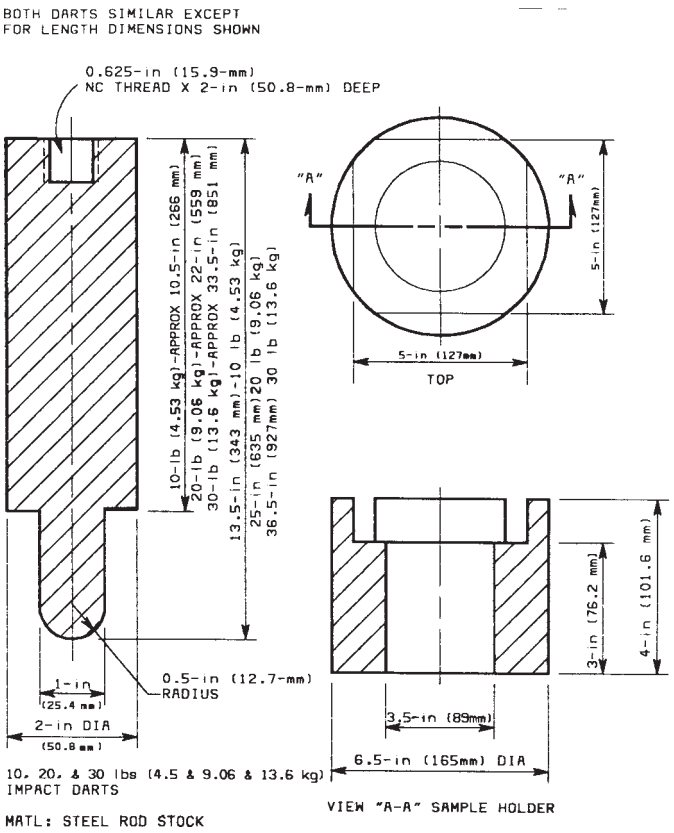

FIG. 2 Dart Drop Impact Test Apparatus

11.3.4.2 Cool bath to − 29°C (−20°F) by immersing small quantities of dry ice in isopropyl alcohol used as the bath medium.

NOTE 4—An alternative temperature for impact is − 40°C (−40°F) or, in some cases, the service temperature. In applications that have a service temperature between − 29°C (−20°F) and − 40°C (−40°F), either the service temperature or − 40°C (−40°F) should be used. For applications that have a service temperature below − 40°C (−40°F), the impact temperature should be at or below the service temperature.

11.3.4.3 **SAFETY WARNING**—Care should be exercised as the dry ice will agitate the solution violently.

11.3.4.4 A freezer may be used if available. Immerse the specimens in the bath for a minimum of 30 min while maintaining the bath temperature. More immersion time is required for specimens greater than 6.4 mm (0.25 in.) thick or for specimens chilled in air instead of alcohol. Two hours is recommended for air chilled specimens.

11.3.4.5 Remove specimens from the freezer or bath one at a time. Within 5 s, release the dart and impact each specimen on the outer surface. Use the impact energy specified in 8.1.1 as calculated by multiplying the dart weight by the drop height (Fig. 1). The specimen shall not fail at the specified impact energy (see 3.2.1 for the definition of failure). Whenever possible, choose a dart weight that permits the drop height to be between 0.8 and 2.3 m (2.5 and 7.5 ft) in order to minimize the effect of velocity on the result of the test.

NOTE 5—Ductile failures indicate proper molding for Type I and Type II tanks, while cracking or shattering indicates improperly molded specimens. The test apparatus is shown in Fig. 1 and Fig. 2.

11.3.5 *Report the Following Information*:

11.3.5.1 Identification of the tank,

11.3.5.2 Date of test,

11.3.5.3 J (foot-pounds) used for the test, and

11.3.5.4 Pass or fail.

11.3.6 *Precision and Bias*:

11.3.6.1 Table 1 is based on a round robin conducted in 1991 in accordance with Practice E 691, involving two materials tested by seven laboratories and two materials tested by four laboratories. For each material, all of the samples were molded at one source. Each laboratory tested 20 specimens of a material on two different days under the same conditions.

