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Standard Specification for Polybutylene (PB) Thermoplastic Thin-Wall Drip Irrigation Tubing¹

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1. Scope

1.1 This specification establishes materials, performance requirements, test methods, workmanship, dimensions, inspection, retest, and marking for polybutylene (PB) tubing products intended for exposed and underground service in the delivery of irrigation water with maximum working pressures of 110 psi (0.76 MPa) at 73°F (23°C) and 75 psi (0.52 MPa) at 140°F (60°C) for DR 17 tubing, and 90 psi (0.62 MPa) at 73°F (23°C) and 60 psi (0.41 MPa) at 140°F (60°C) for DR 21 tubing, both inside diameter-controlled.

1.2 This specification defines tubing only, that is, a hollow cylinder having no special shape or multiple channels.

1.3 The values stated in parentheses are provided for information only.

1.4 The following precautionary caveat pertains only to the test method portion, Section 7, 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 Testing²
- D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement²
- D 1505 Test Method for Density of Plastics by the Density-Gradient Technique²
- D 1598 Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure³
- D 1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings³
- D 1600 Terminology for Abbreviated Terms Relating to Plastics²
- D 1603 Test Method for Carbon Black in Olefin Plastics⁴
- D 1898 Practice for Sampling of Plastics⁴
- D 2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings³

¹ This specification is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.61 on Water.

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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.

D 2581 Specification for Polybutylene (PB) Plastics Molding and Extrusion Materials⁴

D 2749 Symbols for Dimensions of Plastic Pipe Fittings³

D 2837 Test Method of Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials³

F 412 Terminology Relating to Plastic Piping Systems³

F 699 Practice for Accelerated Conditioning of Polybutylene Pipe and Tubing for Subsequent Quality Control Testing³

2.2 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)⁵

2.3 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage⁵

3. Terminology

3.1 The terminology used in this specification is in accordance with Terminology F 412, Terminology D 1600, and Symbols D 2749, unless otherwise specified. The abbreviation for polybutylene plastic is PB.

3.2 *polybutylene plastics*—plastics prepared by polymerization of no less than 85 % butene-1 and no less than 95 weight % of total olefins.

3.3 *standard thermoplastic pipe materials designation code*—the tubing materials designation code shall consist of the abbreviation PB for the type of plastic, followed by the ASTM type and grade in Arabic numerals and the hydrostatic design stress in units of 100 psi with any decimal figures dropped. When the design stress code contains less than two figures, a cipher is used before the number. Thus a complete material code consists of two letters and four figures for PB plastic pipe materials, that is, PB2110.

4. Materials

4.1 *Basic Materials Description*—Polybutylene plastics used to make tubing meeting the requirements of this specification are categorized by two criteria—namely, basic short-term properties and long-term hydrostatic strength, 4.1.2 and 4.1.3 respectively define these categories.

4.1.1 *Class C*—Class C polybutylene shall be used for weatherable application (outdoor exposure).

4.1.2 *Basic Short-Term Properties*—This specification covers tubing made from plastic materials meeting the mechanical strength, melt characteristics, and density requirements of Type 2, Grade 1 material in Specification D 2581.

4.1.3 *Long-Term Hydrostatic Design Strength*—This

⁵ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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specification covers DR 17 and 21 tubing which are made from polybutylene resins designated as PB21 and further have a long-term hydrostatic design stress of 1000 psi (6.90 MPa) at 73°F (23°C) and 500 psi (3.45 MPa) at 180°F (82°C). Minimum hydrostatic pressure requirements for DR 17 and 21 tubing are given in Table 1.

4.2 *Certification*—PB tubing, used for the distribution of drip irrigation water, shall be products approved for that service by the regulatory bodies having such jurisdiction. These products shall be tested for that service by a nationally recognized and accredited testing laboratory and shall bear the certification mark of the testing laboratory.

NOTE 1—Further information regarding testing and approval can be obtained from the National Sanitation Foundation Testing Laboratories, Inc., 3475 Plymouth Rd., Ann Arbor, MI 48106, or other accredited laboratory.

4.3 *Rework Material*—Clean rework material, generated from the manufacturer's own pipe production, may be used by the same manufacturer, as long as the pipe produced meets all the requirements of this specification.

5. Classification

5.1 *General*—This specification includes PB tubing made from PB plastic pipe material in standard dimension ratios, namely, DR 17 and 21. The pressure rating is uniform for all nominal pipe sizes for a given PB tubing material and DR (see Table 2).