11.3.6.2 Table 2 is based on a round robin conducted in 1988 in accordance with Practice E 691, involving two materials tested by seven laboratories. For each material, all the samples were prepared at one source, but the individual specimens were prepared at the laboratories which tested them.

TABLE 1 Precision Summary—Impact Strength at –29°C (–20°F)

Material	Average	S_r[A]	S_R[B]	V_r[C]	V_R[C]	r[D]	R[D]
6	44.4	9.1	11.7	20.5	26.4	25.6	32.8
3	119.8	7.3	11.4	6.1	9.5	20.4	31.9
4	119.8	3.1	15.4	2.6	12.9	8.6	63.1
5	121.6	6.6	26.3	3.8	20.0	12.8	67.9

[A] S_r is the within laboratory repeatability, and

[B] S_R is the between laboratory reproducibility.

[C] V_r and V_R are the coefficients of variation (standard deviation expressed as a percent of the average).

[D] r and R are the 95 % limits for a single sample for repeatability and reproducibility respectively.

TABLE 2 Precision Summary—Impact Strength at –40°C (–40°F)

Material	Average	S_r[A]	S_R[B]	V_r[C]	V_R[D]	r[E]	R[E]
2	155.5714	5.1686	16.3623	3.3	10.5	14.4720	45.8146
1	167.6429	6.2393	13.6268	3.7	8.1	17.4700	38.1551
Average:				3.5	9.3		

[A] S_r is the within laboratory repeatability, and
[B] S_R is the between laboratory reproducibility.
[D] V_r and V_R are the coefficients of variation (standard deviation expressed as a percent of the average).
[E] r and R are the 95 % limits for a single sample for repeatability and reproducibility respectively.

Each test result was the average of 20 individual determinations. Each laboratory obtained two test results for each material.

NOTE 6—**Caution:** The following explanations of *r* and *R* are only intended to present a meaningful way of considering the approximate precision of this test method. The data in Table 1 and Table 2 should not be rigorously applied to acceptance or rejection of material, as those data are specific to the round robin and may not be representative of other lots, conditions, materials, or laboratories. Users of this test method should apply the principles outlined in Practice E 691 to generate data specific to their laboratory and materials, or between specific laboratories. The principles shown below would then be valid for such data.

11.3.6.3 *Concept of r and R*—If S_r and S_R have been calculated from a large-enough body of data, and for test results that were averages from testing 20 specimens:

(*a*) *Repeatability, r*—In comparing two test results for the same material, obtained by the same operator using the same equipment on the same day, the two test results should be judged not equivalent if they differ by more than the *r* value for that material.

(*b*) *Reproducibility, R*—In comparing two test results for the same material, obtained by different operators using different equipment on different days, the two test results should be judged not equivalent if they differ by more than the *R* value for the material.

(*c*) Any judgement in accordance with (*a*) or (*b*) would have an approximate 95 % (0.95) probability of being correct.

11.3.6.4 There are no recognized standards by which to estimate bias of this test method.

11.4 *O-Xylene-Insoluble Fraction (Gel Test)*:

11.4.1 *Scope*—This test method is for determination of the ortho-xylene insoluble fraction (gel) of crosslinked polyethylene.

11.4.2 *Summary of Test Method*—A weighed specimen of the crosslinked polyethylene sample is placed in a screen container and the total weight is taken. The container is submerged in boiling o-xylene overnight which dissolves the uncrosslinked portion of the sample. The container with the specimen is dried in an oven and weighed. The percentage gel content is calculated from the weight loss and the original specimen weight.

11.4.3 *Significance of Test*—The o-xylene insoluble portion (gel) of crosslinked polyethylene is an indication of the amount of crosslinking in the polyethylene. The gel is not a direct measure of the extent of the crosslinking network, but indirectly serves to provide a good measure of the crosslinking. It is, therefore, valuable as a test for the quality of the crosslinked polyethylene part.

11.4.4 *Apparatus:*[11]

11.4.4.1 *Extraction Apparatus*:

(*a*) Resin Kettle 2-L[12]

(*b*) Heating Mantle 2-L[13]

(*c*) Clamp, Resin Kettle[14]

(*d*) Condenser, with ground taperjoint to fit hole in resin kettle lid

(*e*) Variable Transformer

(*f*) Unistrut or equivalent stand with clamp to support the kettle and condenser

(*g*) Metal pan, for setting the apparatus in to retain the o-xylene in the event the kettle breaks

11.4.4.2 *Analytical Balance*, which weighs to four decimal places.

11.4.4.3 *Stainless Steel Screen*, 100-mesh.

11.4.4.4 *Muffle Furnace*.

11.4.4.5 *Forced-Draft Oven*.

11.4.4.6 *Reagents*:

(*a*) O-xylene, technical grade

(*b*) Plastanox 2246, antioxidant[15] or equivalent

11.4.5 *Hazards*:

11.4.5.1 Care should be exercised in handling o-xylene. It may cause irritation to the eyes and prolonged exposure may cause blistering and redness to the skin. Inhalation may cause mucous membrane irritation and other effects. The Material Safety Data Sheet should be consulted prior to its use. O-xylene is listed in Subpart Z—Toxic and Hazardous Substances of 29 CFR Ch. VII (7-1-88 Edition). Other applicable EPA and government standards should be consulted also.

11.4.6 *Test Specimens*:

11.4.6.1 The test specimen shall be from the 3.2 mm (0.125 in.) thickness of the interior wall of Type I tanks. It should be cleanly cut so there are no frayed edges or corners.

11.4.6.2 The specimen shall be taken from a manway, drain opening or similar area which is normally removed from the tank before use.

11.4.7 *Procedure*:

11.4.7.1 Weigh a 0.3 g specimen cut from the molded part to ±0.0002 g. Record the specimen weight as W_1.

11.4.7.2 Cut a 35 by 76 mm (1.5 by 3 in.) piece of 100-mesh stainless steel screen for each specimen. Clean the screen with o-xylene, rinse with acetone, and dry in a stream of air.

11.4.7.3 Fold the screen to form a 38 by 38 mm (1.5 by 1.5 in.) square. Make a fold about 6.4 mm (¼ in.) along each of the two open edges to form a pouch, and staple the folds.

11.4.7.4 Place the specimen into the screen pouch, fold the remaining edge, staple the fold and mark each screen with a metal tag. Do not squeeze the pouch sides together. Leave space for the specimen to swell. Weigh the sample plus screen to + 0.0002 g and record this weight as W_2.

NOTE 7—An alternate specimen holder is a reusable cage made from

[11] Suitable apparatus is available from most laboratory supply firms.
[12] Sargent No. S-34530 or equivalent.
[13] Sargent No. S-40890 or equivalent.
[14] Sargent No. S-34533 or equivalent.
[15] Available from American Cyanamid Co., Organic Chemicals Division, Bound Brook, NJ 08805.

100-mesh stainless steel screen as shown in Fig. 3 and Fig. 4. A size of 15.2 mm by 35.6 mm (0.6 in. by 1.4 in.) has been found satisfactory for the cage. The cages must be cleaned after each test by burning off remaining polyethylene at 427°C (800°F) for approximately 30 min in a muffle furnace.

11.4.7.5 Place 1500 mL of o-xylene and 10 g of Plastanox 2246 or equivalent antioxidant in the resin kettle and heat to reflux.

NOTE 8—The Plastanox 2246 is added to prevent further crosslinking of the polymer during the extraction.

11.4.7.6 Suspend the sample screen in the refluxing solvent for 16 h. An overnight run is convenient.

NOTE 9—A maximum of eight samples can be tested in one run.

11.4.7.7 Remove the sample screen while hot and dry to constant weight (W_3) in a forced-draft oven at 170°C (338°F)—for about two h.