6. Requirements

6.1 *Workmanship*—The tubing shall be homogeneous throughout and essentially uniform in color, opacity, density, and other properties. The inside and outside surfaces shall be glossy in appearance and free of cracks, holes, blisters, voids, foreign inclusions, or other defects that are visible to the naked eye and that may affect the wall integrity.

6.2 Dimensions and Tolerances:

6.2.1 Controlling Diameter:

6.2.1.1 *Inside Diameter-Controlled Tubing*—The inside diameter and tolerances shall be as shown in Table 3 when measured in accordance with Test Method D 2122.

6.2.2 *Wall Thickness*—The wall thickness and tolerances shall be as shown in Table 3 when measured in accordance with Test Method D 2122.

6.2.3 *Wall Thickness Range*—The wall thickness range

TABLE 1 Minimum Sustained Hydrostatic Pressure Requirements for PB Drip Irrigation Tubing, 1000-h Test Duration

Dimension Ratio, DR	Required Pressure, psi (MPa)			
	73°F	(23°C) ^A	140°F	(60°C) ^B
17	220	(1.52)	155	(1.07)
21	180	(1.24)	125	(0.86)

^A The fiber stress used to derive this test pressure is 2000 psi (13.8 MPa).

^B The fiber stress used to derive this test pressure is 1400 psi (9.7 MPa).

TABLE 2 Thermoplastic Pipe Dimension Ratios (DR) and Water Pressure Ratings (PR) for PB Drip Irrigation Tubing in Water

Dimension Ratio, DR	Pressure Rating, psi (MPa)			
	73°F	(23°C)	140°F	(60°C)
17	110	(0.77)	75	(0.52)
21	90	(0.63)	60	(0.41)

TABLE 3 Inside Diameter, Wall Thicknesses, and Tolerances for PB 21 Plastic Thin-Wall ½ in. Nominal Size Tubing^A

	DR 17		DR 21	
	Minimum	Tolerance	Minimum	Tolerance
Inside diameter, in.	0.580	±0.006	0.580	±0.006
Wall thickness, ^B in.	0.035	+0.004	0.028	+0.003

^A All dimensions are in inches (1 in. = 25.4 mm).

^B The minimum is the lowest wall thickness at any cross section. The maximum permitted wall thickness, at any cross section, is the minimum wall thickness plus the stated tolerance. All wall tolerances are on the plus side of the minimum requirement.

shall be within 12 % when measured in accordance with Test Method D 2122.

6.3 *Hydrostatic Sustained Pressure Strength*—Tubing shall meet the minimum hydrostatic sustained pressure strength requirements given in Table 1 when tested in accordance with 7.5.

6.4 *Hydrostatic Burst Pressure*—Tubing shall meet the minimum hydrostatic burst requirements shown in Table 4 when tested in accordance with 7.6.

6.5 *Carbon Black*—The polybutylene tubing extrusion compound shall contain at least 2 % carbon black when tested in accordance with 7.7.

NOTE 2—There is evidence that indicates that type, particle size, and dispersion quality of the carbon black affects the weatherability of the pipe. The problem is being investigated, and when reliable test methods are developed, requirements for weatherability, or other suitable requirements to cover this property, will be included in a revision of this specification.

7. Test Methods

7.1 *Conditioning*—Because of the crystalline transformation that takes place after polybutylene resins are cooled from the melt, it is necessary to delay physical testing until 10 days after tubing extrusion. Alternatively, conditioning may be accelerated in accordance with Practice F 699. During the 10-day period the tubing should be stored at temperatures between 40 and 100°F (4 and 38°C). The test specimens should be taken after 8 days and conditioned at 23 ± 2°C (70 to 77°F) and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Practice D 618, for those tests where conditioning is required.

7.1.1 *Quality-Control Test Conditioning*—Condition the test specimens at 73 ± 4°F (23 ± 2°C) for 4 h in air or 1 h in water.

7.2 *Test Conditions*—Conduct the tests in the standard laboratory atmosphere of 73 ± 4°F (23 ± 2°C) and 50 ± 5 % relative humidity, unless otherwise specified in the test methods or in this specification.

7.3 *Sampling*—The selection of the sample or samples of

TABLE 4 Minimum Hydrostatic Burst Strength Requirements for PB Drip Irrigation Tubing in Water

Dimension Ratio, DR	Required Pressure, psi (MPa)			
	73°F	(23°C) ^A	140°F	(60°C) ^B
17	240	(1.66)	165	(1.14)
21	200	(1.38)	135	(0.93)

^A The fiber stress used to derive the test pressure at this temperature is 2200 psi (15.2 MPa).

^B The fiber stress used to derive the test pressure at this temperature is 1500 psi (10.4 MPa).