11.4.8 *Calculation*:

$$\text{Gel Weight, \%} = \frac{[W_1 - (W_2 - W_3)] \times 100}{W_1} \quad (2)$$

where:

W_1 = weight of sample, g,
W_2 = weight of sample plus screen, g, and
W_3 = weight of sample plus screen after extraction, g.

11.4.9 *Report the Following Information*:

11.4.9.1 Identification of the tank,

11.4.9.2 Date of the test, and

11.4.9.3 Percentage of gel determined in 11.4.8.

11.4.10 *Precision and Bias*:

11.4.10.1 Table 3 is based on a round robin conducted in 1989 in accordance with Practice E 691, involving eight materials tested by seven laboratories. For each material, all the samples were prepared at one source, but the individual specimens were prepared at the laboratories which tested them. Each test result was the average of two individual determinations. Each laboratory obtained three test results for each material.

NOTE 10—**Caution:** The following explanations of *r* and *R* are only intended to present a meaningful way of considering the approximate precision of this test method. The data in Table 3 should not be rigorously applied to acceptance or rejection of material, as those data are specific to the round robin and may not be representative of other lots, conditions, materials, or laboratories. Users of this test method should apply the principles outlined in Practice E 691 to generate data specific to their laboratory and materials, or between specific laboratories. The principles shown below would then be valid for such data.

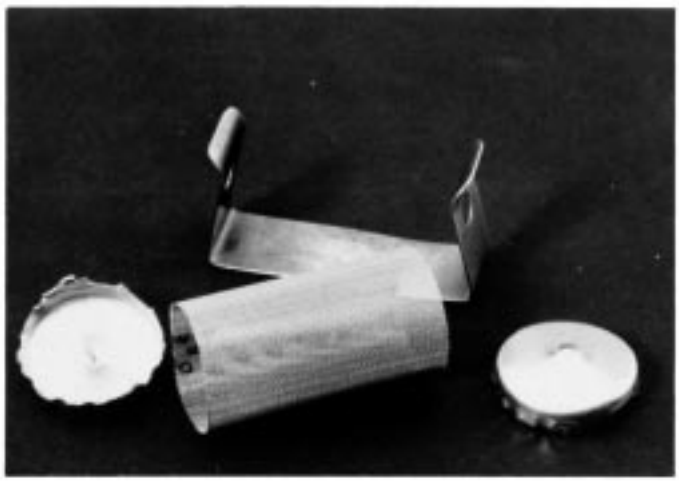

FIG. 3 Gel Cage

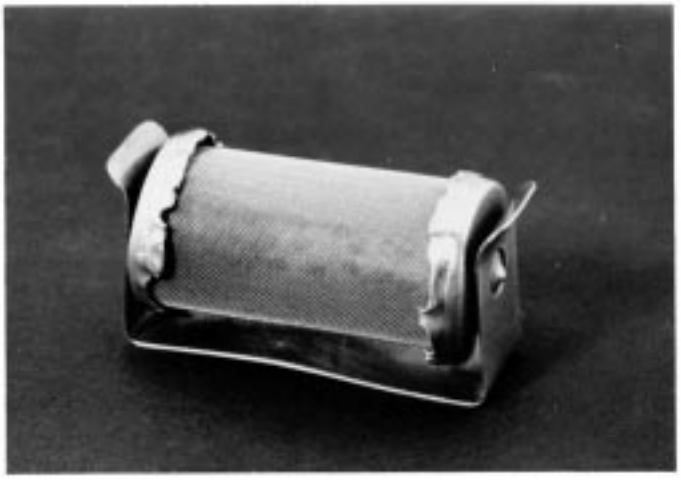

FIG. 4 Gel Cage

TABLE 3 Precision Summary—O-Xylene Insoluble Fraction (Gel)

Material[A]	Average	S_r[B]	S_R[C]	V_r[D]	V_R[D]	r[E]	R[E]
6	79.9605	2.4733	4.1864	3.1	5.2	6.9251	11.7219
5	81.9357	2.1598	3.4861	2.6	4.3	6.0475	9.7612
4	82.1852	1.2954	3.0863	1.6	3.8	3.6271	8.6415
1	84.1072	1.6594	2.9802	2.0	3.5	4.6462	8.3447
7	84.6600	2.0078	2.9978	2.4	3.5	5.6219	8.3938
8	85.4129	1.7201	3.2507	2.0	3.8	4.8164	9.1019
3	91.4138	2.9248	5.1655	3.2	5.7	8.1894	14.4633
2	92.5576	0.9363	1.8244	1.0	2.0	2.6217	5.1083
Average:				2.2	4.0		

[A] The thicknesses of the molded samples from which the specimens were taken were as follows:

	in.	mm
6	>¾	>19
5	>½	>13
4	>¼	>6
1	¼	6
7	>¾	>19
8	¼	6
3	½	13
2	¼	6

The materials were the same for samples (2 and 3), (4, 5 and 6) and (7 and 8). Sample 1 was different from the others.

[B] S_r is the within-laboratory repeatability and

[C] S_R is the between-laboratory reproducibility

[D] V_r and V_R are the coefficients of variation (standard deviation expressed as a percent of the average)

11.4.10.2 *Concept of r and R*—If S_r and S_R have been calculated from a large enough body of data, and for test results that were averages from testing two specimens:

(*a*) *Repeatability, r*—In comparing two test results for the same material, obtained by the same operator using the same equipment on the same day, the two test results should be judged not equivalent if they differ by more than the *r* value for that material.

(*b*) *Reproducibility, R*—In comparing two test results for the same material, obtained by different operators using different

equipment on different days, the two test results should be judged not equivalent if they differ by more than the *R* value for the material.

(*c*) Any judgment in accordance with (*a*) or (*b*) would have an approximate 95 % (0.95) probability of being correct.

11.4.10.3 There are no recognized standards by which to estimate bias of this test method.

11.5 *Visual Inspection*—The tank shall be visually inspected to determine such qualities as are discussed in the Workmanship Section.

11.6 *Water Test*—Each tank shall be hydrostatically tested by the supplier by filling the tank completely with water. The tank shall also be pre-tested at the time of installation by the user by filling the tank completely with water. Such a test also allows final inspection for proper installation of all fittings.

12. Marking

12.1 The tank shall be marked to identify the producer, date (month and year) of manufacturer, capacity, maximum specific gravity of tank design, serial number and Type I or Type II. The marking shall be permanent.

12.2 The proper caution or warning signs as prescribed by OSHA standard 29 CFR 1910.106 shall be affixed to the tank.

12.3 Tank capacity shall be based on the fluid level used to determine the minimum wall thickness as defined in 6.1.

13. Packing, Packaging and Marking

13.1 All packing, packaging, and marking provisions of Practice D 3892 shall apply to this specification.

14. Shipping

14.1 Since there are variations in methods of shipping and handling, the manufacturer's instructions shall be followed in all cases.

14.2 A suitable means shall be provided, if required, at the open end of open-top tanks to keep the loaded tank rigid.

14.3 All fittings and flange faces shall be protected from damage by covering with suitable plywood, hard-board or plastic securely fastened. Tanks shall be positively vented at all times.

14.4 Pipe and tubing, fittings and miscellaneous small parts shall be packaged. Loose items which may scratch the interior surface shall not be placed inside the tank during shipment. Additional protection, such as batens, end wrapping, cross bracing, or other interior fastenings may be required to assure such individual equipment pieces are not damaged in transit.

14.5 Upon arrival at the destination, the purchaser shall be responsible for inspection for damage in transit. If damage has occurred, a claim should be filed with the carrier by the purchaser. The supplier should be notified if the damage is not first repaired by the fabricator prior to the tank being put into service. The purchaser accepts all future responsibility for the effects of the tank failure resulting from damage.

15. Keywords

15.1 polyethylene; tanks; upright

SUMMARY OF CHANGES

Committee D-20 has identified the location of selected changes to this specification since the last issue that may impact the use of this specification.

D 1998 – 97:

(1) 5.1 Specification based on virgin resin.

(2) 9.1.2 Revised wall thickness tolerance to be consistent with industry practice.